Review Article

Influence of Sexual Habits on Human Papillomavirus Infection Risk and Oral Cancer

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Abstract

Certain sexual habits facilitate the oral spread of human papillomavirus (HPV), a virus involved in 70−90% of oropharyngeal cancers. This study aimed to investigate the influence of sexual habits, especially oral sex, on the risk of both HPV infection and oral cancer. We searched the following electronic databases for studies published between 1981 and 2018 on sexual behavior, HPV detection, and oral cancer: PubMed (MEDLINE, Cochrane Library), Web of Science (WoS), and Google Scholar. This meta-analysis included 36 studies involving 10,213 oral cancer patients (7,455 males and 2,758 females) and 52,195 subjects without oral cancer (21,172 males and 31,023 females). The data are expressed as odds ratios (ORs) with their 95% confidence intervals (CIs). The risk factors for oral cancer were first sexual contact before the age of 18 years (OR: 1.98; $P < 0.01$) and number of oral sex partners (> 5) (OR: 1.68; $P < 0.001$). There were no significant differences between oral cancer patients and controls regarding oral sex practices ($P = 0.53$), number of sex partners ($P = 0.20$), number of couples in sex work ($P = 0.61$), and number of marriages ($P = 0.29$). Oral sex increased 1.96 times the probability of HPV infection ($P < 0.001$). Oral cancer patients who engaged in oral sex practices had a 2.75-fold increased risk of HPV positivity ($P < 0.001$). Oral sex practices may be an important risk factor for HPV infection and oral cancer.

Keywords: *Mouth neoplasms, oncogenic viruses, papillomavirus infections, sexual behavior*

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Background

Head and neck cancer is the sixth most frequent cancer worldwide, with oral squamous cell carcinoma the most common histological type (90% of the cases).[1] In the past, oral cancer most commonly affected older adults with a history of tobacco and alcohol use. However, the incidence of smoking-related oral cancers has steadily declined in the last 30 years. Now, the incidence of oropharyngeal cancers (i.e., base of the tongue, soft palate, tonsillar region, and posterior pharynx) is increasing.[2] One recent study reported a 5-fold increase in tongue and tonsillar cancers in young adults (20−39 years), compared with a 2-fold increase in older adults (> 55 years).[3] Today, many oral cancer patients are younger adults with no history of smoking,[4] pointing to the involvement of other etiological factors such as human papillomavirus (HPV) infection. Sexual habits, in particular, oral sex practices, facilitate HPV spread and potential infection via contact with oral mucosa. Estimates today suggest that between 70% and 90%

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of new oropharyngeal cancer cases show evidence of HPV infection.[5] The purpose of this study was to investigate the influence of sexual habits, especially oral sex, on the risk of both HPV infection and oral cancer.

Materials and Methods

A search of the following databases was conducted for studies on sexual habits, oral cancer, and HPV: PubMed (MEDLINE, Cochrane Library), Web of Science (WoS), and Google Scholar. The search strategy included a combination of Medical Subject Headings (MeSH) and free-text terms. The MeSH search terms were "sexual behavior" AND "mouth neoplasms" OR "papillomavirus infections" AND "mouth"; free-text search terms were "papillomavirus" AND "sexual behavior" OR "oral sex" AND "mouth neoplasms" OR "mouth"; the allintitle search terms were "oral sex" OR "sexual behavior" AND "oral" "cancer" OR "carcinoma." The search identified 340 articles (PubMed, n = 122; WoS, n = 201; Google Scholar, n = 17) published between 1981 and 2018. Of these articles, 126 were duplicates. The remaining 214 articles were assessed for eligibility. Two of the authors (AR-A and RS-M) independently reviewed the titles and abstracts of these articles. Articles were included in a subsequent meta-analysis based on the consensus between the two reviewers.

