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Prevalence of human papillomavirus infection among 71,435 women in Jiangxi Province, China

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ABSTRACT

Cervical cancer is the third most common cancer in women worldwide. Human papillomavirus (HPV) has been identified as an etiological factor for cervical cancer. Data on the prevalence and subtype distribution of HPV infection in Jiangxi Province are incomplete. In this study, we investigated HPV subtype distribution and prevalence in Jiangxi Province between August 1, 2010, and December 31, 2015. A total of 71,435 individuals ranging in age from 16 to 77 years were recruited. Cervicovaginal swabs were collected from each participant, and HPV screening was performed. Our results showed that the HPV prevalence was 22.49% in Jiangxi Province. Overall, 14.99% of individuals were positive for a single HPV type, and 7.49% were positive for multiple types. The most frequently detected low-risk genotypes were HPV-6, and high-risk genotypes were HPV-16, -18, -33, -52, and -58. The prevalence and type distribution of HPV infection exhibits regional and age differences; Yingtan had the highest incidence for high-risk HPV infection (32.00%), and peaks in the frequencies of HPV infections were seen for patients under 20 and over 60 years of age. In conclusion, we present data showing that the HPV prevalence varies significantly with age and regions in Jiangxi Province. These results can serve as valuable reference to guide Jiangxi cervical cancer screening and HPV vaccination programs.

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Introduction

Cervical cancer is the third most common cancer in women worldwide [1]. Approximately 527,600 new cervical cancer cases were diagnosed and 265,700 cervical cancer related deaths occurred worldwide in 2012 [1]. Human papillomavirus (HPV), a small double-stranded DNA virus, infects human epithelial cells and has been identified as an etiological factor for cervical cancer [2]. Convincing epidemiological evidence indicates that the risk of

cervical cancer is 50-fold higher among women infected with HPV than among their uninfected counterparts [3].

HPV has many subtypes, which are divided into low-risk or high-risk groups depending on their oncogenic potential. The low-risk subtypes such as HPV-6, -11, and -43 are associated with hyperplastic lesions, have little to no oncogenic risk. In contrast, high-risk subtypes such as HPV-16, -18, -31, -33, -35, -39, -45, -51, -52, -53, -56, -58, -59, -66, and -68 are considered associated with 96.6% of invasive cervical cancers [4]. HPV subtype prevalence shows differences between regions and populations [5]. Thus, HPV screening is strongly advised because of its greater sensitivity and cost-effectiveness for detecting cervical cancer. Research has shown that in China, HPV DNA testing is highly sensitive and more cost-efficient than cytology-based screening for cervical cancer [6]. HPV screening contributes to the understanding of type-specific

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HPV prevalence and distribution in a given population, which are major considerations in the development and evaluation of effective HPV vaccines.

Jiangxi Province is situated in southeastern China and has a population of 45 million. Owing to its large population, a comprehensive study on HPV epidemiology is necessary. In this study, we investigated HPV subtype distribution and prevalence in this region. In addition, this study contributes to the estimation of the potential clinical benefits and cost-effectiveness of HPV screening and vaccination in Jiangxi Province.

Materials and methods

This investigation involved 11 cities (including Nanchang, Jiujiang, Yingtan, Jingdezhen, Shangrao, Yichun, Xinyu, Pingxiang, Fuzhou, Ji'an, and Ganzhou) of Jiangxi Province. A total of 71,435 women aged 16–77 years old were assessed between August 1, 2010, and December 31, 2015. All women attended a gynecological outpatient clinic for cervical cancer screening, which included gynecological examinations, ThinPrep Cytology testing, and HPV DNA testing. Every participant involved in the investigation freely signed informed consent forms. The methods of this investigation were in accordance with the approved guidelines and the principles adopted in the Declaration of Helsinki. The common inclusion criteria included: women (1) with a history of current or past sexual activity; (2) who were not pregnant at the time of enrolment; and (3) were a permanent resident of the local area. Exclusion criteria were pregnancy, acute genital inflammation, cervical or total uterus resection, and immunodeficiency disease.

Cervical cells were obtained from each participant using a cytobrush and placed in phosphate-buffered saline (PBS), stored at -80°C until HPV DNA detection and genotyping were performed in our lab. DNA extraction was performed using the DNA Mini Kit (Takara, Dalian, Liaoning, China) according to the manufacturer's instructions. HPV genotyping was performed using the HPV Genotyping Kit for 23 Types (Yaneng Bioscience, Shenzhen, China), which exploits chip technology to identify 23 different HPV genotypes include 5 low-risk subtypes (HPV-6, -11, -42, -43, and -44) and 18 high-risk subtypes (HPV-16, -18, -31, -33, -35, -39, -45, -51, -52, -53, -56, -58, -59, -66, -68, -73, -83, and -MM4). PCR and HPV genotyping were performed according to the manufacturer's instructions.

Statistical analyses were performed using SPSS 19.0 software. The prevalence of HPV infection, genotype distribution, and the presence of single and multiple HPV infections were analyzed separately. Frequency tables were evaluated using a χ^2 test. For all analyses, $P < 0.05$ was considered statistically significant.

