

Cervical HPV Infection in Female Sex Workers: A Global Perspective

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Abstract: *Introduction:* Approximately 291 million women worldwide are HPV DNA carriers. Studies have indicated that having multiple sexual partners may lead to higher HPV transmission. Thus female sex workers (FSWs) may be at greater risk of infection compared to the general population. Herein we review publications with data on FSW cervical HPV test results. We also examine variations of HPV prevalence and risk behaviors by region. Knowledge of prevalent HPV types in FSWs may lead to improved prevention measures and assist in understanding vaccination in high-risk groups.

Methods: We conducted a review of the literature by searching PUBMED using the terms “prostitution” or “female sex workers”, “human papillomavirus” or “HPV”, and “prevalence” or “PCR” to find articles. We excluded studies without HPV testing or HPV type specific results, or unconventional HPV testing.

Results: A total of 35 peer-reviewed publications were included in our review. High risk HPV types 16 and 18 ranged from 1.1-38.9% in prevalence. In addition to high-risk HPV types, newer studies reported non-carcinogenic HPV types also of high prevalence. The most prevalent HPV types reported among FSWs included HPV 6 (11.5%), 16 (38.9%), 18 (23.1%), 31 (28.4%), 52 (32.7%), and 58 (26.0%).

Conclusions: Female sex workers have an overall high prevalence of HPV infection of high-risk types as evident through various testing methods. FSWs are thought to be at increased risk of cervical cancer because of high HPV exposure. This highlights the need for HPV and cervical prevention campaigns tailored to FSWs.

Keywords: Female sex workers, genotype, HPV, PCR, prevalence, prostitution.

INTRODUCTION

The Human Papilloma Virus (HPV) encompasses a family of viruses that can infect the genital tract and cervix of women. It is a known causal factor in the development of cervical cancer and genital warts [1]. Approximately 291 million women worldwide are HPV DNA carriers [2]. The virus is associated with anal, vaginal, penile and oral cancers [3]. It is most commonly associated with cervical cancer as the virus causes nearly 500,000 incident cases of cervical cancer and 274,000 cervical cancer deaths annually [4]. Cervical cancer is the second most frequently diagnosed type of cancer in women worldwide. It is much more common in developing countries, where 83% of cases occur [5]. Studies have indicated that a high number of lifetime partners may lead to a higher transmission of HPV leading to higher cervical cancer rates [6-8]. In female sex workers (FSWs), the risk of HPV infection and cervical cancer is especially high. A previous studies have reported that FSW had more than twice the probability of having HPV infection than women from the general population and have a higher

prevalence of abnormal pap smears [9, 10]. In addition, HPV can be transmitted from FSWs to the general population through clients thereby increasing the prevalence of the virus.

There are currently two approved HPV vaccines on the market. The vaccines produced by Merck (quadrivalent HPV vaccine) and GlaxoSmithKline (bivalent HPV vaccine) both protect against chronic infection with HPV types 16 and 18, whereas the quadrivalent HPV vaccine also protects against HPV types 6 and 11 among individuals unexposed to the virus. HPV types 6 and 11 cause 90% of genital warts and types 16 and 18 cause 70% percent of cervical cancers worldwide [11]. Approximately 32% of the 291 million HPV infected women from the general population are infected with types 16 and 18 [2]. However there is limited information on the most prevalent HPV types for the FSW population. To our knowledge there have been only two published review papers on sexually transmitted infections (STIs) in FSWs. One review reported results from only 2 studies that assessed HPV in this population [12], whereas the other review focused on FSWs in Asia [13]. In order to assess the burden of HPV infection in the FSW population, we reviewed articles that assessed the prevalence of HPV types in the FSW population worldwide, and the association of HPV with cervical cancer precursors in this population.

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With an understanding of the prevalence of HPV in each region, better screening methods can be developed and utilized that provide more accurate results for the HPV types prevalent in said region. Eventually, HPV vaccines can be tailored to prevent infection with region-specific HPV types.

METHODS

We conducted a review of the literature by searching PUBMED using the terms “Prostitution” or “female sex workers”, “human papillomavirus” or “HPV”, and “prevalence” or “PCR” to find articles published from November 9, 1989 to November 9, 2012.

We excluded studies without HPV testing results, type specific prevalence rates or only reported multiple infection prevalence rates. We also excluded studies based on their methodology including studies that tested less than 5 FSWs,

tested only HIV positive participants, or used unconventional methods of HPV sample collection (tampon). We only included studies that were written in English or Spanish due to the mother tongue of the authors. Original articles that were unavailable, opinion papers, commentaries, case reports, systematic reviews and subsamples from original papers were not reviewed herein, nor were studies that used any method of sample collection other than cervical or vaginal swabs or scrapes. Additionally, we identified significant references in existing review papers and subsequently excluded the review paper itself.

RESULTS

This PUBMED search resulted in a total of 127 manuscripts (Fig. 1). Overall, fourteen papers were excluded because they were in a language other than English or Spanish, the original paper was not available or were out of

