Journal of Obstetrics, Gynecology and Cancer Research | ISSN: 2476-5848

The Application of Multiplex Real-Time PCR to Detect High-Risk HPV in Iraqi Population

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Article Info

10.30699/jogcr.10.6.444

Received: 2024/01/16;
Accepted: 2024/03/10;
Published Online: 05 May 2025;

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ABSTRACT

Background & Objective: Cervical cancer stands as the leading cause of cancer-related fatalities, worldwide. Cervical cancer is unequivocally attributed to the human papillomavirus (HPV) infection, which is both essential and adequate for its development. The particular prevalence of HPV in the population of Iraq is currently unclear. The present study was to examine the application of multiplex real-time PCR to detect high-risk HPV in the Iraqi population.

Materials & Methods: This study was conducted on a total of 300 women with cervical anomalies, who were referred to the Gynecological Oncology Departments in multiple hospitals in Babylon and Baghdad from November 2022 to December 2023. The cervical swabs of the samples were collected. Real-time polymerase chain reaction was utilized to conduct HPV DNA testing on all specimens.

Results: The average age of the participants was 30 years. The overall prevalence of High-risk HPV was 16.7%. The age group of women between 30 and 40 years exhibited the highest overall prevalence of HPV. There was a higher prevalence of genotyping for HPV 16, 18, and 31.

Conclusion: The multiplex real-time PCR has numerous advantages, including HPV detection and genotyping to known prevalent genotypes as well as cost effective and no time consuming.

Keywords: Carcinoma, Cervical Cancer, HPV, Oropharyngeal Malignancies, STDs

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1. Introduction

One of the most prevalent sexually transmitted diseases (STDs), human papillomavirus (HPV) is a leading cause of malignancies of cervical, vaginal, vulvar, anal, penile, and oropharyngeal regions **(1, 2)**. A highly contagious human infection, Human Papillomavirus (HPV) is often spread from one person to another through sexual contact. Hyperplastic lesions can occasionally form as a result of keratinized and mucosal epithelial tissue being invaded and reproduced by DNA viruses known as HPVs **(3)**.

HPV is comprised of two types of genes, namely early genes and late genes **(3)**, which perform several functions, such as regulating the reproductive process, assembling viruses, and contributing to the development of tumors or malignant lesions **(4)**.

Approximately 99% of cervical malignancies worldwide are associated with HPV infection **(5)**. The predominant high-risk HPV genotypes, such as HPV-18 and HPV-16, are frequently accountable for the development of cervical and urogenital cancers **(6)**. HPV is responsible for almost 5% of all malignancies, including cervical cancers and oropharyngeal malignancies **(1, 7-9)**.

To detect high-risk HPV, healthcare providers typically perform an HPV test, which detects the presence of human papillomavirus strains associated with cervical cancer **(10, 11)**. The HPV test is crucial for detecting high-risk HPV strains that can lead to cervical cancer. It is often conducted alongside a Pap smear for early detection and monitoring of abnormal cervical cells **(12, 13)**.

Individuals with a cervix, including women and transgender men, are recommended to undergo HPV testing. Those with abnormal Pap smear results, HIV,

weakened immune systems, a history of cervical cancer, or exposure to certain factors may need more frequent screenings **(14, 15)**. Recommendations vary by age and health status. For individuals aged 21 to 29 years, screening every three years with a Pap smear is recommended. For those aged 30 to 65 years, suggestions include screening every three years with a Pap smear alone, every five years with an HPV test alone, or every five years with both tests **(16, 17)**.

A negative result indicates no high-risk HPV found, while a positive result means that signs of high-risk HPV were detected. Positive results do not mean cancer but suggest an increased risk for cervical cancer and the need for close monitoring and potential further testing or treatment **(18)**. HPV testing is essential for early detection and monitoring but does not directly diagnose cancer; it helps assess the risk of developing cervical cancer based on the presence of high-risk HPV strains **(19, 20)**.