Results

A total of 71,435 individuals (average age, 36.5 ± 8.099) were included in the study. Negative results were observed for 55,370 (average age, 36.7 ± 9.874), and positive HPV test results were obtained for 16,065 (average age, 35.6 ± 8.561), rendering the prevalence of HPV infection in Jiangxi Province as 22.49%.

Among the HPV-positive women, 10,711 (average age, 35.8 ± 8.236) were positive for a single HPV subtype, accounting for 66.67% of the HPV infections, and 14.99% of all samples; 5354 (average age, 35.1 ± 9.176) were positive for multiple HPV subtypes, accounting for 33.33% of the HPV infections, and 7.49% of all samples. Among the women infected with a single HPV subtype, 1926 (average age, 33.6 ± 8.363) were low-risk HPV subtypes, accounting for 17.98% of the patients with single HPV subtype infection, 11.99% of all HPV infections, and 2.70% of all samples; 8785 (average age, 35.2 ± 9.574) were high-risk HPV subtypes, accounting

for 82.02% of the single HPV subtype infections, 54.68% of all HPV infections, and 12.30% of all samples. Among the women infected with multiple HPV subtypes, 188 (average age, 34.8 ± 8.025) were infected with multiple low-risk (low-low) HPV subtypes, accounting for 3.51% of the patients with multiple HPV subtypes infections, 1.17% of all HPV infections, and 0.26% of all samples; 1387 (average age, 35.4 ± 7.327) were infected with a combination of multiple high- and low-risk (high-low) HPV subtypes, accounting for 25.73% of patients with multiple HPV subtypes infections, 8.63% of all HPV infections, and 1.94% of all samples; 3779 (average age, 34.1 ± 9.654) were infected with multiple high-risk (high-high) HPV subtypes, accounting for 70.58% of the multiple HPV subtypes infections, 23.52% of all HPV infections, and 5.29% of all samples. The results of the overall distribution of single HPV infections are shown in Table 1. Results indicated that the frequencies of infection with low-risk HPV subtypes -6, -11, -43, and -44 were 5.27%, 4.56%, 2.16%, and 3.44%, respectively. In addition, the five most prevalent high-risk subtypes were HPV-16, -18, -33, -52, and -58.

The prevalence of HPV infection was 20.88%, 23.39%, 35.50%, 49.23%, 26.95%, 24.46%, 25.17%, 21.78%, 22.89%, 17.96%, and 22.07% for the Ganzhou, Nanchang, Jiujiang, Yingtan, Jingdezhen, Yichun, Xinyu, Pingxiang, Shangrao, Fuzhou, and Ji'an regions, respectively, which was significantly different among the different age groups ($\chi^2 = 628.78$, $P < 0.001$). Yingtan region had the highest prevalence of HPV infection. The results of the effect of region on the overall distribution of HPV infections is shown in Table 2.

Among the single and multiple HPV subtype women, one of the highest incidence regions for HPV infection was Yingtan. Among the low-risk and high-risk HPV subtype women, one of the highest incidence regions for HPV infection was Jingdezhen. The distribution of HPV subtypes in infected individuals in the different regions is shown in Table 3, and the distribution of HPV subtypes in infection prevalence in the different regions is shown in Fig. 1. The regional prevalence was calculated based on all samples received from this region.

The prevalence of HPV infection was 41.43%, 25.94%, 21.19%, 19.96%, 21.79%, and 25.51% for women aged under 20 years old, 20–29 years, 30–39 years, 40–49 years, 50–59 years, and over 60 years old, respectively, which was significantly different among the different age groups ($\chi^2 = 414.96$, $P < 0.001$). In those with single HPV, multiple HPV, low-risk, high-risk, low-low risk, and low-high risk infections, one of the most common age ranges was that under 20 years old for the presence of HPV infection (Table 4). In the high-high risk women, one of the most common age ranges was that over 60 for the presence of HPV infection (Table 4).

The results for distribution of HPV subtypes in infected individuals (prevalence) in the different age ranges are shown in Table 5 and Fig. 2. The age-specific prevalence was calculated based on all samples received from these age groups.

Discussion

Data on the prevalence and subtype distribution of HPV infection in Jiangxi Province are incomplete. In this study, we examined the epidemiology of HPV in Jiangxi Province, southeastern China. Our results showed that the HPV prevalence was 22.49% in Jiangxi Province (16,065/71,435), and the prevalence of high-risk HPV was 19.53% (including the high-risk, low-high-risk, and high-high-risk women). The distribution of HPV prevalence exhibits regional differences. Past research has shown that the total positivity rate for high-risk HPV was 21.07% (18.42–31.94%) in China [7], which is higher than the total rate for high-risk HPV in the Jiangxi Province. Wu et al. [8] conducted a multi-center, population-based study between May 2006 and April 2007 in Beijing, Shanghai, Shanxi, Henan, and Xinjiang, and they found that the HPV prevalence for

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