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Systematic Review

Prevalence of Oral Human Papillomavirus (HPV) in Patients with Genital HPV Infections: A Systematic Review and Meta-analysis

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Abstract

Background and aims: The relationship between oral-genital infections caused by human papillomavirus (HPV) in men and women is not well studied. This systematic review and meta-analysis aimed to determine the prevalence of concurrent and concordant oral-genital HPV infection.

Methods: This systematic review and meta-analysis was conducted by selecting 89 articles from PubMed, Scopus, and Web of Science databases, exclusively searching for English studies published in international journals up to June 2023. The study summarized the percentages of concurrent (presence of any HPV in both oral and genital sites) and concordant (presence of the same types of HPV in both oral and genital sites) oral-genital HPV infections. The quality of these studies was evaluated using the Quality Assessment Tool for Quantitative Studies (QATQS). Moreover, meta-analysis was done using comprehensive meta-analysis (CMA) software with a random-effects method at a significant level of 0.05.

Results: The meta-analysis incorporated a total of 86 articles. Based on QATQS, 83% of these studies achieved 'Moderate' ratings. The overall prevalence of concurrent oral-genital HPV infection was 15.5% (95% CI: 11.2–21) in women and 14% (95% CI: 8–23.3) in men. The concordance rate was 41.9% (95% CI: 33.8–50.5) in women and 32.2% (95% CI: 11–64.7) in men. Additionally, the prevalence of genital and oral HPV infections was 61% (95% CI: 21.3–90.6) and 9.5% (95% CI: 7.7–11.7), respectively.

Conclusion: This meta-analysis showed that the high prevalence of genital HPV and oral-genital HPV can be a reason for the possibility of self-contamination.

Keywords: Human papillomavirus, Oral, Genital, Infection, Prevalence, Systematic review, Meta-analysis

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Introduction

Human papillomavirus (HPV) is the most common sexually transmitted infection worldwide,[1] with more than 80% of sexually active men and women estimated to experience HPV infection at least once during their lifetime.[2] HPV, a double-stranded circular DNA virus in the Papillomaviridae family has over 100 HPV-identified genotypes, 40 of which are associated with human reproductive tract, mouth, and throat infections. Due to the uncontrolled proliferation of squamous epithelia within the mucosa.[3] These genotypes can be categorized as either high-risk (HR) HPV or low-risk (LR) HPV types depending on their potential to cause cancer.[4-6] LR-HPV may lead to warts on or around the genitals, anus, mouth, or throat, while HR-HP with no symptoms can cause various cancers depending on the site of infection, including anal, cervical, oropharyngeal, penile, vaginal, and vulvar cancers.[7-9] In nearly all cases of cervical cancer, DNA sequences from HR-HPV types are detected. Cervical cancer ranks as the second most prevalent cancer among women globally, resulting in over 340 000 women deaths annually.[10] Moreover, at least 90% of oral squamous cell carcinoma (OSCC) cases that tested positive for HPV are related to the HR-HPV type 16.[11] OSCC is the predominant type of oral cancer, accounting for 80%-90% of all malignant growths in the oral cavity.[12] Genital HPV infection primarily spread through vaginal sex, while the oral HPV types associated with head and neck cancers are transmitted primarily through oral sex.[13-15] "Dual-site infections" are defined as any HPV infections occurring in both the oral cavity/oropharynx and cervix.[16] "Concurrency" refers to the existence of an HPV infection in both genital and oral sites, regardless of whether the HPV type is the same or not. "Concordance" refers to the existence of the identical type of HPV in both genital and oral sites, identified synchronously or asynchronously.[17,18] A meta-analysis estimated the concordance rate of HPV infections in both oral and cervical areas at 27%, based on the results of 10 studies.[19] Another study, reviewing the results of 114 studies, found the average

infection rate in oral and cervical areas to be 16%. Among women with infections in both areas, the incidence rate of the same type of HPV (oral-cervical concordance) was reported at 41%.[16] Although the incidence of HPV-related oropharyngeal cancers is higher in men than in women,[20] no studies have specifically addressed the concordance of genital and oral HPV in men. Therefore, it is essential to include studies containing data on both male and female participants or studies that only focus on the concurrence of male oral-genital HPV infections. The dual-site (presence in both oral and genital) and bi-sexual (incidence in men and women) nature of HPV provides a complex perspective for understanding the epidemiology and pathogenesis of the virus, potentially contributing to a better understanding of HPV transmission. As such, the current study presented a comprehensive analysis of the existing literature on the co-occurrence of genital and oral HPV infections in both genders and examined the prevalence of the infection in different continents.

Materials and Methods

Search Strategy and Information Sources

This systematic review was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines. A comprehensive search was conducted in three databases, including PubMed/MEDLINE, Scopus, and Web of Science, using the following keywords up to June 2023: "Human papillomavirus", "oral", "genital" and "infection" or "lesion". AND, OR, and MeSH terms were also used to improve the search results. Furthermore, a manual search of reputable scientific journals was performed to find relevant full-text articles. The search strategy used in PubMed is presented in Table S1 (See Supplementary file 1).

Screening and Selection of Studies

All retrieved articles were entered into Endnote 20 software. After removing duplicates, studies were screened by title and abstract. The process of identifying duplicate articles was conducted in two phases. In the first phase, EndNote was used to detect duplicates. In the second phase, each title was manually reviewed for duplication. Then, their eligibility was verified by examining the full text. Articles that evaluated dual-site HPV infections (oral and genital) in patients with genital HPV infection were included in the analysis.

Inclusion and Exclusion Criteria

The review included all observational studies published in English addressing dual-site HPV infection in patients with genital HPV infection. Review studies, case reports or case series, letters to editors, commentaries, and reports were excluded.

Data Collection Tools and Methods

The prepared checklist was used to extract the data, and information extracted from each study included publication year, country of study, sample size, gender of participants, type of study, method of HPV detection, and methods of collecting oral and genital samples.

Measurement of Outcome Variables

The prevalence of concurrent HPV infections in both oral and genital sites was the primary outcome variable of this study. Concurrent infection refers to the presence of HPV in both genital and oral sites, regardless of the HPV type. The secondary outcome variable was the prevalence of HPV-type concordance, which refers to the presence of an identical type of HPV in both genital and oral sites. Two other outcome variables were the prevalence of oral and genital HPV infections.

Risk of Bias (Quality) Assessment

The quality of the articles in this systematic review was evaluated using the Quality Assessment Tool for Quantitative Studies (QATQS) from the Effective Public Health Practice Project criteria, as described by Thomas et al.[21] This assessment tool examines various factors such as study design, analysis, withdrawals and dropouts, data collection practices, selection bias, invention integrity, and blinding as part of a controlled trial confounders.[21] This review assessed all these factors for the included studies, excluding blinding, because all the studies were observational and we did not include any experimental or randomized clinical trials. Each aspect was evaluated based on specific criteria and assigned a strong, moderate, or weak rating. Studies that received only moderate and/or strong ratings for all aspects were considered "strong" studies. Those with one weak rating were considered "moderate" studies, while studies with more than one weak rating were labeled "weak" studies.[21]

Data Analyses

Meta-analysis was performed by comprehensive meta-analysis (CMA) software with a random method at a 0.05 significant level. To evaluate statistical heterogeneity, Cochran's Q test was used with a significance level of $P \leq 0.1$) and the I^2 index with a significance level of $\geq 50\%$. A low I^2 value (generally considered to be below 25%) indicates that the studies in the meta-analysis are relatively homogenous, and the observed differences are likely due to sampling error rather than true differences between the studies. On the other hand, a high I^2 value (generally considered to be above 50%) indicates that the studies in the meta-analysis are highly heterogeneous, and the observed differences between the studies are likely due to true differences rather than sampling error.[22] Therefore, we applied a random-effects model for meta-analysis of cases with heterogeneity ($P < 0.1$ and $I^2 > 50\%$) and a fixed-effect model for meta-analysis of cases without heterogeneity ($P > 0.1$ and $I^2 < 50\%$). We also used methods such as subgroup analysis to address heterogeneity across studies. In addition, the Trim and Fill method was used to calculate the adjusted prevalence for items with significant

publication bias.

Reporting Bias Assessment

Publication bias across the studies was assessed and illustrated using Funnel plots with pseudo 95% confidence limits, depicting the effects estimated from individual studies along the horizontal axis.

Results

Selection of Studies and Study Characteristics

After a systematic search, 3030 articles were collected from PubMed, Scopus, and Web of Science databases. After eliminating duplicate articles, 1801 records remained. Of these, 1683 articles were considered irrelevant based on the title review, and 11 more were excluded after abstract assessment. Subsequently, we thoroughly examined the full text of the remaining 107 articles, and ultimately, 89 articles met the inclusion criteria for this study (Figure 1).

Studies Characteristics

This review comprised 77 cross-sectional studies (86%), 7 case-control studies (8%), and 5 cohort studies (6%). The publication dates of these articles ranged from 1992 to 2023. Dual-site HPV infection was examined in 70 articles exclusively involving women, 8 articles only involving men, and 11 articles involving both genders. Various methods were used to collect samples from the genital area, with the most common of which being a combination of methods (29.2%) and swabs (23.6%), while other methods included brush, smear, biopsy, and the like. The predominant methods for sampling the oral area were rinse (31.5%) and a combination of methods (27%). The most common HPV detection method in the articles was the polymerase chain reaction (PCR), used in 82% of studies. Furthermore, 6 studies were conducted in Africa, 32 in America, 7 in Asia, and 42 in Europe. Table 1 summarizes the characteristics of the studies included in the systematic review.

Quality Assessment

Table 2 summarizes the quality assessment results. Among the studies, 8 studies (9%) were classified as strong, 74 studies (83%) as moderate, and 7 (8%) as weak. Studies were categorized as weak if their design was cross-sectional (n = 77, 86%)[17-19, 23-97] and moderate if they were case-control (n = 7, 8%)[71, 98-103] or cohort (n = 5, 6%).[104-108] For selection bias, studies were classified as strong if individuals were randomly chosen from an exhaustive

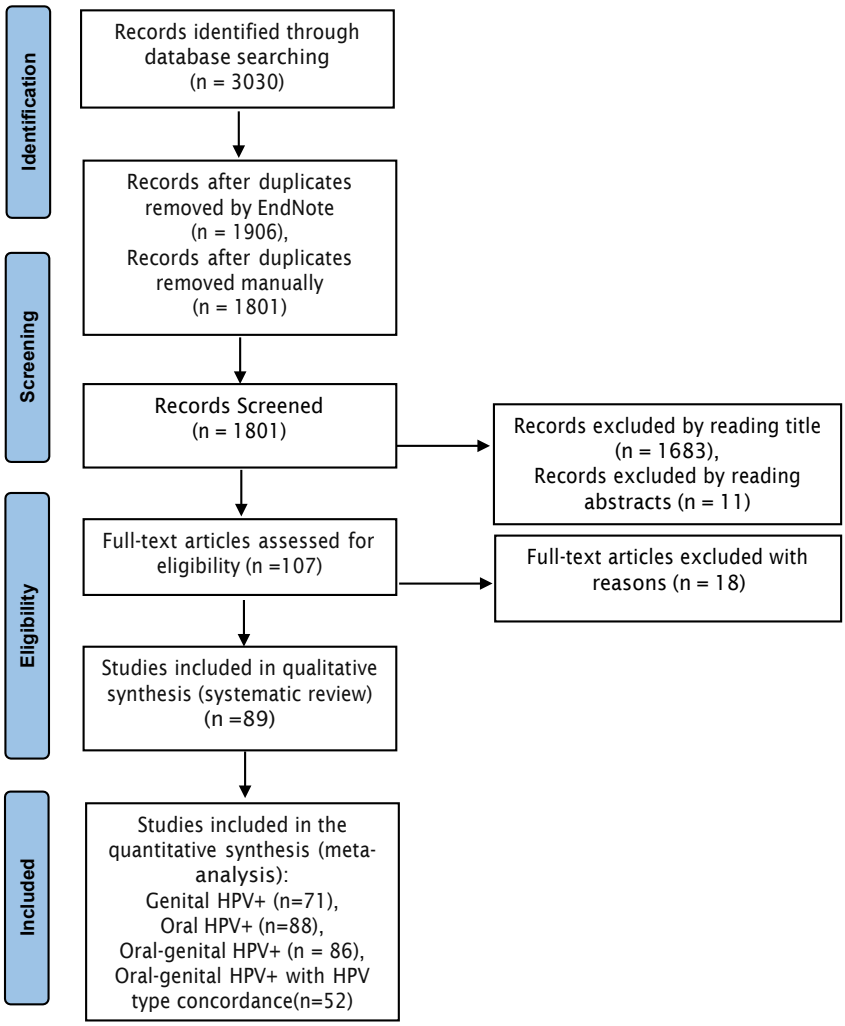

Figure 1. Flow of Information Through the Various Phases of the Systematic Review. *Note.* HPV: Human papillomavirus