The exclusion criteria were: (a) articles without full-text availability (n = 68); (b) articles with ≤ 6 stars out of a maximum of 9 stars on the Newcastle–Ottawa (NOS) methodological quality assessment scale[6] (n = 51); and (c) studies with non-usable data (n = 59). After applying these criteria, 36 studies were included in the meta-analysis [Figure 1].

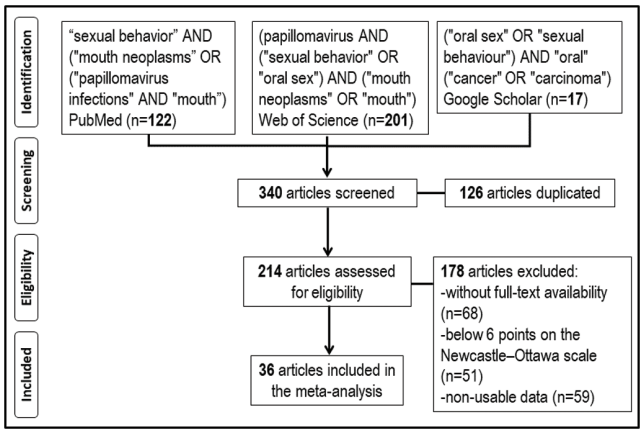

Figure 1: Study flow diagram

Statistical analysis

For the meta-analysis, the data were processed using the RevMan 5.4 program (The Cochrane Collaboration, Oxford, UK). For dichotomous outcomes, the Mantel–Haenszel (M–H) χ^2 formula was used to calculate effect estimates. The data are expressed as odds ratios (ORs), with their 95% confidence intervals (CIs). Heterogeneity was determined according to P-values and the Higgins statistic (I^2). When heterogeneity was high (I^2 > 50%), a random-effects model was applied. Tables and forest plot graphs were used to present the results. A value of P < 0.05 was considered statistically significant.

Results

Table 1 presents the descriptive characteristics and methodological quality (NOS scale) of the studies that assessed HPV status according to oral sex practices.[7-30] Considering sample collection, the two most commonly used methods were oral rinse (n = 15 studies, 62.5%) and oral smears (n = 7 studies, 29.2%). Of these 24 studies, 23 (95.8%) studies used the polymerase chain reaction method for HPV detection, and one (4.2%) study used *in-situ* hybridization.

Table 2 details the descriptive characteristics and methodological quality (NOS scale) of the studies that assessed oral cancer risk according to sexual behavior. In the 13 included studies,[23,31-42] there were 9,636 oral cancer patients (males, n = 6,922, 71.8%; females, n = 2,594, 28.2%) and 10,652 individuals without cancer (males, n = 7,277, 68.3%; females, n = 3,375, 31.7%).

Twenty-two studies examined the impact of oral sex practices on HPV infection risk in oral cancer patients vs. the general population.[7-10,12-29] The results are shown in Figure 2. Oral sex increased 1.89 times the probability of HPV infection in the general population, with a highly significant statistical relationship (OR = 1.89; 95% CI: 1.47–2.43; P < 0.001). Four studies evaluated the effect of oral sex practices on HPV infection risk in oral cancer patients [Figure 2B].[7,11,23,30] The meta-analysis of these studies revealed a 3.56-fold increase in the risk of infection, with a highly significant association between oral sex practices and HPV infection risk in oral cancer patients (OR = 3.56; 95% CI: 2.13–5.94; P < 0.001).

Table 3 shows the main oral cancer risk factors related to sexual habits. Twelve studies examined oral sex habits in patients with oral cancer and controls without the disease.[23,31-37,39-42] Although a slightly higher percentage of controls (35.5%) than oral cancer patients (31.3%) engaged in oral sex practices, the results were not statistically significant (OR = 0.94; 95% CI: 0.76–1.15; P = 0.53).