Despite the relatively low incidence of cervical cancer in developed countries with well-established screening programs, it continues to be one of the major causes of cancer-related mortality among women over the world. HPV-associated oropharyngeal cancer is one of the five types of cancer in the USA that has increased since 1975. Currently, it is more common than cervical cancer and is the leading site for HPV-related cancer **(21-25)**. Two late proteins, L1 and L2, and six early proteins (E1, E2, E4, E5, E6, and E7) are present in the HPV genome. However, it has been established that the E6 and E7 viral proteins play a critical role in the development and maintenance of cervical carcinoma associated with HPV **(26)**.

HPV oncoproteins, including E6, function by attaching to the p53 protein, which then leads to destruction through proteasomes **(27)**. Screening for HPV detection is crucial to minimize the impact of cervical cancer and other disorders associated with HPV. The present study was conducted with aim to determine the prevalence of HPV among a specific group of Iraqi women and to identify any genotypes more commonly seen in this population.

2. Materials and Methods

This study was conducted on women with cervical anomalies, who were referred to the Gynecological Oncology Departments in multiple hospitals in Babylon and Baghdad from November 2022 to December 2023. Cervical swabs from 300 women with cervical anomalies were collected by a gynecologist. The age ranged between **(20-60)** years. Women were asked to complete a structured questionnaire with various clinical characteristics. Pregnant women, patients receiving therapy, and those undergoing total cervical resection were excluded from the study.

2.1. DNA extraction

DNA was extracted and purified from cervical swabs using a DNA-Sorb-A kit. This method is followed as directed by the manufacturer. Other researchers have utilized this kit in comparable work **(28)**.

2.2. HPV high-risk typing kit

HPV high-risk typing kit from Sacase (Italy) was used for qualitative detection and genotyping of forty oncogenic human papillomaviruses (16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59, 66 and 68). The kit detects HPV DNA with a sensitivity of not less than 1000 copies/ml.

2.3. Multiplex HPV DNA amplification

The qualitative detection and typing of genital hr HPV genotypes in cervical specimens was performed using an HPV high risk typing kit from Sacase (Italy) and a specific set of primers for multiplex amplification of HPV-DNA.

3. Results

The mean age of the participants was 36.9 years (20-60 years). The results showed that 2 % of patients were less than 20 years, 28% were between 21-30 years, 44% between 31-40 years, 22% between 41-50 years, and 4% between 51-60 years (Table 1). This indicates that women between 31-40 years were at a higher risk to develop HPV associated cervical abnormalities compared to women at younger ages, which may be due to the decreased ability of older women to clear newly acquired HPV infections, reactivation of latent infections, or immune senescence.

Detection and genotyping of high-risk HPVs

The presence of high-risk HPV types (16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59, 66, and 68) was identified using multiplex PCR. The results showed that 16.7% of the cases had detectable high-risk HPV-DNA, whereas the remaining women with atypical cervix tested negative for HPV, as indicated in Table 2.

High-risk HPV genotype frequency in women infected with HPV genotype

Genotyping of the oncogenic HPV showed eleven cases to each 18, 16 and 31 (22% for each one) and nine case of HPV-45 (18%), eight cases of HPV-68 (16%), six cases for both the HPV- 66 and HPV-51(12%), five cases for HPV -39 (10%), four cases for HPV-33 (8%) and three cases for HPV- 56 (6%). But HPV- 59, 35, 58 and 52 genotypes were absent (Table 3).

Multiple high-risk HPV infections

The prevalence of multiple oncogenic genital HPV infections was 40% among local patients while single infection was 60%; thirty cases had double HPV types, four cases with triple HPV genotypes and three genotypes with quartile HPV genotypes (Table 4).