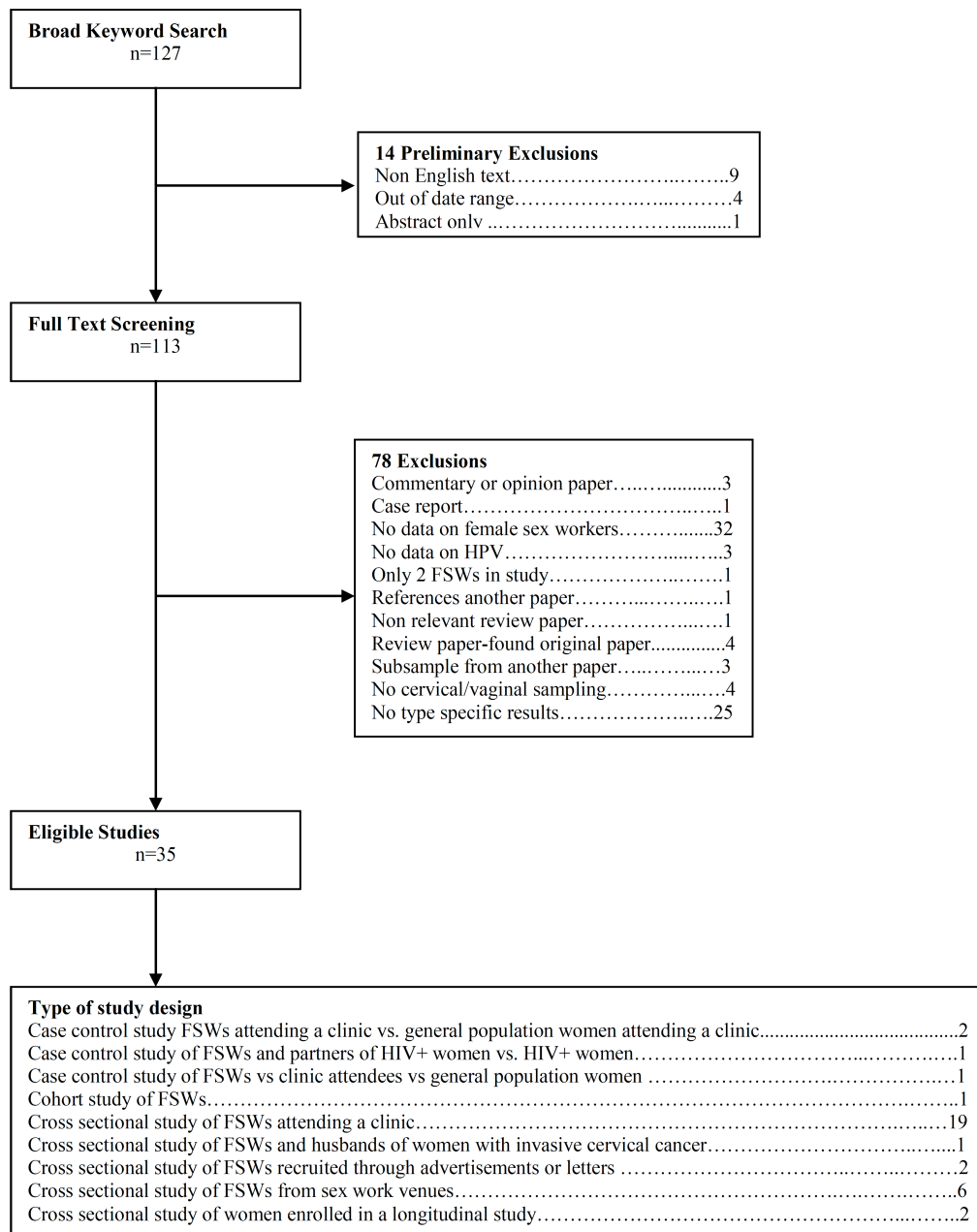


Fig. (1). Flow chart.

the predetermined date range. One hundred and thirteen full text manuscripts were screened. Of these, 78 papers were subsequently excluded because they were a commentary or opinion paper, case report, referenced another paper, review paper and we found the original article [12,14], non-relevant review paper, or was a subsample from another paper in our review. We also excluded papers that had no data on female sex workers, an insufficient number of sex workers, used unconventional HPV testing, no data on HPV or type specific results. A total of 35 eligible manuscripts were included in this review, including four case control studies, one cohort study, and 30 cross sectional studies [9, 15-48]. We included 6 studies from Africa, 6 from the Americas, 2 from Eastern Mediterranean, 10 from Europe, 2 from Southeast Asia and 9 from the Western Pacific Region. For this review, studies that reported the prevalence of type specific single infections among FSWs were used. Numerous studies included both HIV positive and negative FSWs. Data that only presented multiple, coexisting infection data or HIV positive FSWs data was not included. Background information from studies included in the review including sample size and HPV types detected is shown in Table 1.

Demographic Characteristics

In the papers reviewed, the age range of FSWs was between 15-62 years old. The mean weighted age, as calculated from the mean ages reported and number of sex workers in each study, was 26.9 years. The education level was reported by a few studies and a majority of these FSW had only a primary school education. One study found that FSWs in Vietnam with a secondary or high school education were less likely to be positive for multiple HPV infection types in comparison to women with only a primary school education or no formal schooling [15].

HPV and Regions

The median overall prevalence of HPV in these studies is 42.7%, with a range of 2.3 to 100%. Fig. (2) illustrates the prevalence range of 9 HPV types in the 35 studies. The most highly prevalent HPV types are HPV 6 (11.5%), 16 (38.9%), 18 (23.1%), 31 (28.4%), 33 (25.0%), 39 (21.6%), 51 (25.0%), 52 (32.7%), 56 (24.0%) and 58 (26.0%). Among the studies that also reported multiple infection data, the median prevalence is 20.4%. The most prevalent number of coinfections is 2 (32.1%), 3 (19.4%), 4 (17.9%) and over 5 (10.3%) HPV types.

Fig. (3) illustrates the overall HPV prevalence among FSWs by region. Manuscripts were stratified into WHO defined regions. Twenty-five countries were included in the review, with multiple studies from Belgium, Burkina Faso, Japan, Korea, Mexico, Singapore, South Africa, Spain, Thailand, and Tunisia. The number of tested HPV types ranged from one to over 30 different serotypes. Each study presented in this review tested for HPV 16. Fig. (3) shows the median prevalence of the high risk HPV 16 type by region: Africa (8.0%); Americas (11.1%); Eastern Mediterranean (13.7%); Europe (11.5%); South East Asia: (13.9%); Western Pacific: (6.9%). Prevalence of HPV type 16 ranged from 1.1-38.9% across all regions.