Table 1: Descriptive characteristics of 24 studies that analyze human papillomavirus (HPV) status according to oral sex practices

First author	Year	Country	Study groups	Sampling collection method	HPV detection method	NOS
Smith[7]	2004	USA	193 OC (125M, 68F, na)	Oral smears	PCR	7
D'Souza[8]	2009	USA	332 Cont. (251M, 81F, $\bar{X}$=57y)	Oral rinse	PCR	6
Brown[9]	2011	Peru	185 Cont. (0M, 185F, $\bar{X}$=22.9y)	Oral rinse, genital samples	PCR	6
Sánchez-Vargas[10]	2010	Mexico	43 Cont. (0M, 43F, $\bar{X}$=35y)	Oral smears	PCR	6
Dahlstrom[11]	2011	USA	252 OC (195M, 47F, $\bar{X}$=55.7y)	Blood samples	PCR	7
Gillison[12]	2012	USA	5231 Cont. (2748M, 2753F, na)	Oral rinse	PCR	7
Bui[13]	2013	USA	4846 Cont. (2385M, 2461F, na)	Oral rinse	PCR	7
Lang Kus[14]	2013	Costa Rica	5838 Cont. (0, 5838F, $\bar{X}$=26y)	Oral rinse	PCR	7
Antonsson[15]	2014	Australia	307 Cont. (117M, 190F, $\bar{X}$=22y)	Oral rinse	PCR	6
Cook[16]	2014	USA	1010 Cont. (0M, 1010F, na)	Oral rinse	PCR	7
Dahlstrom[17]	2014	USA	222 Cont. (222M, 0F, na)	Oral rinse	PCR	6
Davidson[18]	2014	South Africa	125 Cont. (125M, 0F, $\bar{X}$=50y)	Oral rinse	PCR	7
Hang[19]	2014	China	5410 Cont. (2566M, 2844F, na)	Oral rinse	PCR	7
Machado[20]	2014	Brazil	559 Cont. (559M, 0F, na)	Oral smears	PCR	6
Meyer[21]	2014	Germany	70 Cont. (0M, 70F, $\bar{X}$=35y)	Oral rinse, tonsillar smears, genital smears	PCR	6
Vidotti[22]	2014	Brazil	105 Cont. (0M, 105F, na)	Oral smears, genital smears	PCR	6
Chen[23]	2016	China	178 OC (110M, 68F, $\bar{X}$=58.9y) 189 Cont. (117M, 72F, $\bar{X}$=56.6y)	Oral smears	PCR	8
Kedarisetty[24]	2016	USA	3463 Cont. (0M, 3463F, na)	Oral rinse	PCR	6
Rosen[25]	2016	Peru	980 Cont. (383M, 597F, na)	Oral rinse	PCR	7
Cab-Sanchez[26]	2017	Mexico	102 Cont. (60M, 42F, $\bar{X}$=22y)	Oral smears	PCR	6
Lupato[27]	2017	Italy	500 Cont. (247M, 253F, na)	Oral rinse	PCR	6
Shi[28]	2017	China	3000 Cont. (0M, 3000F, na)	Oral smears, genital smears	PCR	6
Sonawane[29]	2017	USA	9134 Cont. (4493M, 4641F, na)	Oral rinse, genital smears	PCR	6
Taberna[30]	2017	USA	262 OC. (213M, 49F, na) 81 Cont. (9M, 72F, na)	Tissue samples	ISH	7

NOS = Newcastle–Ottawa quality scale, USA = United States of America, OC = oral cancer patients, Cont. = subjects without cancer, M = male, F = female, $\bar{X}$ = mean age, y = years, na = data not available, PCR = polymerase chain reaction, ISH = *in-situ* hybridization

Seven studies analyzed the possible influence of having more than five sex partners on oral cancer risk.[31-35,37,39] Although the results revealed an association between a greater number of partners and oral cancer risks, the association was not statistically significant (OR = 1.40; 95% CI: 0.84–2.33; P = 0.20). According to three studies, engaging in oral sex with more than five partners increased the probability of oral cancer 1.68 times,[32,38,39] with a highly significant statistical difference (OR = 1.68; 95% CI: 1.24–2.28; P < 0.001).