Table 1. Age distribution of study groups including patients and healthy controls

age (Years)	Result		Total	*P.* value
	Negative	Positive		
20 - 30	63	15	78	0.464
	25.2%	30%	26.1%	
31 - 40	93	22	115	
	37.2%	44.0%	38.3%	
41 - 50	64	11	75	
	25.6%	22.0%	25.0%	
51-60	30	2	32	
	12.0%	4.0%	10.7%	
Total	250	50	300	
	100.0%	100.0%	100.0%	

Table 2. Detection of high-risk HPV-DNA among the study population

result		N	Mean	Std. Deviation	Std. Error Mean	*P.* value
Age	**Negative**	250	37.20	9.698	0.613	0.280
	Positive	50	35.84	7.739	1.094	
Total		300	36.98	9.402	0.543	

Table 3. Distribution of high-risk HPV genotypes among women infected with HPV

Genotypes	Frequency for each genotype	Percent %
18, 16, 31	11	22
45	9	18
68	8	16
66, 51	6	12
39	5	10
33	4	8
56	3	6
52, 59, 35, 58	0	0

Table 4. Frequency of single and multiple high-risk HPV infection

Type of infection	Frequency (n)	Percentage (%)
Single infection	30	60
double-infection	13	26
Trible-infection	4	8
Quartile-infection	3	6
Total	50	100

4. Discussion

HPV is responsible for the development of anal, cervical, vaginal and vulvar cancers. Head and neck cancers are often caused by tobacco and alcohol usage, but recently the number of HPV-induced HNSCC cases has risen; it is estimated that it will account for more oropharyngeal cancers than cervical cancers **(29, 30)**. HPV is now well-known to be a causative agent of cervical intraepithelial neoplasia and cervical cancer **(31)**.

The real time amplification (RTA) test is used to qualitatively detect and genotype Human Papillomavirus in urogenital swabs and biopsies. Other research **(32)** employed similar methodologies that produced equivalent outcomes.

PCR-based technologies exceed other techniques in relation of sensitivity and specificity. These technologies are less expensive than commercially accessible signal amplification-based methods and bead array-based methods **(33)**. The identification of HPV-DNA in clinical samples has been accomplished by the development of various multiplex PCR methods **(34, 35)**. In research, ten different HPV strains were studied in two discrete tubes by using three fluorophores. More better-quality multiplex PCR-based technologies have newly been developed for the multiplex diagnosis of HPV, and some of these are commercially available **(33)**. A new method for real-time multiplex PCR with TaqMan probes was recently revealed **(35)**. This method can detect and identify fifteen distinct forms of HPV in just five tubes.

The prevalence of HPV among Iraqi women was low (16.7%), which was consistent with previous research in Iraq **(36)** (12.38%). The Islamic ethics and moral commitment of the Iraqi people may explain the low prevalence of HPV and other sexually transmitted illnesses when compared to developed countries as well as low screening medical centers.

The women's ages were classified into four categories: 20-30, 31-40, 41-50, and 51-60 years. 44% of the women in the study belonged to the age range of 31 to 40 years old. However, there was no significant variation in the age distribution among the different groups of women. The findings is consistent with the results of other studies **(37)**, which demonstrate that HPV infection can occur in women who are sexually active regardless of their age. Women between the ages of 31 and 40 years had the highest occurrence rate. Our explanation for the high incidence of infection in this age group is that the average age of marriage in our study population was 25 years, so the female needs more time to be exposed to the virus, so most infections appeared in the 31 to 40 years group. The findings contradicted with those published by previous research **(38)**, who found that aging is a risk factor for chronic infection. In this study, the persistence rate of high-risk infections was 50% in women over the age of 40 years, compared to 20% in women under the age of 25 years.

In the present investigation, HPV16, 18, and 31 were the most common (22% for each). This finding is consistent with research (39) in which HPV 16 was the most potent carcinogen, accounting for 55 to 60% of cervical malignancies worldwide. The second most carcinogenic HPV is HPV-18 that causes 10-15% of cervical cancer. Various variables, like smoking, being immunocompromised, or having HIV, can increase the likelihood of CIN development and the duration of HPV infection **(39, 40)**.