Table 1. A Summary of the Characteristics of the Studies Included in the Systematic Review (N = 89)

Author, Year	Country	Sample Size and Gender of Participants	Type of Study	HPV-Detecting Method	Sample Collection Method	
					Genital	Oral
Sonawane et al [23]	US	3232 men with information on oral HPV infection 2954 men with genital HPV infection 2883 men with data on both oral-genital HPV infections	Cross-sectional	PCR	Swab	Rinse
Tewari et al [24]	Ireland	223 women	Cross-sectional	Genital: Reverse hybridization Oral: PCR and reverse hybridization	Biopsy	Rinse
Paaso et al [25]	Finland	21 women	Cross-sectional	PCR	Brush	Brush
Mosmann et al [26]	Argentina	100 women	Cross-sectional	PCR	Brush, swab	Swab, scrape
Custer et al [27]	US	7093 women 3241 men	Cross-sectional	PCR	Swab	Rinse
Suehiro et al [28]	Brazil	254 women	Cross-sectional	PCR and Multiplex Kit	Brush, spatula	Brush, rinse
Sánchez-Siles et al [98]	Spain	100 women	Case-Control	PCR	Not specified	Rinse
Perez Quintanilla et al [29]	Mexico	174 women	Cross-sectional	PCR and reverse hybridization	Brush	Brush
Nemesio et al [30]	Brazil	406 women	Cross-sectional	PCR	Cytology, colposcopy, biopsy	Rinse
Gilles et al [31]	Belgium	44 women	Cross-sectional	PCR	Smear	Rinse
Sehnal et al [32]	Czech Republic	718 women	Cross-sectional	Linear array	Brush	Rinse
Le et al [17]	Japan	210 men	Cross-sectional	PCR	Swab	Rinse
Kiwerska et al [33]	Poland	197 women 197 male partners	Cross-sectional	PCR	Brush	Swab
Enerly et al [34]	Norway	312 women	Cross-sectional	PCR and type-specific hybridization	Brush	Swab
Eggersmann et al [35]	Germany	221 women 157 sexual partners	Cross-sectional	PCR	Smear, brush	Smear, rinse, brush
Christensen et al [99]	Denmark	417 women	Case-control	PCR	N/A	Tumor specimens
Brouwer et al [36]	US	10776 women and 1757 men with genital samples 7102 women and 6878 men with oral samples	Cross-sectional	PCR	Swab	Rinse
Tuominen et al [37]	Finland	39 women	Cross-sectional	PCR	Scrape	Scrape
Tsikis et al [38]	Greece	294 men	Cross-sectional	PCR	Swab, brush	Rinse, brush
Thorsteinsson [39]	Denmark	214 women	Cross-sectional	PCR	Swab, brush	Swab, brush
Rietbergen et al [40]	Netherlands	308 women	Cross-sectional	PCR	Pap smear	Biopsy
Grimm et al [41]	Germany	73 women	Cross-sectional	Linear array and "Papillo Check"	Swab, brush	Swab, scrape, brush
Cossellu et al [42]	Italy	44 women	Cross-sectional	PCR	Swab	Swab, brush, rinse
Woelber et al [43]	Germany	235 women	Cross-sectional	PCR	Swab	Scrape
Sonawane et al [44]	US	4641 women 4493 men	Cross-sectional	PCR	Swab	Rinse
Patel et al [45]	US	1683 men	Cross-sectional	Linear array	Swab	Rinse
Oliviera et al., 2017 [46]	Brazil	76 women	Cross-sectional	PCR	Scrape	Scrape, brush
Nunes et al [47]	Brazil, Mexico, US	717 men	Cross-sectional	PCR	Swab	Rinse
Lupato et al [48]	Italy	253 women 247 men	Cross-sectional	Not specified	Self-report from Pap smear	Rinse
Beachler et al [104]	Costa Rica	350 women	Cohort	PCR	Not specified	Rinse
Visalli et al [100]	Italy	125 women	Case-Control	PCR	Medical record	Rinse
Vanya et al [49]	Brazil	43 women 22 male partners	Cross-sectional	PCR	Pap smear	Brush

Table 1. Continued.

Author, Year	Country	Sample Size and Gender of Participants	Type of Study	HPV-Detecting Method	Sample Collection Method	
					Genital	Oral
Uken et al [50]	Germany	101 women 60 male partners	Cross-sectional	PCR	Brush	Brush
Temizkan et al [101]	Turkey	98 women	Case-Control	None (cytology)	Smear, biopsy, colposcopy	Swab, brush
Menezes et al [105]	India	50 women	Cohort	PCR	Swab	Swab
Loverro et al [51]	Italy	35 transgendered individuals (14 female to male, 21 male to female)	Cross-sectional	Linear array	Brush	Brush
Kero et al [106]	Finland	131 women 131 male partners	Cohort	PCR	Brush, scrape	Brush, scrape
Kedarisetty et al [18]	US	3463 women	Cross-sectional	Cervical: Linear array and "Digene HC2 HPV DNA" test Oral: PCR	Swab	Rinse
Tatar et al [52]	Hungary	149 women 60 male partners	Cross-sectional	PCR	Not Specified	Rinse, brush
Skoczynski et al [53]	Poland	152 women	Cross-sectional	PCR	Brush, Swab	Swab
Marques et al [54]	Brazil	43 women 22 male partners	Cross-sectional	PCR	Self-report from Pap Smear, colposcopy	Brush
Liu et al [55]	China	2228 men	Cross-sectional	PCR	Swab	Swab
King et al [56]	UK	151 men	Cross-sectional	PCR	Swab	Rinse
Grun et al [57]	Sweden	211 women 87 men	Cross-sectional	PCR	Swab	Rinse
Brouwer et al [58]	US	10407 women with genital samples 5236 women and 5264 men with oral samples	Cross-sectional	Genital: Linear array and multiplex assay Oral: PCR	Swab	Rinse
Vidotti et al [59]	Brazil	N=105 women	Cross-sectional	PCR	Brush	Brush
Steinau et al [60]	US	1812 women	Cross-sectional	Linear array	Swab	Rinse
Meyer et al [61]	Germany	129 women 15 male partners	Cross-sectional	PCR	Smear, brush	Smear, rinse
Louvanto et al [102]	Finland	95 women	Case-control	PCR	Scrape, brush	Scrape, brush
Lima et al [62]	Brazil	200 women	Cross-sectional	"Digene HC2 HPV DNA" test	Brush	Scrape, brush
Kofoed et al [63]	Denmark	58 women 124 men	Cross-sectional	PCR	Brush	Rinse
Beder Ribeiro et al [64]	Brazil	31 men 31 female partners	Cross-sectional	PCR	Swab, brush	Swab, brush
Vogt et al [65]	South Africa	34 women 34 male partners	Cross-sectional	PCR	Swab	Rinse
Videla et al [66]	Spain	733 men	Cross-sectional	PCR	Swab	Brush, rinse
Schlecht et al [67]	US	97 women	Cross-sectional	PCR	Brush	Rinse
Lang Kuhs et al [68]	Costa Rica	5838 women	Cross-sectional	PCR	Exfoliation	Rinse
Adamopoulou et al [69]	Greece	43 women	Cross-sectional	PCR and nested PCR	Scrape	Rinse
Zonta et al [70]	Brazil	409 women	Cross-sectional	PCR	Brush	Brush
Elasbali et al [71]	Sudan	50 women	Case-Control	PCR	Scrape	Scrape
Du et al [72]	Sweden	408 women 82 men	Cross-sectional	PCR	Swab	Rinse
Termine et al [19]	Italy	100 women	Cross-sectional	PCR	Not specified	Exam, rinse
Sayyah-Melli et al [73]	Iran	104 women	Cross-sectional	PCR	Not specified	Not specified
Ragin et al [74]	US	118 women	Cross-sectional	Linear array	Brush, Pap smear	Brush, rinse
Peixoto et al [75]	Brazil	100 women	Cross-sectional	PCR	Histology	Swab, scrape, brush, biopsy
Paaso et al [107]	Finland	323 women	Cohort	Multiplex kit	Scrape	Scrape
Matsushita et al [76]	Japan	196 women	Cross-sectional	PCR	Scrape, smear	Scrape

Table 1. Continued.

Author, Year	Country	Sample Size and Gender of Participants	Type of Study	HPV-Detecting Method	Sample Collection Method	
					Genital	Oral
Crawford et al [77]	UK	100 women	Cross-sectional	PCR	Swab, brush	Swab
Brown et al [78]	Peru	184 women	Cross-sectional	PCR	Not specified	Rinse
Sánchez-Vargas et al [79]	Mexico	46 women	Cross-sectional	PCR	Not specified	Swab
Saini et al [80]	Malaysia	70 women	Cross-sectional	"Digene HC2 HPV DNA" test	Not specified	Swab, brush
Xavier et al [81]	Brazil	30 men	Cross-sectional	PCR and reverse hybridization	Biopsy	Exam, biopsy, scrape
Termine et al [82]	Italy	140 women	Cross-sectional	PCR	Spatula, brush	Brush
Castro et al [83]	Brazil	30 women	Cross-sectional	PCR	Colposcopy, biopsy	Brush
Richter et al [84]	South Africa	30 women	Cross-sectional	Linear array	Examination, Pap smear	Brush
Marais et al [85]	South Africa	115 women	Cross-sectional	Linear array	Swab	Swab
Ragin et al [86]	Tobago	212 women	Cross-sectional	Linear array, nested PCR	Brush	Rinse
Passmore et al [87]	South Africa	103 women	Cross-sectional	Linear array	Swab	Swab
Nordin et al [88]	Not Specified (Swedish Author Group)	30 women	Cross-sectional	PCR	Brush	Swab
Giraldo et al [103]	Brazil	140 women	Case-Control	PCR	Histopathological examination, colposcopy	Scrape, swab
Fakhry et al [89]	US	221 women	Cross-sectional	PCR	Rinse	Rinse
Smith et al [90]	US	577 women	Cross-sectional	PCR	Pap Smear, swab	Rinse
Canadas et al [91]	Spain	188 women	Cross-sectional	PCR	Exfoliation	Not specified
Marais et al [92]	South Africa	81 women	Cross-sectional	PCR and ELISA	Swab, brush, biopsy	Swab
Premoli De Percoco et al [93]	Not Specified (Venezuelan Author Group)	50 women	Cross-sectional	Non-radioactive DNA probes	Swab	Biopsy
Badaracco et al [94]	Italy	29 women	Cross-sectional	PCR	Spatula (cervix), swab (vulva-vaginal)	Swab
van Doornum et al [108]	Netherlands	162 women 85 men	Cohort	PCR	Spatula, swab, exam, colposcopy	Spatula
van Doornum et al [95]	Netherlands	111 women 65 men	Cross-sectional	PCR	Spatula, swab, exam, colposcopy	Spatula, swab
Panici et al [96]	Italy	66 women 35 men	Cross-sectional	Hybridization	Not specified	Swab, biopsy
Kellokoski et al [97]	Finland	334 women	Cross-sectional	Southern blot hybridization and PCR	Biopsy	Biopsy

Note. HPV: Human papillomavirus; PCR: Polymerase chain reaction; ELISA: Enzyme-linked immunosorbent assay; N/A: Not applicable.

roster of the intended population (n = 17, 19%).[18,23,27,36,39,44,45,47,53,55,58,60,68,78,89,99,104] If the participants were referred from a source such as a clinic, studies were classified as moderate (n = 66, 74%),[17,19,24-26,28-33,35,37,38,40-43,46,48-52,54,56,57,59,61-67,69-73,75-77,79-82,84, 85,87,90-92,94-98,100-103,105-108] and they were classified as weak if the participants were self-referred (n = 6, 7%).[34,74,83,86,88,93]

Regarding data collection methods, studies were classified as strong if they reported the sample collection method for both oral and genital samples (n = 75, 84%).[17,18,23-47,49-51,53,55-72,74-77,81-90, 92-95, 97,100,102,103,105-108] In cases where the research did not explicitly mention the sample collection method for one or both oral and genital samples, they were classified as weak. If studies relied on HPV infections reported by individuals, they were classified as moderate (n = 14, 16%).[19,48,52,54,73, 78-80, 91,96,98,99,101,104]

For confounders, the studies were classified as 'strong' if the researchers addressed confounding factors either through the study design (e.g., stratification or matching) or during the data analysis and took steps to control for potential biases.[17-19,23-29, 31, 32,34-40,42-45,47-51,54-56,58-63,65-68,70,71,73-75,77,78,80-83,85-87,89,90,95,96,99-106,108] For the withdrawals and dropouts, only five cohort studies were considered, four of which described the number or reasons for participants