Another three studies evaluated whether age <18 years at the time of first sexual intercourse influenced the risk of oral cancer.[8,23,32] Based on these studies, the latter was associated with a 1.98-fold increase in the probability of oral cancer, with a significant statistical relationship (OR = 1.98; 95% CI: 1.26–3.12; P < 0.01).

Three studies considered the potential association of sexual contact with prostitutes (more than five partners) with oral cancer risk.[33,34,37] The results revealed no statistically significant association (OR = 0.83; 95% CI: 0.41–1.70; P = 0.61). Finally, two studies assessed the role of marriage number (> 3) as a possible risk factor for oral cancer.[34,37] This factor did not increase the risk, with no statistically significant association (OR = 0.78; 95% CI: 0.50–1.23; P = 0.29).

Discussion

There is limited evidence suggesting that a high number of lifetime sexual partners, engaging in oral sex, and

Table 2: Descriptive characteristics of 13 studies that assess oral cancer risk according to sexual behavior

First author	Year	Country	Study groups	Parameters analyzed	NOS
Maden[31]	1992	USA	131 OC (131M, 0F, na) 136 Cont. (136M, 0F, na)	Number of sexual partners, type of sexual practices	8
Schwartz[32]	1998	USA	284 OC (165M, 119F, na) 477 Cont. (302M, 175F, na)	Number of sexual partners, type of sexual practices, age of first sexual intercourse	7
Talamini[33]	2000	Italy	132 OC (99M, 33F, $\bar{X}$=60y) 148 Cont. (103M, 45F, $\bar{X}$=60y)	Number of sexual partners, type of sexual practices, number of prostitutes	7
Garrote[34]	2001	Cuba	200 OC (143M, 57F, $\bar{X}$=64y) 200 Cont. (136M, 64F, $\bar{X}$=62y)	Number of sexual partners, type of sexual practices, number of marriages, number of prostitutes	8
Herrero[35]	2003	Various countries	10 OC (1074M, 576F, na) 1732 Cont. (1078M, 654F, na)	Number of sexual partners, type of sexual practices	9
Lissowska[36]	2003	Poland	122 OC (78M, 44F, na) 124 Cont. (72M, 52F, na)	Number of sexual partners, type of sexual practices, number of marriages, number of prostitutes	7
Rajkumar[37]	2003	India	591 OC (309M, 282F, $\bar{X}$=57y) 582 Cont. (292M, 290F, $\bar{X}$=54y)	Number of sexual partners, type of sexual practices, number of marriages, number of prostitutes	8
Rosenquist[38]	2005	Sweden	132 OC (91M, 41F, $\bar{X}$=64y) 320 Cont. (215M, 105F, $\bar{X}$=63y)	Number of sexual partners, type of sexual practices	8
D'Souza[39]	2007	USA	100 OC (86M, 14F, na) 200 Cont. (172M, 28F, na)	Number of sexual partners, type of sexual practices, age of first sexual intercourse	7
Heck[40]	2010	Various countries	5642 OC (4401M, 1241F, na) 6069 Cont. (4411M, 1658F, na)	Number of sexual partners, type of sexual practices, age of first sexual intercourse	9
Loyha[41]	2012	Thailand	104 OC (39M, 65F, na) 104 Cont. (39M, 65F, na)	Number of sexual partners, type of sexual practices	7
Chen[23]	2016	China	178 OC (110M, 68F, $\bar{X}$=58.9y) 189 Cont. (117M, 72F, $\bar{X}$=56.6y)	Number of sexual partners, type of sexual practices, age of first sexual intercourse	8
Laprise[42]	2016	Canada	350 OC (196M, 154F, $\bar{X}$=60.8y) 371 Cont. (204M, 167F, $\bar{X}$=60.5y)	Number of sexual partners, type of sexual practices	8