Risk Behaviors

Condom Use and Other Barrier Methods

Consistent condom use with clients varied, with a range of 16%-77% in Africa [16, 17], 65.7-99.2% in the Americas [9,18], 37% in the Eastern Mediterranean [19], 50% in Europe [20], 69.3-82.9% in Southeast Asia [21, 22] and 85-90.8% in the Western Pacific [15,23]. Other popular mechanisms of contraceptives were the barrier method [9] and microbicides [17].

Smoking

Current smoking status varied from 7% in Africa [16], 50.3% in the Americas [9], 83% in the Eastern Mediterranean [19], 44% in Europe [24], and 35% in the Western Pacific [25]. Southeast Asian region studies did not report FSW smoking status.

Alcohol Use

We only have information about alcohol use in studies done in the Eastern Mediterranean region where one study reported all FSW were habitual alcohol users [26], and others reported that 50% currently drank [19].

Age at First Sex

Age at first sexual intercourse for FSWs ranged from 9 [18]-over 20 years old [25]. In all studies the majority of FSWs were less than 20 years old at the age of sexual initiation: Africa 16.7 years old [16]; Americas 9-22 years [18, 27]; Europe: 16 years [24]; and in the Western Pacific 15-20 years of age [15, 23, 28]. Eastern Mediterranean regions did not give a specific age but indicated that a majority were less than 20 years old [19]. Southeast Asian regions did not report an age at first sex.

Time in Sex Work and Partners

Average time in sex work ranged from less than 6 months [27] to 16 years [19]. The number of partners per week ranged from 2 [29] to over 20 [17]. The number of partners per week ranged from 2.3-20 in Africa [17, 29], while 42% of women from studies in the Americas had less than 7 partners [9,30]. Another study from the Americas reported an average of 166 partners in the past month [18], whereas a study from the Western Pacific region reported an average of 18 partners in the past month [15]. One study from Southeast Asia indicated that the majority of women worked less than 20 days per month [22]. A study from Europe reported that 41% of women had less than 1056 partners in the past year [24]. Eastern Mediterranean studies did not report the number of partners.

HIV Co-Infection

The median overall prevalence of HPV among HIV positive FSW is 73.3%. The prevalence ranged from 32-87% [16, 20]. The median prevalence of multiple infections is 48.7%. The most highly prevalent HPV types among HIV positive FSW are HPV 16 (54.2%) and HPV 18 (21.4%).

HPV Sample Types and Detection Methods

All studies included in our review collected samples from cervical or cervico-vaginal swabs, cervico-vaginal lavage

Table 1. Background Information on 35 Studies of Female Sex Workers that Include HPV Genotype Testing

WHO Defined Region-Date	Country	City or State	# FSWs	HPV Sampling and Testing Methods	HPV Types Tested	Overall HPV Prevalence
Africa-2007 [31]	Burkina Faso	Bobo-Dioulasso	350	Samples obtained with a cervical brush. HPV DNA was detected with PCR and genotyped with INNO LiPA (Line Probe Assay) HPV Genotyping v2 test	16, 18, 31, 35, 51 and 52	8.0%
Africa-2010 [29]	Kenya	Mombasa	503	Samples obtained with a cervical brush. HPV DNA was detected and genotyped with real time PCR and TaqMan	6, 16, 18, 31, 33, 35, 39, 45, 51, 52, 53, 56, 58, 59, 66, 67 and 68	45.5%
Africa-2006 [16]	Burkina Faso	Bobo Dioulasso	360	Samples obtained with a cervical brush. HPV DNA was detected with PCR and genotyped with INNO-LiPA HPV genotyping V2 test	6, 11, 16, 18, 31, 33, 35, 39, 40, 42, 43, 44, 45, 51, 52, 53, 54, 56, 58, 59, 66, 68, 70 and 74	66.1%
Africa-2000 [42]	South Africa	KwaZulu-Natal midlands	52	Samples obtained with a cervicovaginal rinse. HPV DNA was detected and genotyped with PCR and a HPV 16 specific primer	16	42%
Africa-2009 [17]	South Africa	KwaZulu-Natal Midlands	52	Samples obtained with a cervicovaginal rinse. HPV DNA was detected with PCR and genotyped through a Roche reverse line blot assay	6, 11, 16, 18, 26, 31, 33, 35, 39, 40, 42, 44, 45, 51, 52, 53, 54, 55, 56, 58, 59, 66, 68, 73, 82, 83 and 84	100%
Americas-2009 [9]	Guatemala	Escuintla	292	Samples obtained with a cervical brush. HPV DNA was detected and genotyped with PCR and Linear Arrays HPV genotyping test.	5, 6, 8, 11, 16, 18, 26, 31, 33, 35, 39, 40, 42, 45, 51, 52, 53, 54, 55, 56, 58, 59, 61, 62, 64, 66, 67, 68, 69, 70, 71, 72, 73, 82, 83, 84, CP6108 and IS39	67.3%
Americas-2001 [27]	Mexico	Mexico City	55	Samples obtained from a gynecological examination. HPV DNA was detected and genotyped with PCR and type specific primers	3, 6, 11, 16, 18, 31, 33, 34, 35, 39, 53, 56, 58, 59, 66, 68 and 72	11.8%
Americas -2001 [30]	Mexico	Mexico City	495	Samples obtained with a cervical swab. HPV DNA was detected and genotyped with PCR and probe hybridization	6, 11, 16, 18, 26, 31, 33, 35, 39, 40, 42, 45, 51, 52, 53, 54, 55, 56, 57, 58, 59, 66, 68, 73, 82, and 83	48.9%
Americas -2012 [18]	Peru	Lima	199	Samples obtained with a cervical swab. HPV DNA was detected through PCR and genotyped with Roche Linear Array	6, 11, 16, 18, 26, 31, 33, 35, 39, 40, 42, 45, 51, 52, 53, 54, 55, 56, 58, 59, 61, 62, 64, 66, 67, 68, 69, 70, 71, 72, 73, 81, 82, 82var, 83, 84, and 89	66.8%
Americas -2011 [43]	Peru	Lima	87	Samples obtained through routine examinations and tested using a line-blot assay	6, 8, 11, 16, 18, 26, 31, 33, 35, 39, 40, 42, 45, 51, 52, 53, 54, 55, 56, 58, 59, 61, 62, 66, 67, 68, 69, 71, 72, 73, 81, 83, 84, CP6108 and IS39.	50.6%
Eastern Mediterranean - 2006 [26]	Tunisia	Tunis	64	Samples obtained with an Ayre spatula. HPV DNA was detected with PCR and genotyped with restriction fragment length polymorphism	6, 16, 18, 31, 33, 35, 45, 52, 56, 58, 72, 82 and 83	43.7%
Eastern Mediterranean-2003 [19]	Tunisia	Sousse	51	Samples obtained with a cytobrush. HPV DNA was detected and genotyped with PCR and type specific primers	6, 11, 16, 18, 31, 33, 52 and 58	39.0%
Europe-2007 [44]	Italy	Campania region	31	Samples obtained with a cytobrush. HPV DNA was detected with PCR, direct nucleotide sequenced and identified with BLASTn software	16, 31, 33, 35, 42, 52, 54, 56, 58, 67, 70 and 81	22.6%