Table 2. A Summary of the Results of Oral and Genital HPV Infections in Studies

Author	Oral-Genital HPV-Positive Patients	Oral-Genital HPV-Positive Patients With HPV-Type Concordance	Oral HPV-Positive Patients	Genital HPV-Positive Patients	QATQS
Sonawane et al [23]	.	Men: n = 50/2883 (1.7%) (Who have data on both oral and genital HPV infections)	Men: n = 208/3232 (6.4%) (Any high-risk HPV)	Men: n = 830/2954 (28%) (Any high-risk HPV)	Moderate
Tewari et al [24]	Women: n = 21/223 (9.4%)	Women: n = 6/21 (28.5%)	Women: n = 22/223 (9.8%)	Women: n = 223/223 (100%)	Moderate
Paaso et al [25]	Women: n = 2/5 (40%)	Women: n = 0/2 (0%)	Women: n = 8/21 (38%)	Women: n = 5/21 (23.8%)	Moderate
Mosmann et al [26]	Women: n = 5/18 (27.7%)	Women: n = 3/5 (60%)	Women: n = 14/100 (14%)	Women: n = 18/100 (18%)	Moderate
Custer et al [27]	Men: n = 109/3040 (3.5%) Women: n = 63/6964 (0.9%)	Men: n = 54/109 (49.5%) Women: n = 39/63 (61.9%)	.	Men: n = 3040/3241 (93.8%) Women: n = 6964/7093 (98.2%)	Moderate
Suehiro et al [28]	Women: n = 15/103 (14.5%)	Women: n = 0/15 (0%)	Women: n = 30/254 (11.8%)	Women: n = 103/254 (40.5%)	Moderate
Sánchez-Siles et al [98]	Women: n = 7/50 (114%)	Women: n = 1/7 (14.2%)	Women: n = 13/100 (13%)	Women: n = 50/100 (50%)	Strong
Perez Quintanilla et al [29]	Women: n = 155/168 (92.2%)	Women: n ≤ 39/155 (Bar graph description)	Women: n = 161/174 (92.5%)	Women: n = 168/174 (96.5%)	Moderate
Nemesio et al [30]	Women: n = 10/251 (3.9%)	Women: n = 9/10 (90%)	Women: n = 16/406 (3.9%)	Women: n = 251/401 (62.6%)	Moderate
Gilles et al [31]	Women: n = 1/11 (9%)	Women: n = 1/1 (100%)	Women: n = 1/36 (2.7%)	Women: n = 11/36 (30.5%)	Moderate
Sehnal et al [32]	Women: n = 6/448 (1.3%)	Women: n = 5/6 (83.3%)	Women: n = 10/438 (2.2%)	Women: n = 448/714 (62.7%)	Moderate
Le et al [17]	Women: n = 5/58 (8.6%)	Women: n = 1/5 (20%)	Men: n = 16/198 (8%)	Men: n = 58/198 (29.3%)	Moderate
Kiwerska et al [33]	Men: n = 45/114 (39.4%) Women: n = 39/197 (19.7%)	Men: n = 20/45 (44.4%) Women: n = 17/39 (43.5%)	Men: n = 56/197 (28.4%) Women: n = 39/197 (19.7%)	Men: n = 114/197 (57.9%) Women: n = 197/197 (100%)	Moderate
Enerly et al [34]	Women: n = 4/122 (3.2%)	Women: n = 2/4 (50%)	Women: n = 4/312 (1.2%)	Women: n = 122/312 (39.1%)	Weak
Eggersmann et al [35]	Sexual Partners: Not Specified Women: n = 1/144 (0.6%)	.	Sexual Partners: n = 1/157 (0.6%) Women: n = 1/221 (0.4%)	Sexual Partners: Not Specified Women: n = 144/221 (65.1%)	Moderate
Christensen et al [99]	Women: n = 42/172 (24.4%)	.	Women: n = 203/417 (48.6%)	Women: n = 172/343 (50.1%)	Strong
Brouwer et al [36]	Data were not specifically reported.	Men: n = 55 Women: n = 66	Men: n = 824/6878 (11.9%) Women: n = 282/7102 (3.9%)	Men: n = 795/1757 (45.2%) Women: n = 2542/10776 (23.6%)	Moderate
Tuominen et al [37]	Women: n = 4/9 (44.4%)	Women: n = 2/4 (50%)	Women: n = 13/39 (33.3%)	Women: n = 9/39 (23%)	Moderate
Tsikis et al [38]	Women: n = 3/67 (4.4%)	Women: n = 0/3 (0%)	Men: n = 11/294 (3.7%)	Men: n = 67/294 (22.8%)	Moderate
Thorsteinsson et al [39]	Women: n = 0 (0%)	N/A	Women: n = 12/214 (5.6%)	Women: n = 108/214 (50.5%)	Moderate
Rietbergen et al [40]	Women: n = 9/16 (56.2%)	.	Women: n = 70/308 (22.7%)	Women: n = 16/224 (7.1%)	Moderate
Grimm et al [41]	Women: n = 3/69 (4.3%)	Women: n = 3/3 (100%)	Women: n = 3/73 (4.1%)	Women: n = 69/73 (94%)	Weak
Cossellu et al [42]	Women: n = 7/36 (19.4%)	Women: n = 1/7 (14.2%)	Women: n = 9/44 (20.4%)	Women: n = 36/43 (83.7%)	Moderate
Woelber et al [43]	Women: n = 6/207 (2.8%)	Women: n = 3/6 (50%)	Women: n = 6/135 (4.4%)	Women: n = 207/223 (92.8%)	Moderate
Sonawane et al [44]	Men: 19.3% Women: 5.1%	.	Men: n = 536/4493 (11.9%) Women: n = 178/4641 (3.8%)	.	Moderate
Patel et al [45]	Women: n = 148/763 (19.3%)	Women: n = 54/148 (36.4%)	Men: n = 189/1683 (11.2%)	Men: n = 763/1683 (45.3%)	Moderate
Oliviera et al [46]	Women: n = 1/7 (14.2%)	Women: n = 0/1 (0%)	Women: n = 4/76 (5.2%)	Women: n = 7/76 (9.2%)	Weak
Nunes et al [47]	Women: n = 181/557 (32.4%)	.	Men: n = 210/717 (29.2%)	Men: n = 557/717 (77.7%)	Moderate

Table 2. Continued.

Author	Oral-Genital HPV-Positive Patients	Oral-Genital HPV-Positive Patients With HPV-Type Concordance	Oral HPV-Positive Patients	Genital HPV-Positive Patients	QATQS
Lupato et al [48]	Women: n = 1/11 (9%)	.	Women: n = 10/253 (3.9%)	Women: n = 11/90 (12.2%)	Moderate
Beachler et al [104]	Women in year 4 of follow-up: n = 47/223 infections (21%)	Women in year 4 of follow-up: n = 31/47 infections (66%)	Women in year 4 of follow-up: n = 82/350 (23.4%) infections	Women in year 4 of follow-up: n = 223/350 infections (63.7%)	Strong
Visalli et al [100]	Women: n = 24/100 (24%)	.	Women: n = 26/125 (20.8%)	Women: n = 100/125 (80%)	Moderate
Vanya et al [49]	Women: n = 1/43 (2.3%)	.	Men: n = 3/22 (13.6%) Women: n = 1/43 (2.3%)	Men: Not specified Women: n = 43/43 (100%)	Moderate
Uken et al [50]	Men: Not Specified Women: n = 3/101 (2.9%)	Men: Not Specified Women: n = 2/3 (66.6%)	Men: n = 3/60 (5%) Women: n = 3/101 (3%)	Men: Not Specified Women: n = 101/101 (100%)	Moderate
Temizkan et al [101]	Women: n = 3/30 (10%)	.	Women: n = 3/98 (3%)	Women: n = 30/98 (30.6%)	Moderate
Menezes et al [105]	Women: n = 4 infections/17 (23.5%)	.	Women at follow-up: n = 5/38 (13.1%)	Women at follow-up: n = 17/41(41.5%)	Strong
Loverro et al [51]	Women: n = 0 (0%)	N/A	Women: n = 0/35 (0%)	Women: n = 3/34 (8.9%)	Moderate
Kero et al [106]	Among 15 concordant couples at baseline: Men: n = 0/3 (0%) Women: n = 2/3 (66.6%)	Among 15 concordant couples at baseline: Men: N/A Women: n = 1/2 (50%)	At baseline: Men: n = 24/131 (18.3%) Women: n = 25/131 (19%)	At baseline: Men: n = 29/128 (22.6%) Women: n = 25/131 (19%)	Moderate
Kedarisetty et al [18]	Women: n = 107/1568 (6.8%)	Women: n = 41/107 (38.3%)	Women: n = 141/3463 (4%)	Women: n = 1568/3463 (45.3%)	Moderate
Tatar et al [52]	Men: n = 3/18 (16.6%) Women: n = 7/33 (21.2%)	Men: n = 3/3 (100%) Women: n = 5/7 (71.4%)	Men: n = 6/34 (17.6%) Women: n = 8/40 (20%)	Men: n = 18/34 (53%) Women: n = 33/40 (82.5%)	Moderate
Skoczynski et al [53]	Women: n = 14/24 (58.3%)	.	Women: n = 19/152 (12.5%)	Women: n = 24/152 (15.8%)	Moderate
Marques et al [54]	Men: Not Specified Women: n = 1/43 (2.3%)	.	Men: n = 3/22 (13.6%) Women: n = 1/43 (2.3%)	Men: Not Specified Women: n = 43/43 (100%)	Moderate
Liu et al [55]	Women: n = 43/376 (11.4%)	Women: n = 27/43 (62.7%)	Men: n = 149/2228 (6.6%)	Men: n = 376/2228 (16.9%)	Moderate
King et al [56]	Women: n = 14/98 (14.2%)	Women: n = 0/14 (0%)	Men: n = 21/151 (13.9%)	Men: n = 98/151 (64.9%)	Moderate
Grun et al [57]	Men: Not Specified Women: n = 4/134 (3%)	.	Men: n = 0/87 (0%) Women: n = 4/200 (2%)	Men: Not Specified Women: n = 134/211 (63.5%)	Moderate
Brouwer et al [58]	Women: n = 116/1791 (6.4%)	Women: n = 45/116 (38.8%)	Men: n = 767/5264 (14.5%) Women: n = 196/5236 (3.7%)	Men: Not Specified Women: n = 1791/10407 (17.2%)	Moderate
Vidotti et al [59]	Women: n = 25/61 (41%)	.	Women: n = 25/105 (23.8%)	Women: n = 61/105 (58%)	Moderate
Steinau et al [60]	Women: n = 55/774 (7%)	Women: n = 4/55 (6.4%)	Women: n = 69/1812 (3.8%)	Women: n = 774/1812 (42.7%)	Moderate
Meyer et al [61]	Women: n = 4/70 (5.7%)	Women: n = 1/4 (25%)	Women: n = 7/129 (5.4%)	Women: n = 70/129 (54.2%)	Moderate
Louvanto et al [102]	Women: n = 13/43 (30.2%)	.	Women: n = 24/94 (25.5%)	Women: n = 43/95	Strong
Lima et al [62]	Women: n = 6/86 (6.9%)	.	Women: n = 13/200 (6.5%)	Women: n = 86/200 (43%)	Moderate
Kofoed et al [63]	Men: n = 15/124 (12%) Women: n = 4/58 (6.9%)	60.9%	Men: n = 15/124 (12%) Women: n = 4/58 (6.8%)	Men: n = 124/124 (100%) Women: n = 58/58 (100%)	Moderate
Beder Ribeiro et al [64]	Men: n = 14/22 (63.6%) Women: n = 12/18 (66.6%)	Men: n = 8/14 (57.1%) Women: n = 7/12 (58.3%)	Men: Not Specified Women: n = 17/31 (54.8%)	Men: n = 22/31 (71%) Women: n = 18/31 (58%)	Moderate
Vogt et al [65]	Men: n = 5/20 (25%) Women: n = 4/31 (12.9%)	Men: n = 3/5 (60%) Women: n = 2/4 (50%)	Men: n = 6/34 (17.6%) Women: n = 4/34 (11.7%)	Men: n = 20/34 (58.8%) Women: n = 31/34 (91.1%)	Moderate

Table 2. Continued.