NOS = Newcastle–Ottawa quality scale, USA = United States of America, OC = oral cancer patients, Cont. = subjects without cancer, M = male, F = female, $\bar{X}$ = mean age, y = years, na = data not available, PCR = polymerase chain reaction, ISH = *in-situ* hybridization

having a female partner with a history of cervical cancer are associated with an elevated risk of both HPV infection and oral cancer, especially oropharyngeal cancer.[2] The present meta-analysis focussed on the possible influence of sexual habits on the risk of both oral cancer and HPV infection included data from 36 studies. According to our results, oral sex practices increased the probability of HPV infection in the general population, with a highly significant statistical association between these factors ($P < 0.001$). Although 19 of 22 studies that reviewed the influence of oral sex practices on the risk of HPV infection found a higher risk among those who engaged in oral sex,[7-10,12-19,21,23-26,28,29] three studies found a higher incidence of HPV infection among those who did not engage in oral sex.[20,22,27] Similarly, oral cancer patients who engaged in oral sex practices raised their probability of HPV infection, with a highly significant statistical association ($P < 0.001$). All the studies that assessed risk factors for HPV highlighted a direct relationship between a higher incidence of oral sex practices and an elevated risk of oral cancer.[7,17,23,30]

The reported increase in the incidence of HPV-positive oropharyngeal cancers, particularly among young people who do not smoke or drink, has been attributed to changes in sexual behavior, such as oral sex habits, which may increase the likelihood of HPV transmission and oral infection.[13] According to Shi *et al.,*[28] the most relevant factors that increase the risk of HPV infections are oral sex practices (multiplies six times the risk) and smoking (multiplies five times the risk). In addition, individuals who engage in oral sex with a higher number of partners have an increased likelihood of oral HPV infections.[29]

As reported previously, oral sex and a greater number of sexual partners are the primary factors that increase the risk of oral HPV infection.[29] Furthermore, oral infection with HPV type 16, the HPV type with the highest oncogenic risk, significantly increases the risk of oropharyngeal cancer by up to 22 times.[5] According to the literature, the most probable mode of transmission of HPV-16 to the upper aerodigestive tract is oral-genital contact.[11] The use of barrier methods is the most effective preventive measure to reduce the risk