Similar findings revealed a predominance of high-risk HPV-16 among Iraqi women **(41, 42)**. Another study found that the most common genotype in Iraq was HPV-33 **(36)**. Previous investigations on the incidence of HPV genotypes in cervical cancer have consistently shown that the highly carcinogenic HPV-16 was the most prevalent type discovered in various studies from diverse global areas **(36, 43)**. In general, the rates of HPV infection vary dramatically between geographic locations and population clusters, particularly in Middle Eastern nations **(44, 45)**. These disparities in the prevalence of carcinogenic HPV genotypes can be attributed to a variety of factors, including the source and type of studied sample (fresh tissue, paraffin embedded, or exfoliated cells, which may differ in viral loads and sampling accuracy), design of oligonucleotide sequences **(32)**, use of different techniques, and, most importantly, prevalence of specific genotypes in a given region.

The prevalence of double HPV infections was 26%, triple infection was 8% and quartile infection was 6% among patients in the present study. The impact of numerous HPV genotypes on cervical diseases remains controversial and poorly understood. Several studies have found that combined HPV infections can provide a high risk for severe cervical lesions. Furthermore, it has been found that co-infection with various HPV genotypes is linearly associated to the severity of cervical intraepithelial neoplasia and operates synergistically in cervical carcinogenesis **(46)**. In contrast, a study discovered that numerous infections of HPV had not a synergistic or cumulative impact on the development of cervical disease outcomes or increased risk for a higher grade of the cervical lesion compared to their single-genotype infection counterparts **(42)**. However, another research **(47)** indicated the existence of competitive and/or cooperative interactions among specific HPV genotypes. It was found that co-infection with the same HPV genotypes reduced the likelihood of progression to a higher grade of a cervical lesion in HPV-positive women, whereas co-infection with different HPV genotypes increased the risk of progression to a higher grade of CIN **(48)**.

To effectively combat HPV, it's important to understand that while there is no cure for existing HPV infections, there are steps you can take to support your immune system in fighting the virus. Strengthening your immune system is crucial in fighting HPV. Lifestyle changes like quitting smoking, reducing stress, eating a healthy diet, maintaining an ideal weight, getting enough sleep, and being physically active can help enhance your body's ability to combat infections like HPV. The HPV vaccine is not a cure for existing infections but is highly effective in preventing future infections of high-risk HPV types that can lead to cancer. HPV vaccine is recommended for individuals to reduce the risk of contracting HPV strains associated with cancer. If HPV causes symptoms like genital warts or abnormal cell changes that could lead to cancer, various treatments are available, including cryotherapy, conization, laser therapy, loop electrosurgical excision procedure (LEEP), and prescription creams for genital warts. Regular cervical screenings are essential for early detection of any abnormal cell changes caused by high-risk HPV. Early detection through screenings allows for timely treatment and improves outcomes. While there is ongoing research into developing a cure for HPV, focusing on lifestyle changes to support your immune system and utilizing available preventive measures like the HPV vaccine are the key strategies to manage and reduce the impact of HPV infections **(49-51)**.

5. Conclusion

The real-time PCR approach has numerous advantages, including HPV detection and genotyping to known prevalent genotypes as well as cost effective and no time consuming. Women between 31-40 years were at a higher risk to develop HPV associated cervical abnormalities more than younger ages, which may be due to the decreased ability of older women to clear newly acquired HPV infections, reactivation of latent infections, or immune senescence.

6. Declarations

Acknowledgments

None.

Ethical Considerations

Not applicable.

Authors' Contributions

The authors have been involved in drafting the manuscript. All authors read and approved the final manuscript.

Conflict of Interest

The authors declare no conflict of interest.

Fund or Financial Support

This research received no specific grant from any funding agency in the public, commercial, or not for profit sector.

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How to Cite This Article:

D. Marhash, A., S. Abdul-Razaq, M., AL-Jeborry, M. M., Jasim, W., Khaleel Khalaf, S. The Application of Multiplex Real-Time PCR to Detect High-Risk HPV in Iraqi Population. J Obstet Gynecol Cancer Res. 2025;10(6):444-51.

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