(Table 1) contd.....

WHO Defined Region-Date	Country	City or State	# FSWs	HPV Sampling and Testing Methods	HPV Types Tested	Overall HPV Prevalence
Europe-2006 [45]	Spain	Madrid and Alicante	1071	Samples obtained with a cervical brush. HPV DNA was detected with HPV DNA test Hybrid Capture II and genotyped through PCR	16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59 and 68	31.5%
Europe-2012 [32]	Spain	Galician	208	Samples obtained with a cervical brush. HPV DNA was detected and genotyped with Digene Hybrid Capture II	16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59 and 68	7.50-35.5%
Europe-2004 [37]	Belgium	Ghent	93	Samples were obtained, identified as HPV positive through a reverse hybridization assay and genotyped.	6, 11, 16, 18, 31, 33, 34, 35, 39, 40, 42, 43, 44, 45, 51, 52, 53, 54, 56, 58, 59, 66, 68, 70, 73 and 74	77.4%
Europe-2011 [46]	Bulgaria	Sofia	46	Samples obtained with a cytobrush. HPV DNA was detected and genotyped through PCR	6, 11, 16, 18, 31 and 33	43.4%
Europe-2004 [33]	Spain	Oviedo	187	Samples obtained from a gynecological examination. HPV DNA was detected and genotyped through PCR	6, 11, 16, 18, 31, 33, and 39	27.8%
Europe-2009 [24]	Spain	Alicante	549	Samples obtained with a cervical brush. HPV DNA was detected and genotyped through PCR and Digene Hybrid Capture II	16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59 and 68	31%
Europe-1997 [47]	Turkey	Ankara	88	Samples obtained from a gynecological examination. HPV DNA was detected and genotyped through PCR and type specific primers	6, 11, 16, 18, 31, 33, 35, 42, 51 and 58	2.3%
Europe-1993 [20]	The Netherlands	Amsterdam	44	Samples obtained with an Ayre spatula or cervical brush. HPV DNA detected and genotyped with PCR and type specific oligonucleotide probes	6, 11, 16, 18 and 33	6.8%
Europe-2000 [48]	Denmark	Copenhagen	182	Samples obtained through a self administered cervicovaginal lavage kit. HPV DNA was detected and genotyped with PCR and an enzyme immunoassay	6, 11, 16, 18, 31, 33, 35, 39, 40, 41, 42, 43, 44, 45, 51, 52, 56, 58, 59, 66 and 68	32.4%
South East Asia-2012 [34]	India	West Bengal	45	Samples obtained with a cervical brushes. HPV DNA was detected and genotyped with PCR and type specific PCR primers	16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59 and 68	73.3%
South East Asia-2012 [21]	Bangladesh	Dhaka	809	Samples obtained with a cervical brush. HPV DNA was detected and genotyped with PCR and type specific primers	16, 18 and 33	18.2%
South East Asia-2001 [22]	Thailand	Bangkok	251	Samples obtained with a cervical swab. HPV DNA was detected and genotyped with PCR based assays	6, 11, 16, 18, 31, 33, 35, 39 and 45	47.0%
Western Pacific-2009 [28]	Philippines	Manila	295	Samples obtained with a cervical brush. HPV DNA was detected with PCR, cloned and compared with BLAST	6, 9, 11, 16, 18, 26, 30, 31, 32, 33, 34, 35, 38, 39, 40, 42, 43, 44, 45, 51, 52, 53, 54, 55, 56, 58, 59, 61, 62, 66, 67, 68, 70, 73, 74, 81, 82, 83, 84, 86, 87, 90, 91, 102 and JEB2	57.2%
Western Pacific-2008 [15]	Vietnam	Soc Trang	282	Samples obtained through a physical examination and sent to a HPV testing lab	6, 11, 16, 18, 26, 31, 33, 35, 39, 40, 42, 45, 51, 52, 53, 54, 55, 56, 58, 59, 61, 62, 64, 66, 67, 68, 69, 70, 71, 72, 73, 81, 82, 83, 84, IS39 and CP6108,	85.0%

(Table 1) contd.....