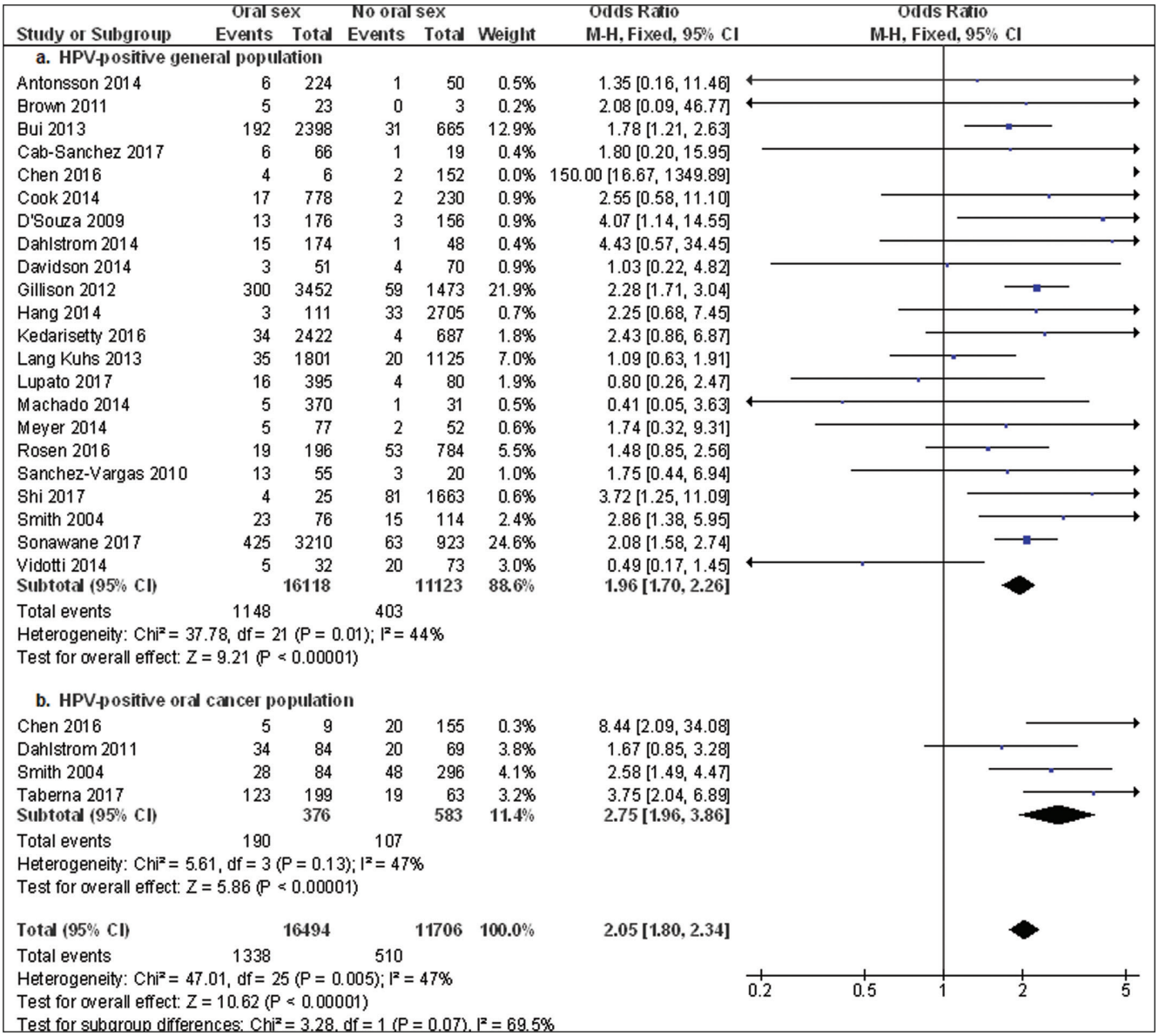

Figure 2: Study data and forest plot graph for the oral sex practice in both general population (A) and oral cancer patients (B) infected by the human papillomavirus (HPV+)

Table 3: Oral cancer risk factors related to sexual habits

Risk factor	*n*	Outcome	OR	[95% CI]	I^2 (%)	*P*-value
Oral sex practices	12	Non-oral cancer subjects	0.94	[0.76–1.15]	69	0.53
Oral sex partners	3	>5 partners	1.68	[1.24–2.28]	0	<0.001*
Non-oral sex partners	7	>5 partners	1.40	[0.84–2.33]	89	0.20
First sexual intercourse	3	<18 years old	1.98	[1.26–3.12]	65	<0.01*
Number of prostitutes	3	>5 partners	0.83	[0.41–1.70]	47	0.61
Number of marriages	2	>3 marriages	0.78	[0.50–1.23]	24	0.29

n = number of studies, OR = odds ratio, [95% CI] = 95% confidence interval, I^2 = Higgins statistic for heterogeneity (percentage). *Statistically significant

of both HPV infection and other sexually transmitted infections.[30]

In this study, when we analyzed oral sex practices among oral cancer patients and controls without cancer, there was a slightly higher percentage among the controls, although the finding was not statistically significant (P = 0.53). Of the 12 studies that evaluated oral sex practices, 8 of the studies found a higher incidence of

oral sex practices among the controls,[31-36,40,42] and the remaining 4 studies found a higher incidence among oral cancer patients.[23,37,39,41] Several studies found no relevant differences between oral cancer patients and controls in terms of oral sex habits.[32-34,41] Of note, one study found an inexplicable protective effect of oral sex on oral cancer risk.[31]