Author	Oral-Genital HPV-Positive Patients	Oral-Genital HPV-Positive Patients With HPV-Type Concordance	Oral HPV-Positive Patients	Genital HPV-Positive Patients	QATQS
Videla et al [66]	Women: n = 47/52 (90.4%)	.	Women: n = 35/650 (5.3%)	Women: n = 52/733 (7%)	Moderate
Schlecht et al [67]	Women: n = 8/57 (14%)	Women: n = 0/8 (0%)	Women: n = 11/93 (11.8%)	Women: n = 57/96 (59.3%)	Moderate
Lang Kuhs et al [68]	Women: n = 35/1953 (1.8%)	.	Women: n = 101/5838 (1.7%)	Women: n = 1953/5838 (33.4%)	Moderate
Adamopoulou et al [69]	Women: n = 19/26 (73%)	Women: n = 14/19 (73.6%)	Women: n = 19/43 (44.1%)	Women: n = 26/43 (60.4%)	Moderate
Zonta et al [70]	Women: n = 18/27 (66.6%)	Women: n = 1/18 (5.5%)	Women: n = 23/27 (85.1%)	Women: n = 27/409 (6.6%)	Moderate
Elasbali et al [71]	Women: n = 1/40 (2.5%)	.	Women: n = 1/50 (2%)	Women: n = 40/50 (80%)	Moderate
Du et al [72]	Men: Not Specified Women: n = 22/129 (17%)	Men: Not Specified Women: n = 20/22 (90.9%)	Men: n = 8/82 (9.7%) Women: n = 37/401 (9.2%)	Men: Not Specified Women: n = 129/174 (74.1%)	Weak
Termine et al [19]	Women: n = 14/98 (14.2%)	Women: n = 3/14 (21.4%)	Women: n = 14/98 (14.2%)	Women: n = 98/98 (100%)	Moderate
Sayyah-Melli et al [73]	Women: n = 45/65 (69.2%)	.	Women: n = 49/104 (47.1%)	Women: n = 65/104 (62.5%)	Moderate
Ragin et al [74]	Women: n = 5/37 (13.5%)	Women: n = 1/5 (20%)	Women: n = 12/118 (10.1%)	n = 37/110 (33.6%)	Weak
Peixoto et al [75]	Women: n = 81/100 (81%)	.	Women: n = 81/100 (81%)	Women: n = 100/100 (100%)	Moderate
Paaso et al [107]	Women: n = 0 (0%)	N/A	Women: n = 0/316 (0%)	Women at baseline: n = 54 infections/323 (16.7%)	Strong
Matsushita et al [76]	Women: n = 6/103 (5.8%)	Women: n = 2/6 (33.3%)	Women: n = 12/196 (6.1%)	Women: n = 103/196 (52.5%)	Moderate
Crawford et al [77]	Women: n = 88/96 (91.6%)	.	Women: n = 92/100 (92%)	Women: n = 96/100 (96%)	Moderate
Brown et al [78]	Women: n = 10/121 (8.2%)	.	Women: n = 14/184 (7.6%)	Women: n = 121/184 (65.7%)	Moderate
Sánchez-Vargas et al [79]	Women: n = 43/43 (100%)	.	Women: n = 43/43 (100%)	Women: n = 43/43 (100%)	Moderate
Saini et al [80]	Women: n = 4/70 (5.7%)	.	Women: n = 4/70 (5.7%)	Women: n = 70/70 (100%)	Moderate
Xavier et al [81]	Women: n = 1/30 (3.3%)	.	Men: n = 1/30 (3.3%)	Men: n = 30/30 (100%)	Moderate
Termine et al [82]	Women: n = 2/76 (2.6%)	Women: n = 0/2 (0%)	Women: n = 2/140 (1.4%)	Women: n = 76/140 (54.2%)	Moderate
Castro et al [83]	Women: n = 0 (0%)	N/A	Women: n = 0/30 (0%)	Women: n = 17/30 (56.6%)	Moderate
Richter et al [84]	Women: n = 6/29 (20.6%)	Women: n = 3/6 (50%)	Women: n = 6/30 (20%)	Women: n = 29/30 96.6%)	Moderate
Marais et al [85]	Women: n = 25/98 (25.5%)	Women: n = 5/25 (20%)	Women: n = 28/105 (26.6%)	Women: n = 98/109 (89.9%)	Moderate
Ragin et al [86]	Women: n = 7/75 (9.3%)	Women: n = 1/7 (14.3%)	Women: n = 14/212 (6.6%)	Women: n = 75/212 (35.3%)	Weak
Passmore et al [87]	Women: n = 4/92 (4.3%)	Women: n = 4/4 (100%)	Women: n = 22/91 (24.1%)	Women: n = 92/103 (89.3%)	Moderate
Nordin et al [88]	Women: n = 0 (0%)	N/A	Women: n = 0/30 (0%)	Women: n = 2/30 (6.6%)	Weak
Giraldo et al [103]	Women: n = 26/70 (37.1%)	.	Women: n = 29/140 (20.7%)	Women: n = 70/140 (50%)	Strong
Fakhry et al [89]	Women: n = 37/145 (25.5%)	Women: n = 14/37 (37.8%)	Women: n = 43/221 (19.4%)	Women: n = 145/221 (65.6%)	Moderate
Smith et al [90]	Women: n = 6/165 (3.6%)	Women: n = 0/6 (0%)	Women: n = 14/577 (2.4%)	Women: n = 165/577 (28.5%)	Moderate
Canadas et al [91]	Women: n = 7/52 (13.4%)	Women: n = 3/7 (42.8%)	Women: n = 15/188 (7.9%)	Women: n = 52/187 (27.8%)	Moderate
Marais et al [92]	Women: n = 2/81 (2.4%)	Women: n = 0/2 (0%)	Women: n = 2/28 (7.1%)	Women: n = 81/81 (100%)	Moderate

Table 2. Continued.

Author	Oral-Genital HPV-Positive Patients	Oral-Genital HPV-Positive Patients With HPV-Type Concordance	Oral HPV-Positive Patients	Genital HPV-Positive Patients	QATQS
Premoli De Percoco et al [93]	Women: n = 23/28 (82.1%)	Women: n = 23/23 (100%)	Women: n = 35/50 (70%)	Women: n = 28/50 (56%)	Moderate
Badaracco et al [94]	Women: n = 5/10 (50%)	Women: n = 3/5 (60%)	Women: n = 11/29 (37.9%)	Women: n = 10/29 (34.4%)	Moderate
van Doornum et al [108]	Men: n = 0 (0%) Women: n = 0 (0%)	N/A	Baseline: Men: n = 0/85 (0%) Women: n = 0/162 (0%) Follow up: Men: n = 0/48 (0%) Women: n = 1/110 (0.9%)	Baseline: Men: n = 22 infections/85 (25.8%) Women: n = 36 infections/162 (22.2%) Follow up: Men: n = 32/49 infections in 48 men Women: n = 59/99 infections in 110 women	Strong
van Doornum et al [95]	Men: n = 0 (0%) Women: n = 0 (0%)	N/A	Men: n = 0/65 (0%) Women: n = 0/111 (0%)	Men: n = 17/65 (26.1%) Women: n = 24/111 (21.6%)	Moderate
Panici et al [96]	Women: n = 49/101 (48.5%)	.	Women: n = 49/101 (48.5%)	Women: n = 101/101 (100%)	Moderate
Kellokoski et al [97]	Women: n = 14/14 (100%)	Women: n = 2/14 (14.3%)	Women: n = 42/272 (15.4%)	Women: n = 14/272 (5.1%)	Moderate

Note. HPV: Human papillomavirus; QATQS: Quality assessment tool for quantitative studies; N/A: Not applicable.

lost to follow-up (n = 4/5, 80%).[104,105,107,108]

Main Results

Table 2 summarizes the results of each of the 89 studies. Due to high heterogeneity ($P < 0.001$), a random model was used to analyze the data. Heterogeneity tests and funnel plots of studies included in the meta-analysis indicated no publication bias except in studies reporting genital positive among women (Figures 2 and 3). Moreover, due to insufficient data or heterogeneous results, several articles for each variable were excluded from the meta-analysis. Specifically, 88 articles reported the prevalence of genital HPV infection, and 71 out of 88 articles were included in the meta-analysis. Articles were excluded if they initially selected all their samples from genital HPV-positive individuals or selected case-control articles containing genitally HPV-positive case grou ps.[19,24,33,50,54,63,71,75,79-81,85,96,98,100-103]

The overall prevalence of concurrent oral-genital HPV infection was 12% (95% CI: 3.4–34.7) in both genders, 15.5% (95% CI: 11.2–21) for women, and 14% (95% CI: 8–23.3) for men (Table 3). The overall prevalence of concordance HPV-type was 53.5% (95% CI: 47.8–59.0) for both genders (Table 2 and Figure 4), 41.9% (95% CI: 33.8–50.5) for women (Table 2 and Figure 5), and 32.2% (95% CI: 11–64.7) for men (Table 3 and Figure 6).

In both genders, the higher prevalence of concurrent oral-genital HPV infection was observed in America at 16.7% (95% CI: 10.4–25.7), and the lower prevalence was observed in Africa at 9.2% (95% CI: 2.9–25.9). Table 4 provides a summary of each meta-analysis result.

The overall prevalence of genital HPV infection was 61.0% (95% CI: 21.3 – 90.6) for both genders (Table 3) and 48.5% (95% CI: 33.4–63.9) for men (Table 3). Using the Trim and Fill method for adjustment, the imputed point estimate was 0.31 (95% CI: 0.25–0.38).

Discussion

This study aimed to explore the occurrence of oral HPV infection among individuals with genital HPV infection. To achieve this goal, a systematic search of three databases, namely, PubMed, Scopus, and Web of Science, was performed, and 89 articles were included in the systematic review. A meta-analysis was conducted to synthesize the prevalence data. To the best of our knowledge, this is the first meta-analytic research exploring dual-site HPV infections in oral and genital areas for both men and women.

The findings of our meta-analysis showed that the overall prevalence of genital infection is higher than that of oral infection in both genders. In women, the pooled prevalence of genital infection was 47.5% (95% CI: 41.1–54.1), while oral HPV infection prevalence was 11.8% (95% CI: 8.9–15.4). In men, genital HPV infection prevalence was 48.5% (95% CI: 33.4–63.9), and oral HPV infection prevalence was 11.1% (95% CI: 9–13.6).

Concerning the overall prevalence of concurrent oral-genital HPV infection, only two studies have been published up to now: a meta-analysis by Termine et al and a systematic review by Jordan et al, both investigating the concurrent oral-cervical HPV infection in female patients.[16,19] These studies found low rates of dual-site and concordant oral-cervical HPV infections in women. Our systematic review and meta-analysis gathered new information on the concurrent oral-genital HPV infection by including additional data on HPV concurrency in men.[17,27,33,38,45,47,52,55,56,63-65,81,95,106,108]

In total, 86 articles were included in our meta-analysis on concurrent oral-genital HPV infection. Various values were observed in the data ranging from 0% to 100%.