WHO Defined Region-Date	Country	City or State	# FSWs	HPV Sampling and Testing Methods	HPV Types Tested	Overall HPV Prevalence
Western Pacific-2008 [35]	Korea	Seoul	188	Samples obtained with a cervical swab and cytobrush scrape. HPV DNA was detected and genotyped with PCR and a HPV DNA Chip package	6, 11, 16, 18, 31, 33, 34, 35, 39, 40, 42, 44, 45, 51, 52, 56, 58, 59, 66, 68 and 69	31.9%
Western Pacific-2007 [36]	Korea	Seoul	743	Samples obtained with a cervical swab. HPV DNA detected and genotyped with an oligonucleotide chip	6, 11, 16, 18, 31, 33, 34, 35, 39, 40 and 42	50.3%
Western Pacific-2003 [38]	Korea		417	Samples obtained with a cytobrush. HPV DNA was detected through Digene Hybrid Capture II and genotyped through an oligonucleotide microarray	6, 11, 16, 18, 31, 35, 39, 42, 43, 44, 45, 51, 56, 58, 59 and 68	46.5%
Western Pacific-2011 [39]	Japan	Kyoto	196	Samples were obtained. HPV DNA was detected with PCR and genotyped with the Kurabo GeneSquare Microarray system.	6, 11, 16, 18, 30, 31, 33, 34, 35, 39, 40, 42, 45, 51, 53, 54, 56, 58, 59, 61, 66 and 68	52.6%
Western Pacific-2001 [25]	Singapore	Singapore	187	Samples obtained with a spatula and cytobrush. HPV DNA was detected and genotyped through PCR	6b, 16, 18, 31, 33, 34, 35, 45, 56 and 58	14.4%
Western Pacific-2000 [40]	Singapore	Singapore	188	Samples obtained with a cervical scrape. HPV DNA detected and genotyped with PCR and type specific primers	6b, 16, 18, 31, 33, 34, 35, 45, 56 and 58	14.4%
Western Pacific-2012 [41]	China	Guangxi	810	Samples obtained with a cervical swab. HPV DNA was detected and genotyped with a HPV GenoArray test kit	6, 11, 16, 18, 31, 33, 35, 39, 42, 43, 44, 45, 51, 52, 53, 56, 58, 59, 66, 68 and CP8304	38.9%
Western Pacific-2012 [23]	Cambodia	Phnom Penh	220	Samples obtained with a cytobrush. HPV DNA was detected and genotyped with PCR and type specific probes.	6, 11, 16, 18, 26/69, 31, 32/42, 33, 35, 39, 45, 51, 52, 53, 54, 56, 58, 59, 61, 62, 66, 67, 68, 70, 71, 72, 73, 81, 82, 83 and 84	41.1%

kits or from gynecological examinations for HPV detection. HPV testing methods varied between studies and over time, and was independent of geographical region. The most common methods in reviewed studies included line blot hybridization [17], line probe assay [31], hybrid capture 2 [32], linear array [9], RFLP [26], in house PCR [33], and reverse line blot [15].

DISCUSSION

High risk HPV DNA infection is common among FSWs globally, with no clear heightened risk in any geographic location when excluding HIV prevalence. A wide range of sample and testing methodologies over time make it difficult to compare HPV prevalence across any studies. However, the results of this review are indicative of the demographic characteristics of a group of women at high risk for incident HPV infection, the types most common among HPV positive FSWs, and the areas where preventative interventions should be focused for cervical cancer prevention.

One study saw that HPV prevalence was higher in 20-year-old or younger women compared to women over 20 years old [33]. There may be a decrease in HPV type prevalence by age due to clearance of infection and natural immunity, but this may also be due to increased safe sex practices at older ages [49]. While we cannot make this conclusion here from limited data in our review, a decrease in the number of sexual partners with increasing age may

also explain this age related patterns of HPV prevalence. Previous studies have shown that this may be attributed to a constant systemic production of HPV antibodies contributing to an immune response against new infection [33].

The prevalence of type specific HPV varied by region. All regions exhibited a high prevalence of the high-risk HPV types 16 and 18 despite differences in HPV detection methods. These results specify the importance of cervical cancer screening in high-risk groups such as FSWs. Other prevalent high-risk types varied by region and were dependent on HPV testing capability for specific genotypes.

HIV is a known risk factor for increased HPV detection and is common among FSWs worldwide [50]. For this reason, we excluded FSWs with HIV infection from the main analysis in our review. We separately analyzed HIV positive women and the prevalence of HPV. The overall prevalence of HPV in HIV positive women is higher than that of HIV negative women. Further reviews warrant analysis of HPV prevalence in HIV positive and HIV negative FSWs for comparison. We also examined various risk factors which are related to HPV infection such as condom use and other barrier methods, smoking, alcohol use, age at first sex, time in sex work and number of partners.

Our review of HPV in FSWs has several limitations. Each study utilized unique laboratory methods in testing multiple HPV types. Additionally, HPV detection methods

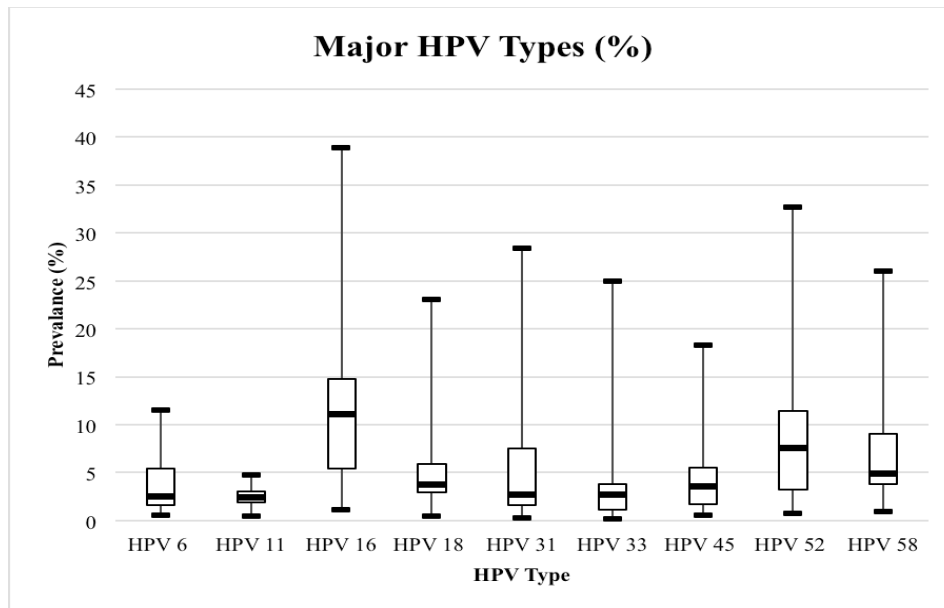


Fig. (2). Range of HPV DNA prevalence in 35 studies by 9 major HPV genotypes. Legend: Boxplot markers represent minimum, quartile 1, median, quartile 3 and maximum HPV type prevalence.

