MAJOR ARTICLE

Prevalence and Determinants of Genital Infection with Papillomavirus, in Female and Male University Students in Busan, South Korea

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Background. Little is known about the prevalence of human papillomavirus (HPV) infection in young adults in Asia.

Methods. We invited female and male students in Busan, South Korea, to participate in a survey that included, for females, self-collection of vaginal cells and, for males, physician-performed collection of exfoliated genital cells. The prevalences of 25 HPV types were evaluated, by a polymerase chain reaction–based assay, in 672 female students (median age, 19 years) and in 381 male students (median age, 22 years).

Results. HPV DNA was detected more frequently in female students (15.2%) than in male students (8.7%); in both sexes, high-risk HPV types were predominant. Among sexually active students, HPV prevalence was 38.8% in females and 10.6% in males. In female students, currently smoking cigarettes and having multiple lifetime sex partners were the strongest risk factors for HPV infection; in male students, associations between HPV prevalence and sexual habits were similar to those in female students but never attained statistical significance.

Conclusions. Young women in South Korea start having penetrative sexual intercourse relatively late (median age, 18 years), but, once they begin, HPV prevalence quickly rises to levels comparable with those found in university students in the United States and in northern Europe. The high rate of participation in our study suggests that trials of new vaccines against HPV may be feasible among university students in South Korea.

More than 50 types of human papillomavirus (HPV) that infect the genital tract have been identified, and a few of them—notably HPV 16, 18, 31, 33, 45, and 58—are predominant in tissue specimens from individuals with invasive cervical carcinoma (ICC) [1]. Overall, HPV is found in >90% of ICC tissue specimens [1], and HPV has also been shown to be an extremely common sexually transmitted pathogen in many countries. In sexually active young women, the prevalence of HPV in cervical specimens ranges from 20% [2] to 50% [3]. In women 13–23 years of age, a cumulative incidence of HPV infection of 40%–50% has been reported in 3–5-year follow-up studies conducted in the United States [2, 4, 5] and in the United Kingdom [6].

The limited available information on HPV in Asia confirms that peak HPV prevalence occurs in young women [7–9], except in extremely low-risk populations (e.g., Hanoi, North Vietnam [7]). In a community-based survey on HPV infection in Busan, South Korea, we have reported an overall HPV prevalence, in 863 sexually active women 20–74 years of age, of 10.4% [9]. However, recruitment of women <25 years of age was low in that study, because of the tendency of young women in South Korea to prolong their education, to marry late, and, if unmarried, to be unwilling to undergo a pelvic examination. Of 73 virgin women <25 years of age who provided serum samples, only 1 was positive for anti–virus-like–particle immunoglobulin antibodies (against HPV 18) [9].

To address the paucity of information on HPV infection in young women in Asia, we decided to target

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university students in South Korea and use, for HPV testing in female students, self-collected vaginal specimens, which can be obtained from both virgins and nonvirgins. This university-based approach allowed us to also include male students in our study.

SUBJECTS, MATERIALS, AND METHODS

Study subjects. The present survey was conducted between 29 August 2002 and 30 September 2002, in Busan, South Korea. To include a broad range of adolescents and young adults from different socioeconomic backgrounds, we contacted students from 3 institutions of higher education: DB College (300 females and 300 males); D University (300 females and 300 males), and the Institute for Continuing Education (300 females), at which evening classes for working women are given. After extensive discussions with the local education and health authorities, the study team (which included 2 physicians, 1 male and 1 female; 2 nurses; 1 laboratory technician; and 1 research assistant) arranged meetings with classes of 30–70 students of both sexes. At each meeting, a brief presentation on various issues concerning health education and disease prevention was given. Then the main purposes of the present survey were explained, and reassurance was given that the collection of exfoliated genital cells was safe for all participants, including women who had not had sexual intercourse. In keeping with the recommendations of the International Agency for Research on Cancer (Lyon, France) and of local ethics-review committees (all of which had approved the present study), students who chose to participate read and signed a consent form.

Students were asked to complete, in private, a self-administered questionnaire that included questions on sociodemographic information, lifestyle habits (including cigarette smoking and consumption of alcohol and of food from selected food groups), and history of vaccinations, selected diseases (e.g., hepatitis), and surgical procedures (e.g., circumcision [male students only]). Students also were asked to report whether they had engaged in penetrative sexual intercourse, age at first intercourse, number of lifetime sex partners, and use of contraceptive methods (i.e., condoms, oral contraceptives, and/or the withdrawal method). Finally, students were asked whether they would be willing to be inoculated with a vaccine, if it were available, for the prevention of HPV infection and ICC, either for their own sake (asked of female students) or for the sake of their partner (asked of male students).