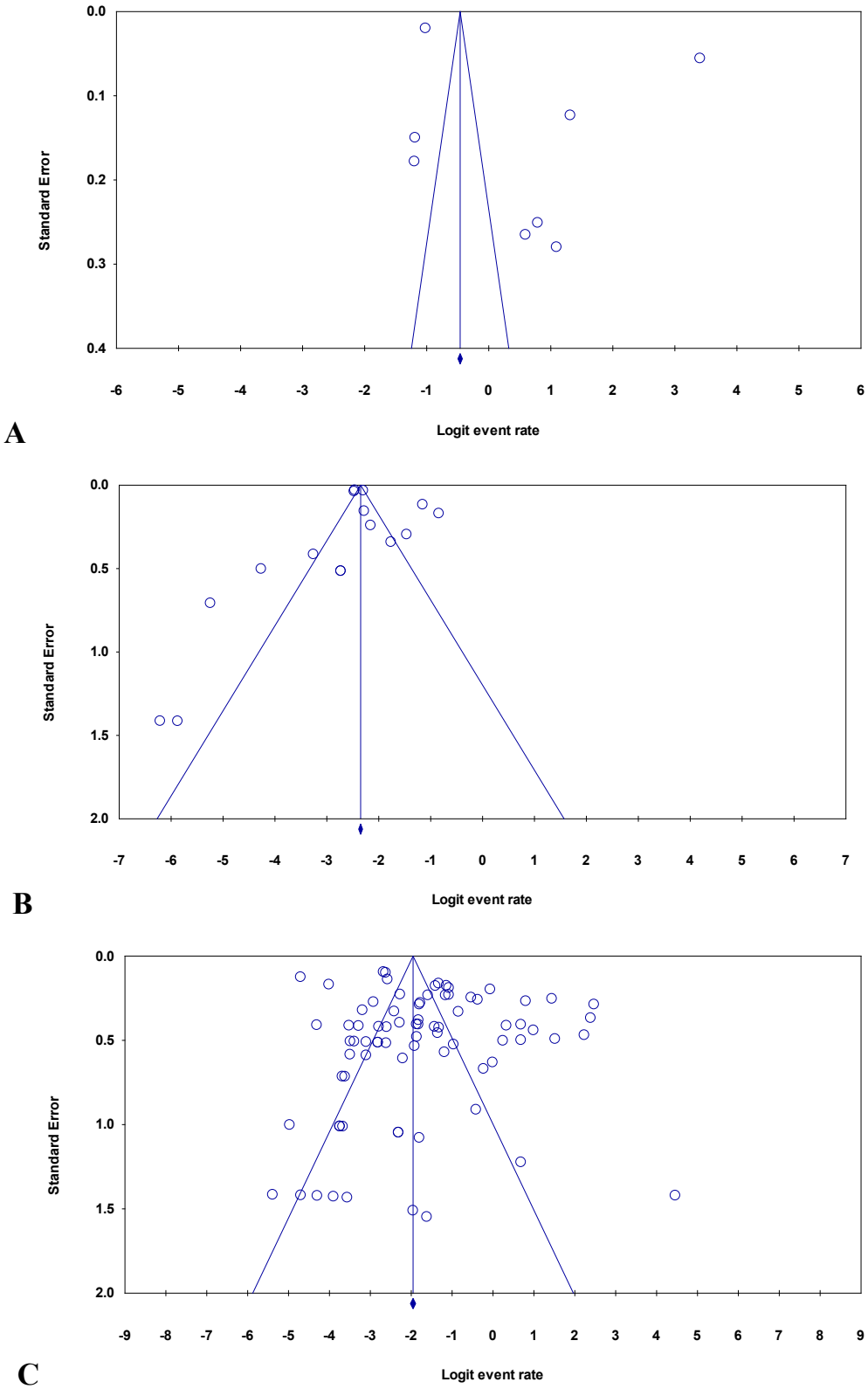

Figure 2. Funnel Plot of Studies Included in Meta-analysis Reporting Concurrent Oral-genital HPV Infection; A: Both Genders (9 studies), B: Men (16 studies), C: Women (79 studies) *Note.* HPV: Human papillomavirus

The pooled prevalence of oral HPV infection in genital HPV-positive patients was 15.5% (95% CI: 11.2–21) in women, 14% (95% CI: 8–23.3) in men, and 12% (95% CI: 3.4–34.7) in studies that reported the concurrency for both genders. These values are higher than those generally reported in healthy adult populations without genital HPV infection.[109] The wide range of these values suggests considerable variation in the prevalence of HPV infection across different populations and studies. This could be due to differences in the study populations, HPV detection methods, and the types of HPV analyzed.

HPV-type concordance was examined in 52 articles,

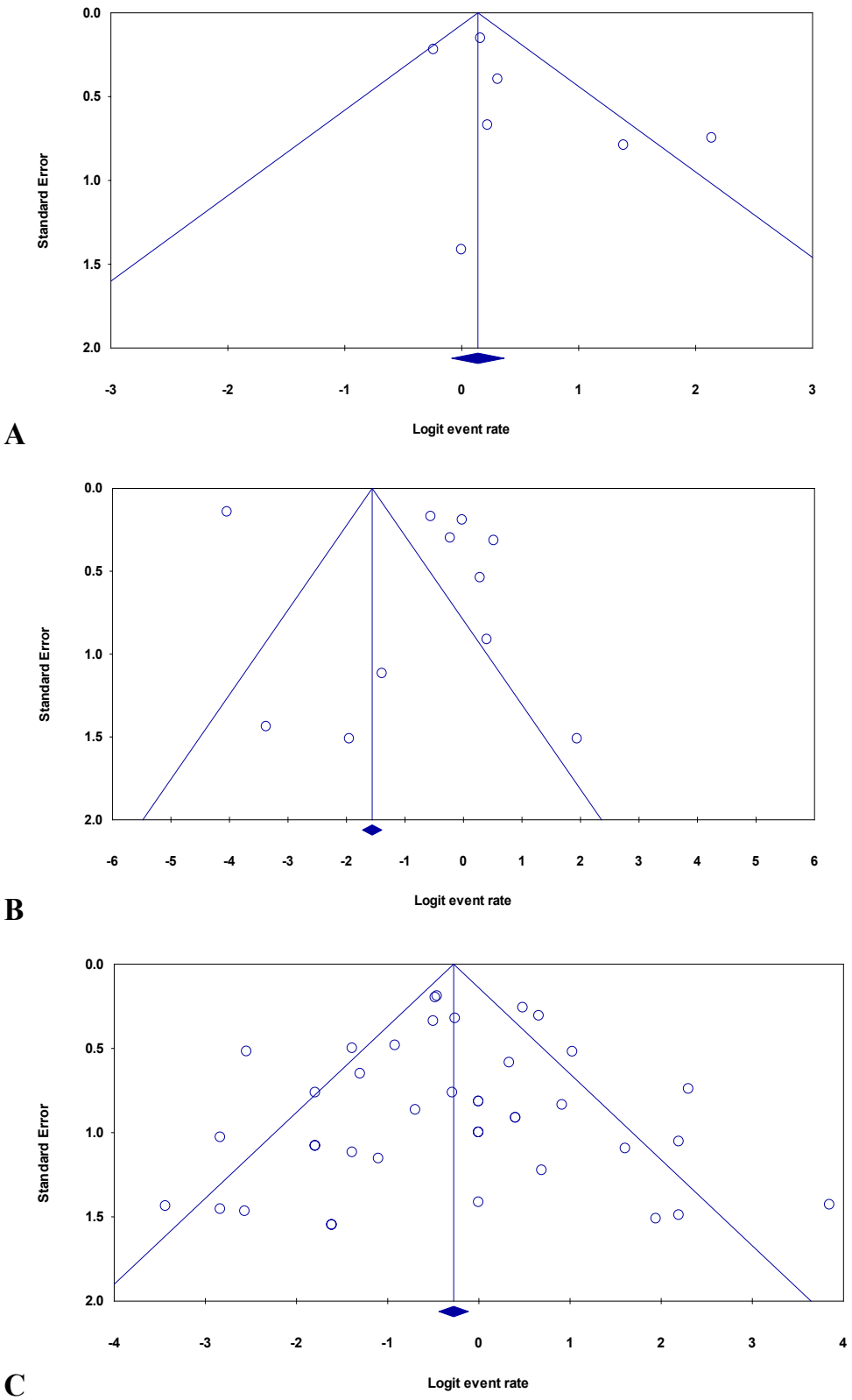

Figure 3. Funnel Plot of Studies Included in Meta-analysis Reporting Concordant Oral-genital HPV Infection Prevalence; A: Both Genders (7 studies), B: Men (11 studies), C: Women (43 studies). *Note.* HPV: Human papillomavirus

indicating a pooled prevalence of 41.9% (95% CI: 33.8–50.5) in women, 32.2% (95% CI: 11–64.7) in men, and 53.5% (95% CI: 47.8–59) in studies reporting HPV-type concordance in both genders. Many studies that have examined the relationship between HPV infection in oral and genital areas have not assessed whether the HPV types are the same in these two areas or not, highlighting the need to conduct more studies to better understand HPV type concordance. Most of these articles (83%) were scored 'moderate' according to the QATQS.

Our results indicated a relatively low percentage of concurrent oral-genital HPV infection in both men and

Table 3. A Summary of the Meta-analysis Results Based on Infection Site

Result	Gender	Number of Studies	Prevalence (%) (95% CI)	Lower Limit (%)	Upper Limit (%)
Concurrent oral-genital HPV infection	Women	79	15.5	11.2	21
	Men	16	14	8	23.3
	Both*	9	12	3.4	34.7
Concordant oral-genital HPV infection	Women	45	41.9	33.8	50.5
	Men	11	32.2	11	64.7
	Both	7	53.5	47.8	59
Genital HPV infection	Women	62	47.5	41.1	54.1
	Men	15	48.5	33.4	63.9
	Both	8	61	21.3	90.6
Oral HPV infection	Women	80	11.8	8.9	15.4
	Men	24	11.1	9	13.6
	Both	16	9.5	7.7	11.7

Note. HPV: Human papillomavirus; CI: Confidence interval; *The number of articles provided data for both men and women, whose overall results were included in this group.

Table 4. A Summary of the Meta-analysis Results in Both Genders Based on Continents

Result	Number of Studies	Prevalence (%)	Lower Limit (%)	Upper Limit (%)
Africa	6	9.2	2.9	25.9
America	32	16.7	10.4	25.7
Asia	7	14.5	5.3	34.1
Europe	42	14.4	9.4	21.3

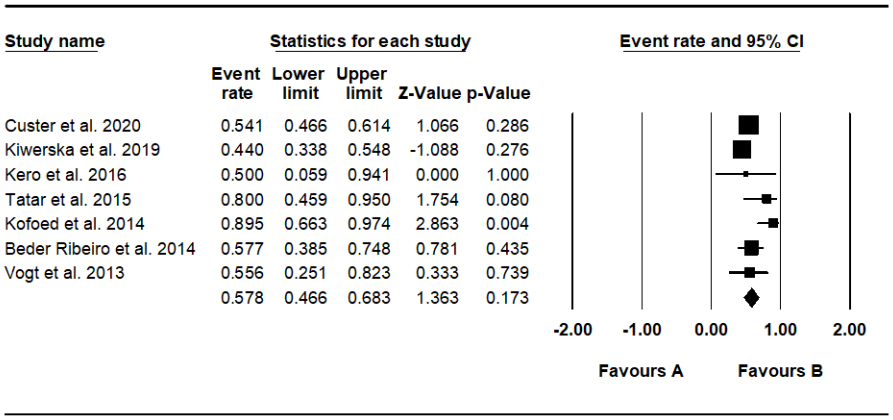

Figure 4. Forest Plot of Studies in Meta-analysis Reporting Concordant Oral-genital HPV Infection Prevalence in Both Genders. *Note*. HPV: Human papillomavirus

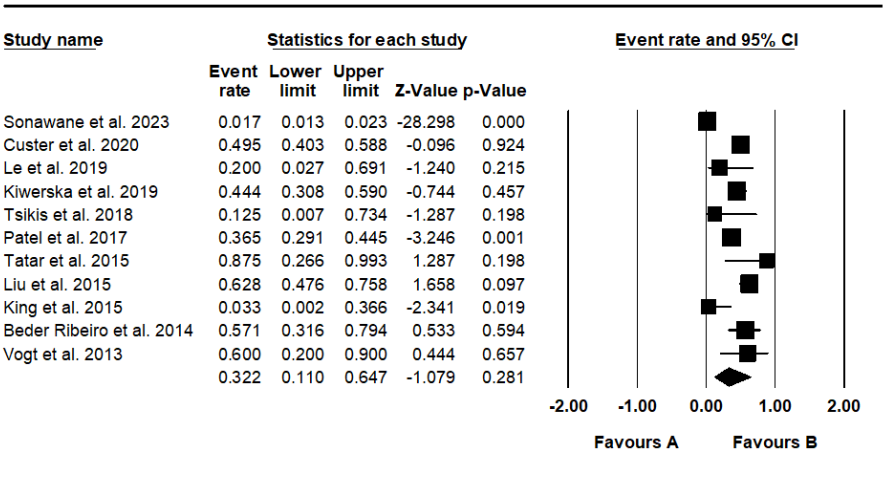

Figure 5. Forest Plot of Studies in Meta-analysis Reporting Concordant Oral-genital HPV Infection Prevalence in Men. *Note*. HPV: Human papillomavirus