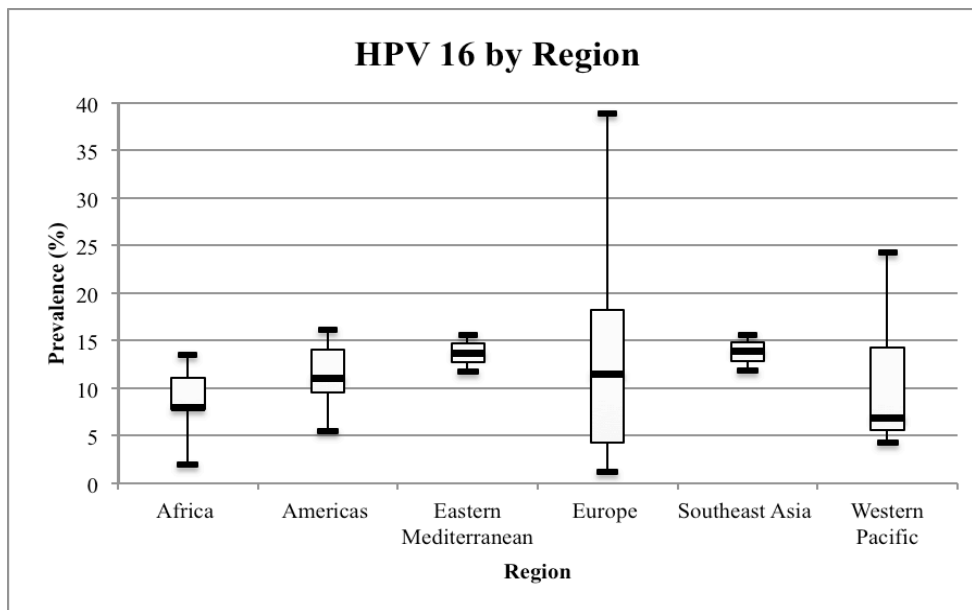


Fig. (3). Range of HPV 16 in the WHO defined regions. Legend: Boxplot markers represent minimum, quartile 1, median, quartile 3 and maximum HPV 16 prevalence.

have markedly improved over time [51]. For example, HPV 16 prevalence has increased when comparing the earliest to the most recent studies in the review, even when testing the same samples at different time periods [17, 42] For this reason, comparing the prevalence of HPV between studies and over time is challenging, as is making conclusions based on data by grouping studies. Potential contamination and limitations of testing only certain genotypes makes it difficult to compare the reported prevalence. Also, some but not all studies evaluated the adequacy of the sample, which might influence HPV DNA detection.

The high HPV prevalence shown among FSWs from 35 studies and 25 countries illustrates the need to prevent chronic infection in high-risk groups. They have a high

frequency of abnormal pap smears and are at higher risk of HPV infection due to their exposure to multiple partners in their occupation [10,37]. Both of these factors presumably increase their risk of cervical cancer. They also have a higher prevalence of high-risk types that are associated with cervical cancer. While condoms are effective in decreasing the risk of infection, they do not fully protect against the infection and are not routinely used with FSW clients [52]. Recent clinical trials have shown HPV vaccines to be highly effective against cervical intraepithelial neoplasia (CIN) associated with HPV types 16 and 18 in women who were not infected with these 2 subtypes at the time of immunization [53,54]. Tailoring vaccine interventions that prevent against infection of region-specific HPV subtypes in

FSWs may be successful in preventing transmission and cervical cancer cases.

Our findings suggest the need for cervical cancer prevention campaigns especially in developing countries, tailored to high-risk groups such as FSWs. While this population may be difficult to reach, the nature of their job as well as their high prevalence of high-risk serotypes put both themselves and the general population at risk for HPV and cervical cancer. Since few papers present antibody testing among FSWs [55], it is difficult to ascertain the true cumulative exposure to HPV genotypes. However previous studies illustrate antibody prevalence is significantly higher compared to DNA prevalence. While one study has shown acceptability of HPV vaccine in this population, early vaccination before sexual debut is necessary to ensure protection.

Overall we found that FSWs have a high prevalence of HPV, especially high risk subtypes 16 and 18. That being said, the prevalence of HPV identified in this review spans the spectrum from near 0 to 100%, likely dependent on both HPV sampling and testing methods, and risk factors which vary by region. Results of this review highlight the need for tailored intervention programs tailed to FSWs population for prevention of HPV related disease and outcomes.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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REFERENCES