Of a total of 900 female students and 600 male students who were contacted, 860 (95.6%) and 541 (90.2%), respectively, agreed to participate. Each study participant returned, in a sealed envelope, a coded but anonymous questionnaire.

Collection of biological samples. Of the study participants, 678 (78.8%) female students and 453 (83.7%) male students provided samples of exfoliated genital cells. Female students were instructed to perform the collection themselves, in private stalls: Each female student was asked to bend her legs and to introduce and gently rotate a Dacron swab (Medical Packing) in the vagina, until she reached its top (the uterine cervix); each female student also was asked to repeat the procedure with a second swab, and both swabs were placed in a tube that contained 5 mL of PBS. Each female student was specifically instructed not to touch the self-collected specimens, to avoid contamination.

The collection of exfoliated genital cells from male students was performed by a urologist. A cytobrush (Sang-A Medical) was moistened with PBS and used to brush the penis, in a continuously rotational movement, from bottom to top, starting at the middle third of the scrotum. After retraction of the prepuce (for uncircumcised males), the coronal sulcus, the glans, and the tip of the penis also were brushed. The brush was cut and placed in a tube containing 5 mL of PBS. Finally, a premoistened Dacron swab was gently rotated into the urethral opening (~1-cm deep) and was placed in the same tube. All tubes, from female students and from male students, were labeled, stored in iceboxes, and sent, on a daily basis, to the laboratory of Dong-A University Hospital (Busan, South Korea).

After the collection of genital samples, 662 female students and 378 male students provided 2 blood samples each—1 in a 3-mL tube containing EDTA and 1 in a 10-mL heparinized Vacutainer (Becton Dickinson). These tubes too were sent, on a daily basis and in iceboxes, to the laboratory of Dong-A University Hospital.

HPV testing. Samples of exfoliated genital cells were centrifuged at 3000 *g*. The resultant pellets were diluted in 1 mL of PBS and stored at −70°C until being shipped to the Delft Diagnostic Laboratory (Delft, The Netherlands), where HPV testing was performed.

DNA was isolated by use of the MagNA Pure LC Robot and the MagNA Pure LC Total Nucleic Acid Isolation Kit (Roche Diagnostics), according to the manufacturer's instructions. In brief, DNA was isolated from 200 μL of PBS and eluted into 100 μL of water. Each isolation run comprised 29 samples as well as 2 negative controls and 1 positive control.

HPV DNA was amplified by use of the short polymerase chain-reaction (PCR) fragment $(SPF)_{10}$ primer set, as described elsewhere [10, 11]. For quality control, during each PCR run samples were tested in parallel with 1 negative control (water) and 1 positive control (comprising a diluted sample and HPV 18–containing cells at a concentration of ~10-fold above the assay's limit of detection). Amplification products first were tested by probe hybridization in a microtiter-plate assay, to detect the presence of HPV DNA; this assay also included appropriate negative and positive controls, as described elsewhere [10]. SPF_{10} amplimers from HPV-positive samples were subsequently analyzed by reverse hybridization in an HPV line-probe assay (version 1.0; LiPA) [11]; this assay includes a membrane strip containing type-

specific oligonucleotide probes that are immobilized as parallel lines. PCR products are hybridized, at high stringency, to these probes, generating a type-specific hybridization pattern. The HPV LiPA permits specific detection of 25 HPV types: HPV 6, 11, 16, 18, 31, 33–35, 39, 40, 42–45, 51–54, 56, 58, 59, 66, 68/73, 70, and 74. The specificity of the HPV LiPA has been tested extensively [11–13]. HPV 6, 11, 34, 40, 42–44, 53, 54, 70, and 74 were considered to be low-risk (LR) types, whereas HPV 16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59, 66, and 68/73 were considered to be high-risk (HR) types [14]. Part of the β-globin gene [15] from each sample was amplified as a positive control for DNA isolation. This led to the exclusion of 6 (0.9%) of the female students and 72 (15.9%) of the male students, whose genital specimens were negative for β-globin. Therefore, the following analysis of the prevalence of and risk factors for HPV infection is based on 672 female students (median age, 19 years [range, 16–29 years]) and 381 male students (median age, 22 years [range, 18–28 years]).