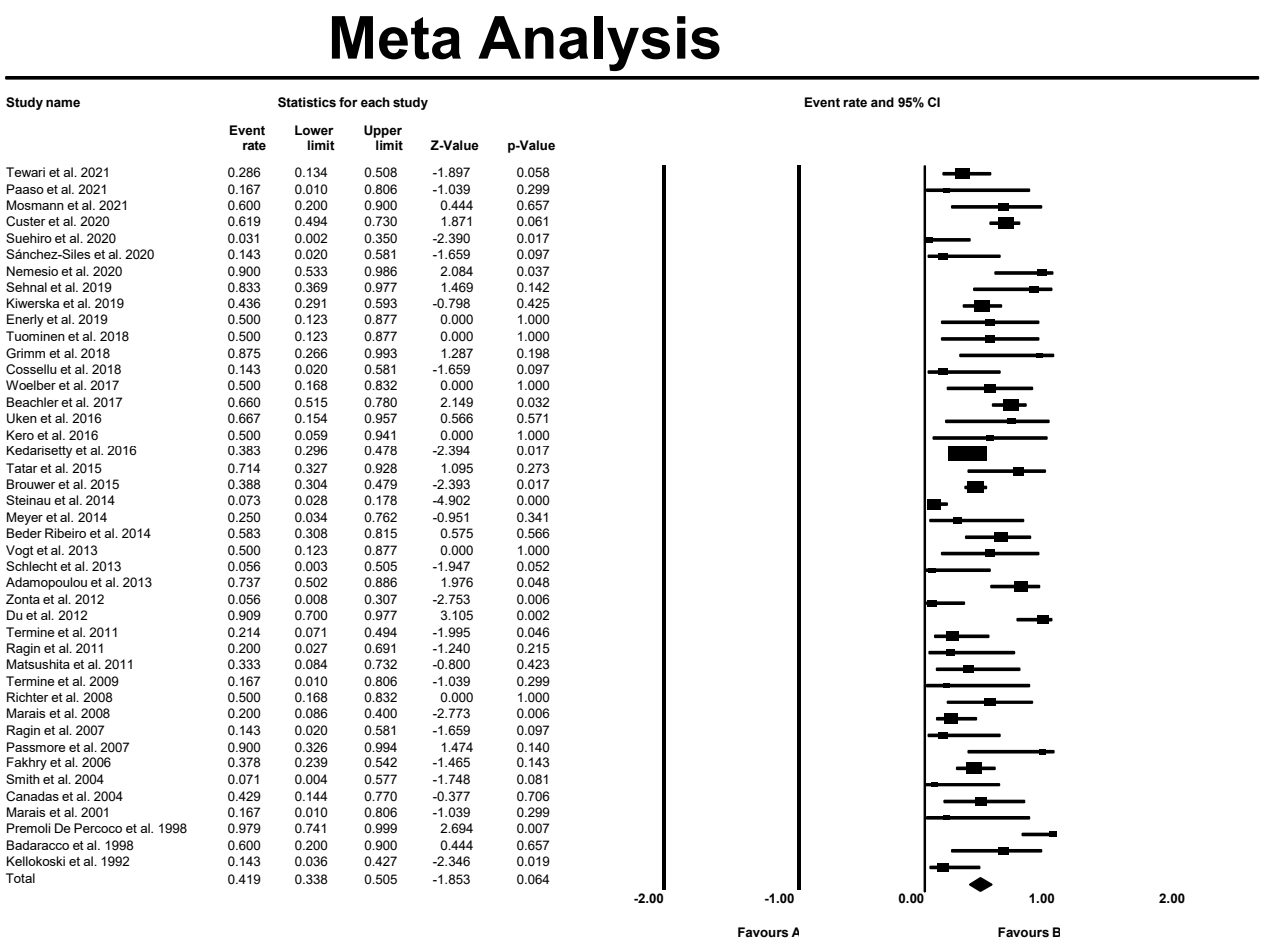

Figure 6. Forest Plot of Studies in Meta-analysis Reporting Concordant Oral-genital HPV Infection Prevalence in Women. *Note.* HPV: Human papillomavirus

women, which may be attributed to various factors such as different exposure levels in the oral and genital regions, transmission dynamics, and the oral cavity's potential to be constantly cleared of the virus by saliva. Another reason may be the differences in the sensitivity and specificity of HPV detection methods in the oral and genital areas. These are potential reasons, but the exact factors remain unknown. Further research is needed to understand these factors entirely.

One of the strengths of our study lies in the large number of studies included in the meta-analysis from different countries around the world. In addition, our study is the first meta-analysis performed on oral-genital concurrence data in both genders. However, the limitations of our study include high heterogeneity among studies, which can affect the reliability of our results, and a lack of HPV-type reporting in patients. Another limitation is excluding non-original and non-English studies from the systematic review and meta-analysis, which may have led to unwanted missing information. Regarding the quality assessment of the articles, the standardized QATQS tool could not be fully employed due to the specific nature of this study, which solely relied on observational studies.

The overall risk of oral HPV infection was not significant. However, it is still higher in patients with genital HPV infections, so it is crucial to take proactive measures. Encouraging HPV vaccination for both genders at the recommended ages can prevent both genital and potential oral HPV infections. Governments should consider policies to make these vaccines accessible and affordable for all individuals. Regular HPV screening, especially for sexually active individuals, can aid in early detection and treatment of the infection. Health organizations should invest in public awareness campaigns to educate people about the risks of HPV, its transmission, and prevention methods. Further research is needed to understand the transmission dynamics between oral and genital HPV infections, especially in men. Lastly, policies should be implemented to promote sexual health education and provide resources for HPV testing and treatment.

Conclusion

In summary, our meta-analysis demonstrated low rates of concurrent oral-genital HPV infection in both male and female patients. However, HPV-type concordance is significant, with 41.9% pooled prevalence of concordant

oral-genital HPV infection in women and 32.2% in men. This suggests a relationship between oral and genital HPV types and potential virus transmission from one area to another. However, further research needs to be conducted, especially on men, to fully understand the viral transmission to the oral cavity or other sites.

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Authors' Contribution
Conceptualization: Narjes Akbari, Mahnegar Hadinia.
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Methodology: Mahnegar Hadinia, Hamid Salehiniya.
Project administration: Narjes Akbari, Mahnegar Hadinia.
Supervision: Narjes Akbari.
Validation: Mahnegar Hadinia, Narjes Akbari.
Visualization: Mahnegar Hadinia.
Writing–original draft: Mahnegar Hadinia.
Writing–review & editing: Mahnegar Hadinia.

Competing Interests
The authors declare that there is no conflict of interests.

Ethical Approval
The study was approved by the Research Ethics Committees of Birjand University of Medical Sciences under the code IR.BUMS.REC.1400.231, and all ethical standards related to basic research were followed.

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Supplementary File
Supplementary file 1 contains Table S1.

References
1. Gross G, Pfister H. Role of human papillomavirus in penile cancer, penile intraepithelial squamous cell neoplasias and in genital warts. Med Microbiol Immunol. 2004;193(1):35-44. doi: 10.1007/s00430-003-0181-2.
2. Tao Y, Shao H, Zhang T, Pu J, Tang C. Factors influencing men's attitudes toward HPV vaccination in males included in the Chinese National Immunization Program. Vaccines (Basel). 2022;10(7):1054. doi: 10.3390/vaccines10071054.
3. Ardekani A, Sepidarkish M, Mollalo A, Afradiasbagharani P, Rouholamin S, Rezaeinejad M, et al. Worldwide prevalence of human papillomavirus among pregnant women: a systematic review and meta-analysis. Rev Med Virol. 2023;33(1):e2374. doi: 10.1002/rmv.2374.
4. Stanley M. Pathology and epidemiology of HPV infection in females. Gynecol Oncol. 2010;117(2 Suppl):S5-10. doi: 10.1016/j.ygyno.2010.01.024.
5. Bernard HU. The clinical importance of the nomenclature, evolution and taxonomy of human papillomaviruses. J Clin Virol. 2005;32 Suppl 1:S1-6. doi: 10.1016/j.jcv.2004.10.021.
6. Quinlan JD. Human papillomavirus: screening, testing, and prevention. Am Fam Physician. 2021;104(2):152-9.
7. Szymonowicz KA, Chen J. Biological and clinical aspects of HPV-related cancers. Cancer Biol Med. 2020;17(4):864-78. doi: 10.20892/j.issn.2095-3941.2020.0370.
8. Walboomers JM, Jacobs MV, Manos MM, Bosch FX, Kummer JA, Shah KV, et al. Human papillomavirus is a necessary cause of invasive cervical cancer worldwide. J Pathol. 1999;189(1):12-9. doi: 10.1002/(sici)1096-9896(199909)189:1<12::aid-path431>3.0.co;2-f.
9. Tan Y, Wang Z, Xu M, Li B, Huang Z, Qin S, et al. Oral squamous cell carcinomas: state of the field and emerging directions. Int J Oral Sci. 2023;15(1):44. doi: 10.1038/s41368-023-00249-w.
10. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin. 2021;71(3):209-49. doi: 10.3322/caac.21660.
11. Kreimer AR, Clifford GM, Boyle P, Franceschi S. Human papillomavirus types in head and neck squamous cell carcinomas worldwide: a systematic review. Cancer Epidemiol Biomarkers Prev. 2005;14(2):467-75. doi: 10.1158/1055-9965.epi-04-0551.
12. Johnson NW, Jayasekara P, Amarasinghe AA. Squamous cell carcinoma and precursor lesions of the oral cavity: epidemiology and aetiology. Periodontol 2000. 2011;57(1):19-37. doi: 10.1111/j.1600-0757.2011.00401.x.
13. Burchell AN, Winer RL, de Sanjosé S, Franco EL. Chapter 6: epidemiology and transmission dynamics of genital HPV infection. Vaccine. 2006;24 Suppl 3:S52-61. doi: 10.1016/j.vaccine.2006.05.031.
14. Smith EM, Parker MA, Rubenstein LM, Haugen TH, Hamsikova E, Turek LP. Evidence for vertical transmission of HPV from mothers to infants. Infect Dis Obstet Gynecol. 2010;2010:326369. doi: 10.1155/2010/326369.
15. Candotto V, Lauritano D, Nardone M, Baggi L, Arcuri C, Gatto R, et al. HPV infection in the oral cavity: epidemiology, clinical manifestations and relationship with oral cancer. Oral Implantol (Rome). 2017;10(3):209-20. doi: 10.11138/orl/2017.10.3.209.
16. Jordan KH, Beverly Hery CM, Zhang X, Paskett ED. Low rates of dual-site and concordant oral-cervical human papillomavirus infections and cancers: a systematic review. Front Oncol. 2022;12:848628. doi: 10.3389/fonc.2022.848628.
17. Le HH, Bi X, Ishizaki A, Van Le H, Nguyen TV, Ichimura H. Low concordance of oral and genital HPV infection among male patients with sexually transmitted infections in Vietnam. BMC Infect Dis. 2019;19(1):578. doi: 10.1186/s12879-019-4175-0.
18. Kedarisetty S, Orosco RK, Hecht AS, Chang DC, Weissbrod PA, Coffey CS. Concordant oral and vaginal human papillomavirus infection in the United States. JAMA Otolaryngol Head Neck Surg. 2016;142(5):457-65. doi: 10.1001/jamaoto.2016.0064.
19. Termine N, Giovannelli L, Matranga D, Caleca MP, Bellavia C, Perino A, et al. Oral human papillomavirus infection in women with cervical HPV infection: new data from an Italian cohort and a metanalysis of the literature. Oral Oncol. 2011;47(4):244-50. doi: 10.1016/j.oraloncology.2011.02.011.
20. Bettampadi D, Sirak BA, Abrahamsen ME, Reich RR, Villa LL, Ponce EL, et al. Factors associated with persistence and clearance of high-risk oral human papillomavirus (HPV) among participants in the HPV infection in men (HIM) study. Clin Infect Dis. 2021;73(9):e3227-34. doi: 10.1093/cid/ciaa1701.
21. Thomas BH, Ciliska D, Dobbins M, Micucci S. A process for systematically reviewing the literature: providing the research evidence for public health nursing interventions. Worldviews Evid Based Nurs. 2004;1(3):176-84. doi: 10.1111/j.1524-475X.2004.04006.x.
22. Thorlund K, Imberger G, Johnston BC, Walsh M, Awad T, Thabane L, et al. Evolution of heterogeneity (I2) estimates and their 95% confidence intervals in large meta-analyses. PLoS One. 2012;7(7):e39471. doi: 10.1371/journal.pone.0039471.
23. Sonawane K, Shyu SS, Damgacioglu H, Li R, Nyitray AG, Deshmukh AA. Prevalence and concordance of oral and genital HPV by sexual orientation among US men. JNCI Cancer Spectr. 2023;7(1):pkac088. doi: 10.1093/jncics/pkac088.