When oral sex practices in the general population were analyzed according to gender, our results revealed differences between males and females with respect to oral cancer risk, with males who frequently engaged in oral sex showing a higher oral cancer risk compared to females who never engaged in oral sex. Nevertheless, other researchers did not find evidences of an association between oral sex practices and oral cancer risk among females.[37] In the case of HPV oral infections, the results suggest that males who engage in oral sex with females may have a higher risk of HPV oral infection, but not vice versa.[23] It is important to note that non-reporting of oral sex practices, possibly due to embarrassment, may preclude accurate assessments of the association between oral cancer risk and gender.[42]

In the present study, although having a higher number of sex partners (> 5) did not affect the risk of oral cancer, a higher incidence or engaging in oral sex practices was significantly associated with an elevated oral cancer risk.

An increase in the number of non-oral sex partners does not seem to have a significant impact on oral cancer risk or to be associated with an increased risk of oral HPV infection, which is closely linked with oropharyngeal carcinoma.[37] In contrast, individuals with a greater number of oral sex partners are more likely to contract oral HPV and therefore to have an elevated risk of oral cancer.[39]

In this study, first sexual contact aged younger than 18 years increased the probability of oral cancer. According to the literature, earlier initiation of sexual activity, together with oral sex practices and tobacco consumption, is associated with an elevated incidence of oral HPV infection.[8] According to Chen *et al.*,[23] individuals with HPV infection who engaged in sexual activity before the age of 18 years had a 13-fold increase in oral cancer risks compared with those without HPV infection who had their first sexual contact after the age of 18 years.

In the present paper, sexual contact with a greater number of prostitutes (> 5) was not significantly associated with oral cancer risk (P = 0.61). Of the three studies that evaluated this variable, two studies found a higher incidence of engaging in sexual activity with prostitutes among oral cancer patients than controls,[34,37] whereas the other study found the opposite finding.[33] The possible link between sexual contact with prostitutes and oral cancer is inconsistent, suggesting that other indicators of sexual habits (history of sexually transmitted diseases, total number of sexual partners, etc.) influence oral cancer risk.[34,37] Based on the literature, it seems that the risk of oral cancer rises in association with an increase in the number of sexual partners, irrespective of the identity of these partners (i.e., prostitutes or not).[33]

In this study, the number of marriages (> 3 marriages) was not statistically significantly associated with oral cancer risk (P = 0.29). Of the two studies that considered this variable, one study found a higher number of marriages among oral cancer patients,[37] whereas the other study found a greater number among healthy controls.[34] Thus, the potential role of marriage number in oral cancer risk is inconclusive. More studies are needed to shed light on this issue. Many factors other than marriage number seem to influence oral cancer risk. These include the number of sexual partners, type of sexual practices, history of sexually transmitted diseases, existence of wounds due to sexual activity, and HPV status of sexual partners.[37]

The present study has some limitations. It is difficult to obtain reliable information on the sexual habits of the population, as such information is personal, and many individuals may not be totally honest about these habits. Possibly, sexual habits of the general population, including oral sex practices, have a greater influence on the risk of oral HPV infection than on the risk of oral cancer. If this is the case, sexual practices may have infective but not oncogenic potential.

The findings of this meta-analysis should be interpreted cautiously because of the high heterogeneity of some comparisons and differences between the studies in terms of data collection methods, statistical analyses, and characteristics of the study populations.

Conclusions

In this meta-analysis, oral sex practices increased the probability of HPV infection more in oral cancer patients than in the general population. Other significant oral cancer risk factors were engaging in first sexual contact before the age of 18 years and having more than five oral sex partners. No significant differences were observed between oral cancer patients and controls with respect to oral sex practices, number of sex partners, number of sexual encounters with prostitutes, and number of marriages.

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Conflicts of interest

There are no conflicts of interest.

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