- [1] Walboomers JM, Jacobs MV, Manos MM, *et al.* Human papillomavirus is a necessary cause of invasive cervical cancer worldwide. *J Pathol* 1999; 189: 12-19.
- [2] de Sanjosé S, Diaz M, Castellsagué X, *et al.* Worldwide prevalence and genotype distribution of cervical human papillomavirus DNA in women with normal cytology: a meta-analysis. *Lancet Infect Dis* 2007; 7: 453-9.
- [3] McLaughlin-Drubin ME, Meyers J, Munger K. Cancer associated human papillomaviruses. *Curr Opin Virol* 2012; 2: 459-66.
- [4] Hakim A, Dinh T. Worldwide impact of the human papillomavirus vaccine. *Curr Treat Options Oncol* 2009; 10: 44-53.
- [5] Parkin DM, Bray F, Ferlay J, Pisani P. Global Cancer Statistics, 2002. *CA Cancer J Clin* 2005; 55: 74-108.
- [6] Bauer HM, Hildesheim A, Schiffman MH, *et al.* Determinants of genital human papillomavirus infection in low-risk women in Portland, Oregon. *Sex Transm Dis* 1993; 20: 274-8.
- [7] Winer RL, Lee SK, Hughes JP, Adam DE, Kiviat NB, Koutsky LA. Genital human papillomavirus infection: incidence and risk factors in a cohort of female university students. *Am J Epidemiol* 2003; 157: 218-26.
- [8] Sellors JW, Karwalajtys TL, Kaczorowski J, *et al.* Incidence, clearance and predictors of human papillomavirus infection in women. *CMAJ* 2003; 168: 421-5.
- [9] Valles X, Murga GB, Hernandez G, *et al.* High prevalence of human papillomavirus infection in the female population of Guatemala. *Int J Cancer* 2009; 125: 1161-7.
- [10] Leung KM, Yeoh GP, Cheung HN, Fong FY, Chan KW. Prevalence of abnormal Papanicolaou smears in female sex workers in Hong Kong. *Hong Kong Med J* 2013; 19: 203-6.
- [11] Wiley D, Masongsong E. Human papillomavirus: the burden of infection. *Obstet Gynecol Surv* 2006; 61: S3-14.
- [12] Cwikel JG, Lazer T, Press F, Lazer S. Sexually transmissible infections among female sex workers: an international review with an emphasis on hard-to-access populations. *Sex Health* 2008; 5: 9-16.
- [13] Peng RR, Li HM, Chang H, Li JH, Wang AL, Chen XS. Prevalence and genotype distribution of cervical human papillomavirus infection among female sex workers in Asia: a systematic literature review and meta-analysis. *Sex Health* 2012; 9: 113-9.
- [14] Sharma VK, Khandpur S. Changing patterns of sexually transmitted infections in India. *Natl Med J India* 2004; 17: 310-9.
- [15] Hernandez BY, Vu Nguyen T. Cervical human papillomavirus infection among female sex workers in southern Vietnam. *Infect Agent Cancer* 2008; 3: 7.
- [16] Didelot-Rousseau MN, Nagot N, Costes-Martineau V, *et al.* Human papillomavirus genotype distribution and cervical squamous intraepithelial lesions among high-risk women with and without HIV-1 infection in Burkina Faso. *Br J Cancer* 2006; 95: 355-62.
- [17] Marais DJ, Carrara H, Ramjee G, Kay P, Williamson AL. HIV-1 seroconversion promotes rapid changes in cervical human papillomavirus (HPV) prevalence and HPV-16 antibodies in female sex workers. *J Med Virol* 2009; 81: 203-10.
- [18] Brown B, Blas MM, Cabral A, *et al.* Human papillomavirus prevalence, cervical abnormalities and risk factors among female sex workers in Lima, Peru. *Int J STD AIDS* 2012; 23: 242-7.
- [19] Hassen E, Chaieb A, Letaief M, *et al.* Cervical human papillomavirus infection in Tunisian women. *Infection* 2003; 31: 143-8.
- [20] Van Doornum GJ, Van den Hoek JA, Van Ameijden EJ, *et al.* Cervical HPV infection among HIV-infected prostitutes addicted to hard drugs. *J Med Virol* 1993; 41: 185-90.
- [21] Huq M, Nahar S, Alam A, Imam H, Rahman M. The prevalence of selected high-risk human papillomavirus infections among female sex workers in Dhaka, Bangladesh. *Int J STD AIDS* 2012; 23: 151-2.
- [22] Thomas DB, Ray RM, Kuypers J, *et al.* Human papillomaviruses and cervical cancer in Bangkok. III. The role of husbands and commercial sex workers. *Am J Epidemiol* 2001; 153: 740-8.
- [23] Couture MC, Page K, Stein ES, *et al.* Cervical human papillomavirus infection among young women engaged in sex work in Phnom Penh, Cambodia: prevalence, genotypes, risk factors and association with HIV infection. *BMC Infect Dis* 2012; 12: 166. [cited 2013 October 24]; 1-11. Available from: <http://www.biomedcentral.com/1471-2334/12/166>
- [24] Del Amo J, Gonzalez C, Belda J, *et al.* Prevalence and risk factors of high-risk human papillomavirus in female sex workers in Spain: differences by geographical origin. *J Womens Health* 2009; 18: 2057-64.
- [25] Chan R, Khoo L, Hong HT, *et al.* A comparative study of cervical cytology, coloscopy and PCR for HPV in female sex workers in Singapore. *Int J STD AIDS* 2001; 12: 159-63.
- [26] De Marco F, Houissa-Kchouk F, Khelifa R, Marcante ML. High-risk HPV types in Tunisia. A pilot study reveals an unexpectedly high prevalence of types 58 and 82 and lack of HPV 18 among female prostitutes. *J Med Virol* 2006; 78: 950-3.
- [27] Volkow P, Rubi S, Lizano M, *et al.* High prevalence of oncogenic human papillomavirus in the genital tract of women with human immunodeficiency virus. *Gynecol Oncol* 2001; 82: 27-31.
- [28] Miyashita M, Agdamag DM, Sasagawa T, *et al.* High-risk HPV types in lesions of the uterine cervix of female commercial sex workers in the Philippines. *J Med Virol* 2009; 81: 545-51.
- [29] Luchters SM, Broeck VD, Chersich MF, *et al.* Association of HIV Infection with distribution and viral load of HPV types in Kenya: a survey with 820 female sex workers. *BMC Infect Dis* 2010; 10: 18 [cited 2013 October 24]; 1-10. Available from: <http://www.biomedcentral.com/1471-2334/10/18/>
- [30] Juarez-Figueroa L, Wheeler CM, Uribe-Salas FJ, *et al.* Human Papillomavirus: a highly prevalent sexually transmitted disease agent among female sex workers from Mexico city. *Sex Transm Dis* 2001; 28: 125-30.
- [31] Rousseau MN, Costes V, Konate I, *et al.* Viral load and genomic integration of HPV 16 in cervical samples from HIV-1-infected and uninfected women in Burkina Faso. *J Med Virol* 2007; 79: 766-70.
- [32] Rodriguez-Cerdeira C, Sanchez-Blanco E, Alba A. Evaluation of association between vaginal infections and high-risk human papillomavirus types in female sex workers in Spain. *ISRN Obstet*