24. Tewari P, Banka P, Kernan N, Reynolds S, White C, Pilkington L, et al. Prevalence and concordance of oral HPV infections with cervical HPV infections in women referred to colposcopy with abnormal cytology. J Oral Pathol Med. 2021;50(7):692-9. doi: 10.1111/jop.13172.
25. Paaso A, Koskimaa HM, Welters MJ, Kero K, Rautava J, Syrjänen K, et al. Interferon-γ and IL-5 associated cell-mediated immune responses to HPV16 E2 and E6 distinguish between persistent oral HPV16 infections and noninfected mucosa. Clin Exp Dent Res. 2021;7(5):903-13. doi: 10.1002/cre2.396.
26. Mosmann JP, Zayas S, Kiguen AX, Venezuela RF, Rosato O, Cuffini CG. Human papillomavirus and Chlamydia trachomatis in oral and genital mucosa of women with normal and abnormal cervical cytology. BMC Infect Dis. 2021;21(1):422. doi: 10.1186/s12879-021-06118-3.
27. Custer J, Patel R, Delclos GL, DeSantis SM. Concurrent and concordant oral and genital high-risk human papillomavirus in the United States: results from the National Health and Nutrition Examination Survey. J Infect Dis. 2021;223(8):1400-9. doi: 10.1093/infdis/jiaa519.
28. Suehiro TT, Damke G, Damke E, de Azevedo Ramos PL, de Andrade Pereira Silva M, Pelloso SM, et al. Cervical and oral human papillomavirus infection in women living with human immunodeficiency virus (HIV) and matched HIV-negative controls in Brazil. Infect Agent Cancer. 2020;15:31. doi: 10.1186/s13027-020-00301-y.
29. Pérez-Quintanilla M, Méndez-Martínez R, Vázquez-Vega S, Espinosa-Romero R, Sotelo-Regil R, Pérez-Montiel MD, et al. High prevalence of human papillomavirus and European variants of HPV 16 infecting concomitantly to cervix and oral cavity in HIV positive women. PLoS One. 2020;15(4):e0227900. doi: 10.1371/journal.pone.0227900.
30. Nemesio I, Cury F, Longatto-Filho A, Fregnani JH, Musselwhite L, Vazquez F, et al. Identification of human papillomavirus in oral rinse specimens from women with and without cervical intraepithelial lesions. Sex Transm Infect. 2020;96(6):408-10. doi: 10.1136/sextrans-2019-054359.
31. Gilles C, Buljubasic M, Konopnicki D, Manigart Y, Barlow P, Rozenberg S. Cervical, anal and oral human papillomavirus (HPV) infection in young women: a case control study between women with perinatally HIV infection and women with non-perinatally HIV infection. Eur J Obstet Gynecol Reprod Biol. 2020;244:114-9. doi: 10.1016/j.ejogrb.2019.11.022.
32. Sehnal B, Zikan M, Nipcova M, Dusek L, Cibula D, Slama J. The association among cervical, anal, and oral HPV infections in high-risk and low-risk women. Eur J Obstet Gynecol Reprod Biol X. 2019;4:100061. doi: 10.1016/j.eurox.2019.100061.
33. Kiwerska K, Jozefiak A, Markowska J, Kedzia W, Jackowska J, Wierzbicka M. Oral-genital human papillomavirus infection in Polish couples: frequent detection of HPV 42. BMC Infect Dis. 2019;19(1):122. doi: 10.1186/s12879-018-3645-0.
34. Enerly E, Flingtorp R, Christiansen IK, Campbell S, Hansen M, Myklebust T, et al. An observational study comparing HPV prevalence and type distribution between HPV-vaccinated and -unvaccinated girls after introduction of school-based HPV vaccination in Norway. PLoS One. 2019;14(10):e0223612. doi: 10.1371/journal.pone.0223612.
35. Eggersmann TK, Sharaf K, Baumeister P, Thaler C, Dannecker CJ, Jeschke U, et al. Prevalence of oral HPV infection in cervical HPV positive women and their sexual partners. Arch Gynecol Obstet. 2019;299(6):1659-65. doi: 10.1007/s00404-019-05135-7.
36. Brouwer AF, Eisenberg MC, Carey TE, Meza R. Multisite HPV infections in the United States (NHANES 2003-2014): an overview and synthesis. Prev Med. 2019;123:288-98. doi: 10.1016/j.ypmed.2019.03.040.
37. Tuominen H, Rautava S, Syrjänen S, Collado MC, Rautava J. HPV infection and bacterial microbiota in the placenta, uterine cervix and oral mucosa. Sci Rep. 2018;8(1):9787. doi: 10.1038/s41598-018-27980-3.
38. Tsikis S, Hoefer L, Bethimoutis G, Nicolaidou E, Paparizos V, Antoniou C, et al. Risk factors, prevalence, and site concordance of human papillomavirus in high-risk Greek men. Eur J Cancer Prev. 2018;27(5):514-20. doi: 10.1097/cej.0000000000000366.
39. Thorsteinsson K, Storgaard M, Katzenstein TL, Ladelund S, Rönsholt FF, Johansen IS, et al. Prevalence of cervical, oral, and anal human papillomavirus infection in women living with HIV in Denmark - the SHADE cohort study. J Clin Virol. 2018;105:64-71. doi: 10.1016/j.jcv.2018.05.010.
40. Rietbergen MM, van Bokhoven A, Lissenberg-Witte BI, Heideman DA, Leemans CR, Brakenhoff RH, et al. Epidemiologic associations of HPV-positive oropharyngeal cancer and (pre)cancerous cervical lesions. Int J Cancer. 2018;143(2):283-8. doi: 10.1002/ijc.31315.
41. Grimm D, Woelber L, Prieske K, Schmalfeldt B, Kürti S, Busch CJ, et al. Comparison of PapilloCheck and linear array to detect and differentiate human papillomaviruses in cervical and tonsillar smears from females with cervical intraepithelial lesions. Eur J Microbiol Immunol (Bp). 2018;8(4):107-11. doi: 10.1556/1886.2018.00018.
42. Cossellu G, Fedele L, Badaoui B, Angiero F, Farronato G, Monti E, et al. Prevalence and concordance of oral and genital HPV in women positive for cervical HPV infection and in their sexual stable partners: an Italian screening study. PLoS One. 2018;13(10):e0205574. doi: 10.1371/journal.pone.0205574.
43. Woelber L, Breuer J, Meyer T, Vettorazzi E, Prieske K, Bohlmann I, et al. Oral human papillomavirus in women with high-grade cervical intraepithelial neoplasia. J Low Genit Tract Dis. 2017;21(3):177-83. doi: 10.1097/lgt.0000000000000313.
44. Sonawane K, Suk R, Chiao EY, Chhatwal J, Qiu P, Wilkin T, et al. Oral human papillomavirus infection: differences in prevalence between sexes and concordance with genital human papillomavirus infection, NHANES 2011 to 2014. Ann Intern Med. 2017;167(10):714-24. doi: 10.7326/m17-1363.
45. Patel EU, Rositch AF, Gravitt PE, Tobian AA. Concordance of penile and oral human papillomavirus infections among men in the United States. J Infect Dis. 2017;215(8):1207-11. doi: 10.1093/infdis/jix116.
46. Oliveira LH, Santos LS, Silva CO, Augusto EF, Neves FP. Papillomavirus infections in the oral and genital mucosa of asymptomatic women. Braz J Infect Dis. 2017;21(1):88-91. doi: 10.1016/j.bjid.2016.08.015.
47. Nunes EM, López RV, Sudenga SL, Gheit T, Tommasino M, Baggio ML, et al. Concordance of betapapillomavirus across anogenital and oral anatomic sites of men: the HIM study. Virology. 2017;510:55-9. doi: 10.1016/j.virol.2017.07.006.
48. Lupato V, Holzinger D, Höfler D, Menegaldo A, Giorgi Rossi P, Del Mistro A, et al. Prevalence and determinants of oral human papillomavirus infection in 500 young adults from Italy. PLoS One. 2017;12(1):e0170091. doi: 10.1371/journal.pone.0170091.
49. Vanya M, Jakó M, Terhes G, Szakács L, Kaiser L, Deák J, et al. [Low rate of oropharyngeal human papillomavirus infection among women with cervical lesion. Preliminary results from the South-Eastern Hungarian population]. Orv Hetil. 2016;157(2):70-3. doi: 10.1556/650.2015.30321. [Hungarian].
50. Uken RB, Brummer O, von Schubert-Bayer C, Brodegger T, Teudt IU. Oral HPV prevalence in women positive for cervical HPV infection and their sexual partners: a German screening study. Eur Arch Otorhinolaryngol. 2016;273(7):1933-42. doi: 10.1007/s00405-016-3953-1.
51. Loverro G, Di Naro E, Caringella AM, De Robertis AL, Loconsole D, Chironna M. Prevalence of human papillomavirus infection in a clinic sample of transsexuals in Italy. Sex Transm Infect. 2016;92(1):67-9. doi: 10.1136/sextrans-2014-051987.

52. Tatár TZ, Kis A, Szabó É, Czompa L, Boda R, Tar I, et al. Prevalence of human papillomaviruses in the healthy oral mucosa of women with high-grade squamous intra-epithelial lesion and of their partners as compared to healthy controls. J Oral Pathol Med. 2015;44(9):722-7. doi: 10.1111/jop.12302.
53. Skoczyński M, Goździcka-Józefiak A, Kwaśniewska A. The prevalence of human papillomavirus between the neonates and their mothers. Biomed Res Int. 2015;2015:126417. doi: 10.1155/2015/126417.
54. Marques AE, Barra GB, de Resende Oyama CN, Guerra EN. Low rate of oropharyngeal human papillomavirus infection of women with cervical lesions and their partners: new data from Brazilian population. J Oral Pathol Med. 2015;44(6):453-8. doi: 10.1111/jop.12252.
55. Liu F, Hang D, Deng Q, Liu M, Xi L, He Z, et al. Concurrence of oral and genital human papillomavirus infection in healthy men: a population-based cross-sectional study in rural China. Sci Rep. 2015;5:15637. doi: 10.1038/srep15637.
56. King EM, Gilson R, Beddows S, Soldan K, Panwar K, Young C, et al. Oral human papillomavirus (HPV) infection in men who have sex with men: prevalence and lack of anogenital concordance. Sex Transm Infect. 2015;91(4):284-6. doi: 10.1136/sextrans-2014-051955.
57. Grün N, Ährlund-Richter A, Franzén J, Mirzaie L, Marions L, Ramqvist T, et al. Oral human papillomavirus (HPV) prevalence in youth and cervical HPV prevalence in women attending a youth clinic in Sweden, a follow up-study 2013-2014 after gradual introduction of public HPV vaccination. Infect Dis (Lond). 2015;47(1):57-61. doi: 10.3109/00365548.2014.964764.
58. Brouwer AF, Eisenberg MC, Carey TE, Meza R. Trends in HPV cervical and seroprevalence and associations between oral and genital infection and serum antibodies in NHANES 2003-2012. BMC Infect Dis. 2015;15:575. doi: 10.1186/s12879-015-1314-0.
59. Vidotti LR, Vidal FC, Monteiro SC, Nunes JD, Salgado JV, Brito LM, et al. Association between oral DNA-HPV and genital DNA-HPV. J Oral Pathol Med. 2014;43(4):289-92. doi: 10.1111/jop.12141.
60. Steinau M, Hariri S, Gillison ML, Broutian TR, Dunne EF, Tong ZY, et al. Prevalence of cervical and oral human papillomavirus infections among US women. J Infect Dis. 2014;209(11):1739-43. doi: 10.1093/infdis/jit799.
61. Meyer MF, Huebbers CU, Siefer OG, Vent J, Engbert I, Eslick GD, et al. Prevalence and risk factors for oral human papillomavirus infection in 129 women screened for cervical HPV infection. Oral Oncol. 2014;50(1):27-31. doi: 10.1016/j.oraloncology.2013.10.009.
62. Lima MD, Braz-Silva PH, Pereira SM, Riera C, Coelho AC, Gallottini M. Oral and cervical HPV infection in HIV-positive and HIV-negative women attending a sexual health clinic in São Paulo, Brazil. Int J Gynaecol Obstet. 2014;126(1):33-6. doi: 10.1016/j.ijgo.2014.01.017.
63. Kofoed K, Sand C, Forslund O, Madsen K. Prevalence of human papillomavirus in anal and oral sites among patients with genital warts. Acta Derm Venereol. 2014;94(2):207-11. doi: 10.2340/00015555-1718.
64. Beder Ribeiro CM, Ferrer I, Santos de Farias AB, Fonseca DD, Morais Silva IH, Monteiro Gueiros LA, et al. Oral and genital HPV genotypic concordance between sexual partners. Clin Oral Investig. 2014;18(1):261-8. doi: 10.1007/s00784-013-0959-6.
65. Vogt SL, Gravitt PE, Martinson NA, Hoffmann J, D'Souza G. Concordant oral-genital HPV infection in South Africa couples: evidence for transmission. Front Oncol. 2013;3:303. doi: 10.3389/fonc.2013.00303.
66. Videla S, Darwich L, Cañadas MP, Coll J, Piñol M, García-Cuyás F, et al. Natural history of human papillomavirus infections involving anal, penile, and oral sites among HIV-positive men. Sex Transm Dis. 2013;40(1):3-10. doi: 10.1097/OLQ.0b013e31827e87bd.
67. Schlecht NF, Rojas M, Lorde-Rollins E, Nucci-Sack A, Strickler HD, Burk RD, et al. Burden of cervical, anal, and oral HPV in an inner-city pre-vaccine adolescent population. J Urban Health. 2013;90(1):141-6. doi: 10.1007/s11524-012-9756-9.
68. Lang Kuhs KA, Gonzalez P, Struijk L, Castro F, Hildesheim A, van Doorn LJ, et al. Prevalence of and risk factors for oral human papillomavirus among young women in Costa Rica. J Infect Dis. 2013;208(10):1643-52. doi: 10.1093/infdis/jit369.
69. Adamopoulou M, Vairaktaris E, Nkenke E, Avgoustidis D, Karakitsos P, Sioulas V, et al. Prevalence of human papillomavirus in saliva and cervix of sexually active women. Gynecol Oncol. 2013;129(2):395-400. doi: 10.1016/j.ygyno.2013.02.015.
70. Zonta MA, Monteiro J, Santos G Jr, Pignatari AC. Oral infection by the human papillomavirus in women with cervical lesions at a prison in São Paulo, Brazil. Braz J Otorhinolaryngol. 2012;78(2):66-72. doi: 10.1590/s1808-86942012000200011.
71. Elasbali AM, El Din AH, Abdallah RA, Ahmed HG. Cervical and oral screening for HR-HPV types 16 and 18 among Sudanese women cervical lesions. Infect Agent Cancer. 2012;7(1):17. doi: 10.1186/1750-9378-7-17.
72. Du J, Nordfors C, Ahrlund-Richter A, Sobkowiak M, Romanitan M, Näsman A, et al. Prevalence of oral human papillomavirus infection among youth, Sweden. Emerg Infect Dis. 2012;18(9):1468-71. doi: 10.3201/eid1809.111731.
73. Sayyah-Melli M, Kazemi-Sheshvan M, Bonyadi M, Ouladsahebmadarek E, Dasranj-Tabrizi A, Ghojazadeh M, et al. Detection of human papillomavirus in the saliva of women with concurrent human papillomavirus related genital lesions. Saudi Med J. 2011;32(2):141-6.
74. Ragin C, Edwards R, Larkins-Pettigrew M, Taioli E, Eckstein S, Thurman N, et al. Oral HPV infection and sexuality: a cross-sectional study in women. Int J Mol Sci. 2011;12(6):3928-40. doi: 10.3390/ijms12063928.
75. Peixoto AP, Campos GS, Queiroz LB, Sardi SI. Asymptomatic oral human papillomavirus (HPV) infection in women with a histopathologic diagnosis of genital HPV. J Oral Sci. 2011;53(4):451-9. doi: 10.2334/josnusd.53.451.
76. Matsushita K, Sasagawa T, Miyashita M, Ishizaki A, Morishita A, Hosaka N, et al. Oral and cervical human papillomavirus infection among female sex workers in Japan. Jpn J Infect Dis. 2011;64(1):34-9.
77. Crawford R, Grignon AL, Kitson S, Winder DM, Ball SL, Vaughan K, et al. High prevalence of HPV in non-cervical sites of women with abnormal cervical cytology. BMC Cancer. 2011;11:473. doi: 10.1186/1471-2407-11-473.
78. Brown B, Blas MM, Cabral A, Carcamo C, Gravitt PE, Halsey N. Oral sex practices, oral human papillomavirus and correlations between oral and cervical human papillomavirus prevalence among female sex workers in Lima, Peru. Int J STD AIDS. 2011;22(11):655-8. doi: 10.1258/ijsa.2011.010541.
79. Sánchez-Vargas LO, Díaz-Hernández C, Martinez-Martinez A. Detection of human papillomavirus (HPV) in oral mucosa of women with cervical lesions and their relation to oral sex practices. Infect Agent Cancer. 2010;5(1):25. doi: 10.1186/1750-9378-5-25.
80. Saini R, Saini S, Sharma S. Oral sex, oral health and orogenital infections. J Glob Infect Dis. 2010;2(1):57-62. doi: 10.4103/0974-777x.59252.
81. Xavier SD, Bussoloti Filho I, de Carvalho JM, Castro TM, de Souza Framil VM, Syrjänen KJ. Prevalence of human papillomavirus (HPV) DNA in oral mucosa of men with anogenital HPV infection. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2009;108(5):732-7. doi: 10.1016/j.tripleo.2009.06.020.
82. Termine N, Giovannelli L, Matranga D, Perino A, Panzarella V, Ammatuna P, et al. Low rate of oral human papillomavirus