Statistical analysis. The associations between HPV prevalence and various characteristics and levels of exposure were assessed separately in female and male students, by odds ratios (ORs) and 95% confidence intervals (CIs), which were computed by unconditional multiple logistic regression. All models included groups for age (<18 years, 18–19 years, 20–21 years, 22–23 years, and ⩾24 years) and number of lifetime sex partners (0 partners, 1 partner, 2–3 partners, and ⩾4 partners).

RESULTS

Table 1 shows the overall prevalence of HPV infection in the study population, by HR and LR type, by multiplicity of HPV infection, and by sex; all HPV types detected are listed. The prevalence of HPV infection was higher in female students (OR, 15.2% [95% CI, 12.5–18.1]) than in male students (OR, 8.7% [95% CI, 6.1–11.9]) ($\chi_1^2 = 9.24$; $P = .003$). Among the HPV infections that could be typed, HR types were predominant both in female students (68.9%) and in male students (54.8%) ($\chi_1^2 = 2.16$; $P = .141$). Infection with multiple HPV types was more common in female students (41.3%) than in male students (15.4%) ($\chi_1^2 = 5.74$; $P = .017$). In 11 female students and 1 male student, ⩾3 HPV types were detected. (For a list of HPV types present in multiple infections, see the Appendix.)

In female students, 22 HPV types were identified, in either single or multiple infections; the most frequent types were HPV 51 (12 female students), HPV 53 and 56 (10 female students each), HPV 16 and 52 (9 female students each), and HPV 18 (8 female students) (table 1 and figure 1). In male students, 16 different HPV types were identified, and, except for the absence of HPV 56, the pattern of the frequency of types was similar to that observed in female students (figure 1).

Table 2 shows the prevalence of HPV infection and the association, in all study subjects, between positivity for HPV (any type) and age and other selected characteristics. There was no statistically significant association between HPV prevalence and increasing age after adjustment for number of sex partners (OR for female students ⩾24 years of age vs. female students <18 years of age, 2.0 [95% CI, 0.4–11.4]; OR for male students ⩾24 years of age vs. male students 18–19 years of age, 1.7 [95% CI, 0.6–5.1]). A higher HPV prevalence was observed in current cigarette smokers (16.3% of female students and 51.6% of male students) than in either former smokers or students who had never smoked, but, after adjustment for the number of lifetime sex partners, the association between HPV prevalence and cigarette smoking was statistically significant only in female students (OR for current smokers vs. students who had never smoked, 3.8 [95% CI, 1.7–8.3]). Conversely, only in male students was there a direct, but not statistically significant, association between HPV prevalence and alcohol consumption; the latter was relatively rare and generally entailed a moderate amount (OR for ⩾1–2 drinks/week vs. nondrinker or ⩽1 drink/month, 3.6 [95% CI, 0.8–16.6]).

Of the male students, 325 (88.3%) reported having undergone circumcision (in most instances at 10–15 years of age), but there was no statistically significant association between HPV prevalence and history of circumcision (OR, 1.8 [95% CI, 0.4–8.2]) (table 2). Of the 165 (29.0%) female students who reported having had penetrative sexual intercourse, 64 (38.8%) were positive for HPV, which was significantly higher than the HPV prevalence (4.7%) in female students who reported never having had penetrative sexual intercourse (OR, 12.7 [95% CI, 7.2–22.2]. Conversely, in the 217 (63.1%) male students who reported having had penetrative sexual intercourse, the HPV prevalence (10.6%) was not significantly higher than that (7.1%) in male students who reported never having had penetrative sexual intercourse (OR, 1.6 [95% CI, 0.7–3.8]). In the study population, 20 female students and 1 male student were married.

The distribution of HPV types in sexually active infected students was compared with that in non–sexually active infected students (figure 1); the proportion of HR HPV types among type-specific infections in sexually active infected students (108/133; 81.2%) was similar to that in non–sexually active infected students (15/20; 75.0%) ($\chi_1^2 = 0.42$; $P = .515$). HPV 16 was not identified in non–sexually active infected students, whereas HPV 18 was found in 2 non–sexually active infected students. Infections with multiple HPV types were rarer in non–sexually active infected students (12.5%) than in sexually active infected students (38.8%) ($\chi_1^2 = 4.12$; $P = .04$).