- Gynecol 2012; 240190. [cited 2013 October 24]; 1-7. Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3415090/>
- [33] Canadas M, Bosch FX, Junquera ML, *et al.* Concordance of prevalence of human papillomavirus DNA in anogenital and oral infections in a high-risk population. *J Clin Microbiol* 2004; 42: 1330-2.
- [34] Ghosh I, Ghosh P, Bharti AC, Mandal R, Biswas J, Basu P. Prevalence of human papillomavirus and co-existent sexually transmitted infections among female sex workers, men having sex with men and injectable drug abusers from eastern India. *Asian Pac J Cancer Prev* 2012; 13930: 799-802.
- [35] Yun H, Park J, Choi I, Kee M, Choi B, Kim S. Prevalence of human papillomavirus and herpes simplex virus type 2 infection in Korean commercial sex workers. *J Microbiol Biotechnol* 2008; 18: 350-4.
- [36] Choi BS, Kim SS, Yun H, Jang DH, Lee JS. Distinctive distribution of HPV16 E6 D25E and E7 N29S intratypic Asian variants in Korean commercial sex workers. *J Med Virol* 2007; 79: 426-30.
- [37] Mak R, Van Renterghem L, Cuvelier C. Cervical smears and human papillomavirus typing in sex workers. *Sex Transm Infect* 2004; 80: 118-20.
- [38] Choi BS, Kim O, Park MS, Kim KS, Jeong JK, Lee JS. Genital human papillomavirus genotyping by HPV oligonucleotide microarray in Korean commercial sex workers. *J Med Virol* 2003; 71: 440-5.
- [39] Matsushita K, Sasagaqa T, Miyashita M, *et al.* Oral and cervical human papillomavirus infection among female sex workers in Japan. *Jpn J Infect Dis* 2011; 64: 34-9.
- [40] Chow VT, Loh E, Yeo WM, Tan SY, Chan R. Identification of multiple genital HPV types and sequence variants by consensus and nested type-specific PCR coupled with cycle sequencing. *Pathology* 2000; 32: 204-8.
- [41] Li HM, Liang GJ, Yin YP, *et al.* Prevalence and genotype distribution of human papillomavirus infection among female sex workers in Guangxi, China: implications for interventions. *J Med Virol* 2012; 84: 798-803.
- [42] Marais DJ, Vardas E, Ramjee G, *et al.* The impact of human immunodeficiency virus type 1 status on human papillomavirus (HPV) prevalence and HPV antibodies in serum and cervical secretions. *J Infect Dis* 2000; 182: 1239-42.
- [43] Montano SM, Hsieh EJ, Calderon M, *et al.* Human papillomavirus infection in female sex workers in Lima, Peru. *Sex Transm Infect* 2011; 87: 81-2.
- [44] Tornesello ML, Duraturo ML, Buonaguro L, *et al.* Prevalence of human papillomavirus genotypes and their variants in high risk West Africa women immigrants in South Italy. *Infect Agent Cancer* 2007; 2: 1. [cited 2013 October 24]; 1-9. Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1779264/>
- [45] Ortiz M, Torres M, Munoz L, *et al.* Oncogenic human papillomavirus (HPV) type distribution and HPV type 16 E6 variants in two Spanish population groups with different levels of HPV infection risk. *J Clin Microbiol* 2006; 44: 1428-34.
- [46] Shikova E, Todorova I, Ganchev G, Kouzeva-Dragneva V, Kalasheva-Zaimova P. Prevalence of human papillomavirus infection among female sex workers in Bulgaria. *Int J STD AIDS* 2011; 22: 278-80.
- [47] Donmez H, Menevse S, Guner H, Menevse A. Detection and typing of human papillomavirus DNAs by restriction endonuclease mapping of the PCR products. *Isr J Med Sci* 1997; 33: 789-93.
- [48] Kjaer SK, Svare EI, Worm AM, Walboomers JM, Meijer CJ, van den Brule AJ. Human papillomavirus infection in Danish female sex workers. Decreasing prevalence with age despite continuously high sexual activity. *Sex Transm Dis* 2000; 27: 438-45.
- [49] Hildesheim AGP, Schiffman MH, Kurman RJ, *et al.* Determinants of genital human papillomavirus infection in low-income women in Washington, D.C. *Sex Transm Dis* 1993; 20: 279-85.
- [50] Baral S, Beyrer C, Muessig K, *et al.* Burden of HIV among female sex workers in low-income and middle-income countries: a systematic review and meta-analysis. *Lancet Infect Dis* 2012; 12: 538-49.
- [51] Castle PE, de Sanjosé S, Qiao YL, Belinson JL, Lazcano-Ponce E, Kinney W. Introduction of human papillomavirus DNA screening in the world: 15 years of experience. *Vaccine* 2012; 30: F117-22.
- [52] Winer R, Hughes JP, Feng Q, *et al.* Condom use and the risk of genital human papillomavirus infection in young women. *N Engl J Med* 2006; 354: 2645-54.
- [53] FutureII. Quadrivalent vaccine against human papillomavirus to prevent high-grade cervical lesions. *N Engl J Med* 2007; 356: 1915-27.
- [54] Villa L, Costa R, Petta C, *et al.* High sustained efficacy of a prophylactic quadrivalent human papillomavirus types 6/11/16/18 L1 virus-like particle vaccine through 5 years of follow-up. *Br J Cancer* 2006; 95: 1459-66.
- [55] Brown B, Blas M, Cabral A, Carcamo C, Gravitt P, Hasley N. Randomized trial of HPV4 vaccine assessing the response to HPV4 vaccine in two schedules among Peruvian female sex workers. *Vaccine* 2012; 30: 2309-14.

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