(HPV) infection in women screened for cervical HPV infection in Southern Italy: a cross-sectional study of 140 immunocompetent subjects. J Med Virol. 2009;81(8):1438-43. doi: 10.1002/jmv.21509.
83. Castro TM, Bussoloti Filho I, Nascimento VX, Xavier SD. HPV detection in the oral and genital mucosa of women with positive histopathological exam for genital HPV, by means of the PCR. Braz J Otorhinolaryngol. 2009;75(2):167-71. doi: 10.1016/s1808-8694(15)30773-4.
84. Richter KL, van Rensburg EJ, van Heerden WF, Boy SC. Human papillomavirus types in the oral and cervical mucosa of HIV-positive South African women prior to antiretroviral therapy. J Oral Pathol Med. 2008;37(9):555-9. doi: 10.1111/j.1600-0714.2008.00670.x.
85. Marais DJ, Passmore JA, Denny L, Sampson C, Allan BR, Williamson AL. Cervical and oral human papillomavirus types in HIV-1 positive and negative women with cervical disease in South Africa. J Med Virol. 2008;80(6):953-9. doi: 10.1002/jmv.21166.
86. Ragin CC, Wheeler VW, Wilson JB, Bunker CH, Gollin SM, Patrick AL, et al. Distinct distribution of HPV types among cancer-free Afro-Caribbean women from Tobago. Biomarkers. 2007;12(5):510-22. doi: 10.1080/13547500701340384.
87. Passmore JA, Marais DJ, Sampson C, Allan B, Parker N, Milner M, et al. Cervicovaginal, oral, and serum IgG and IgA responses to human papillomavirus type 16 in women with cervical intraepithelial neoplasia. J Med Virol. 2007;79(9):1375-80. doi: 10.1002/jmv.20901.
88. Nordin P, Hansson BG, Hansson C, Blohmè I, Larkö O, Andersson K. Human papillomavirus in skin, mouth and uterine cervix in female renal transplant recipients with or without a history of cutaneous squamous cell carcinoma. Acta Derm Venereol. 2007;87(3):219-22. doi: 10.2340/00015555-0235.
89. Fakhry C, D'Souza G, Sugar E, Weber K, Goshu E, Minkoff H, et al. Relationship between prevalent oral and cervical human papillomavirus infections in human immunodeficiency virus-positive and -negative women. J Clin Microbiol. 2006;44(12):4479-85. doi: 10.1128/jcm.01321-06.
90. Smith EM, Ritchie JM, Yankowitz J, Wang D, Turek LP, Haugen TH. HPV prevalence and concordance in the cervix and oral cavity of pregnant women. Infect Dis Obstet Gynecol. 2004;12(2):45-56. doi: 10.1080/10647440400009896.
91. Cañadas MP, Bosch FX, Junquera ML, Ejarque M, Font R, Ordoñez E, et al. Concordance of prevalence of human papillomavirus DNA in anogenital and oral infections in a high-risk population. J Clin Microbiol. 2004;42(3):1330-2. doi: 10.1128/jcm.42.3.1330-1332.2004.
92. Marais DJ, Best JM, Rose RC, Keating P, Soeters R, Denny L, et al. Oral antibodies to human papillomavirus type 16 in women with cervical neoplasia. J Med Virol. 2001;65(1):149-54.
93. Premoli-De-Percoco G, Ramírez JL, Galindo I. Correlation between HPV types associated with oral squamous cell carcinoma and cervicovaginal cytology: an in-situ hybridization study. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1998;86(1):77-81. doi: 10.1016/s1079-2104(98)90153-6.
94. Badaracco G, Venuti A, Di Lonardo A, Scambia G, Mozzetti S, Benedetti Panici P, et al. Concurrent HPV infection in oral and genital mucosa. J Oral Pathol Med. 1998;27(3):130-4. doi: 10.1111/j.1600-0714.1998.tb01928.x.
95. van Doornum GJ, Hooykaas C, Juffermans LH, van der Lans SM, van der Linden MM, Coutinho RA, et al. Prevalence of human papillomavirus infections among heterosexual men and women with multiple sexual partners. J Med Virol. 1992;37(1):13-21. doi: 10.1002/jmv.1890370104.
96. Panici PB, Scambia G, Perrone L, Battaglia F, Cattani P, Rabitti C, et al. Oral condyloma lesions in patients with extensive genital human papillomavirus infection. Am J Obstet Gynecol. 1992;167(2):451-8. doi: 10.1016/s0002-9378(11)91428-8.
97. Kellokoski JK, Syrjänen SM, Chang F, Yliskoski M, Syrjänen KJ. Southern blot hybridization and PCR in detection of oral human papillomavirus (HPV) infections in women with genital HPV infections. J Oral Pathol Med. 1992;21(10):459-64. doi: 10.1111/j.1600-0714.1992.tb00975.x.
98. Sánchez-Siles M, Remezal-Solano M, López-López AM, Camacho-Alonso F. Prevalence of human papillomavirus in the saliva of sexually active women with cervical intraepithelial neoplasias. Med Oral Patol Oral Cir Bucal. 2020;25(2):e195-204. doi: 10.4317/medoral.23300.
99. Christensen JT, Grønhøj C, Zamani M, Brask J, Kjær EK, Lajer H, et al. Association between oropharyngeal cancers with known HPV and p16 status and cervical intraepithelial neoplasia: a Danish population-based study. Acta Oncol. 2019;58(3):267-72. doi: 10.1080/0284186x.2018.1546059.
100. Visalli G, Currò M, Facciolà A, Riso R, Mondello P, Laganà P, et al. Prevalence of human papillomavirus in saliva of women with HPV genital lesions. Infect Agent Cancer. 2016;11(1):48. doi: 10.1186/s13027-016-0096-3.
101. Temizkan O, Aydogan B, Sanverdi I, Sakiz D, Arici B, Karaca K, et al. Prevalence of abnormal oral cytology and impact of sexual behavior in women with abnormal cervical cytology. Clin Exp Obstet Gynecol. 2016;43(3):388-92.
102. Louvanto K, Rautava J, Syrjänen K, Grénman S, Syrjänen S. The clearance of oral high-risk human papillomavirus infection is impaired by long-term persistence of cervical human papillomavirus infection. Clin Microbiol Infect. 2014;20(11):1167-72. doi: 10.1111/1469-0691.12700.
103. Giraldo P, Gonçalves AK, Pereira SA, Barros-Mazon S, Gondo ML, Witkin SS. Human papillomavirus in the oral mucosa of women with genital human papillomavirus lesions. Eur J Obstet Gynecol Reprod Biol. 2006;126(1):104-6. doi: 10.1016/j.ejogrb.2005.09.009.
104. Beachler DC, Lang Kuhs KA, Struijk L, Schussler J, Herrero R, Porras C, et al. The natural history of oral human papillomavirus in young Costa Rican women. Sex Transm Dis. 2017;44(7):442-9. doi: 10.1097/olq.0000000000000625.
105. Menezes LJ, Poongulali S, Tommasino M, Lin HY, Kumarasamy N, Fisher KJ, et al. Prevalence and concordance of human papillomavirus infection at multiple anatomic sites among HIV-infected women from Chennai, India. Int J STD AIDS. 2016;27(7):543-53. doi: 10.1177/0956462415587226.
106. Kero K, Rautava J, Louvanto K, Syrjänen K, Grenman S, Syrjänen S. Genotype-specific concordance of oral and genital human papillomavirus infections among marital couples is low. Eur J Clin Microbiol Infect Dis. 2016;35(4):697-704. doi: 10.1007/s10096-016-2589-9.
107. Paaso AE, Louvanto K, Syrjänen KJ, Waterboer T, Grénman SE, Pawlita M, et al. Lack of type-specific concordance between human papillomavirus (HPV) serology and HPV DNA detection in the uterine cervix and oral mucosa. J Gen Virol. 2011;92(Pt 9):2034-46. doi: 10.1099/vir.0.032011-0.
108. Van Doornum GJ, Prins M, Juffermans LH, Hooykaas C, van den Hoek JA, Coutinho RA, et al. Regional distribution and incidence of human papillomavirus infections among heterosexual men and women with multiple sexual partners: a prospective study. Genitourin Med. 1994;70(4):240-6. doi: 10.1136/sti.70.4.240.
109. Giuliano AR, Felsher M, Waterboer T, Mirghani H, Mehanna H, Roberts C, et al. Oral human papillomavirus prevalence and genotyping among a healthy adult population in the US. JAMA Otolaryngol Head Neck Surg. 2023;149(9):783-95. doi: 10.1001/jamaoto.2023.1573.