Table 3 is an analysis of students who reported having had penetrative sexual intercourse and shows the relationship of HPV prevalence to selected aspects of sexual history and to use of contraceptive methods. In female students, a strong trend of an increase in HPV prevalence with an increase in the number of lifetime sex partners was found: 36 (22.4%) female stu-

Table 1. Infection with human papillomavirus (HPV), by HPV type and by multiplicity of infection, in 672 female students and 381 male students—Busan, South Korea, 2002.

Category	No. (%)[a] of female students			No. (%)[b] of male students		
	Single infection	Multiple infection	Total	Single infection	Multiple infection	Total
HPV type						
HPV−	…	…	570 (84.8)	…	…	348 (91.3)
HPV+						
HR types	29	29	58 (8.6)	13	3	16 (4.2)
LR types	15	2	17 (2.5)	9	1	10 (2.6)
Undetermined type	…	…	27 (4.0)	…	…	7 (1.8)
Total	…	…	102 (15.2)	…	…	33 (8.7)
HPV+						
HR						
16	3	6	9 (1.3)	2	…	2 (0.5)
18	3	5	8 (1.2)	2	…	2 (0.5)
31	…	5	5 (0.7)	…	…	…
33	…	3	3 (0.4)	1	…	1 (0.3)
35	…	2	2 (0.3)	…	…	…
39	3	3	6 (0.9)	…	3	3 (0.8)
45	…	1	1 (0.1)	2	…	2 (0.3)
51	7	5	12 (1.8)	2	1	3 (0.8)
52	2	7	9 (1.3)	3	…	3 (0.8)
56	6	4	10 (1.5)	…	…	…
58	2	3	5 (0.7)	1	…	1 (0.3)
59	…	3	3 (0.4)	…	…	…
66	1	3	4 (0.6)	…	…	…
68/73	2	5	7 (1.0)	…	…	…
Subtotal	29	55	84	13	4	17
LR						
6	3	2	5 (0.7)	1	1	2 (0.5)
11	…	2	2 (0.3)	…	1	1 (0.3)
34	…	…	…	…	1	1 (0.3)
43	…	2	2 (0.3)	2	…	2 (0.5)
44	1	3	4 (0.6)	1	1	2 (0.3)
53	4	6	10 (1.5)	2	1	3 (0.8)
54	3	1	4 (0.6)	2	…	2 (0.5)
70	3	3	6 (0.9)	1	…	1 (0.3)
74	1	4	5 (0.7)	…	…	…
Subtotal	15	23	38	9	5	14
HPV+ total	44	78	122	22	9	31

NOTE. HR, high risk; LR, low risk; −, negative; +, positive.

[a] Indicates the percentage of the total female-student study population.

[b] Indicates the percentage of the total male-student study population.

dents reported having had ⩾4 lifetime sex partners (OR vs. 1 lifetime sex partner, 6.9 [95% CI, 2.8–16.8]); the corresponding OR for the 98 (46.0%) male students who reported having had ⩾4 lifetime sex partners was 2.4 (95% CI, 0.6–9.0). The median age at first penetrative sexual intercourse was 18 years, for female students, and 19 years, for male students. Age at first penetrative sexual intercourse showed a weak, non–statistically significant inverse correlation with HPV prevalence in male students (OR for age at first intercourse of 18–19 years vs. ⩾20 years, 4.4 [95% CI, 1.2–15.9]; OR for age at first intercourse of <18 years vs. ⩾20 years, 3.6 [95% CI, 0.7–18.4]) but not in female students (corresponding ORs, 1.3). A slight non–statistically significant increase in HPV prevalence also was found in female students who had been engaged in penetrative sexual intercourse for ⩾3 years versus those so engaged for <1 year. ORs for withdrawal as a contraceptive method versus no use of contraceptive method were 1.9, in female students, and 4.4, in male students, but neither OR was statistically significant (table 3). ORs for condom use versus no use of contraceptive method were 0.4, in female students, and 2.3, in male students, with broad CIs for both. By and large, contraceptive methods were used infrequently (table 3).

Of the study population, 61.0% of female students and 65.9% of male students expressed a willingness to be inoculated with a vaccine, if one were available, for the prevention of HPV infection and ICC. No statistically significant difference between the willingness of female students to be inoculated and that of male students to be inoculated was found, and no sig-

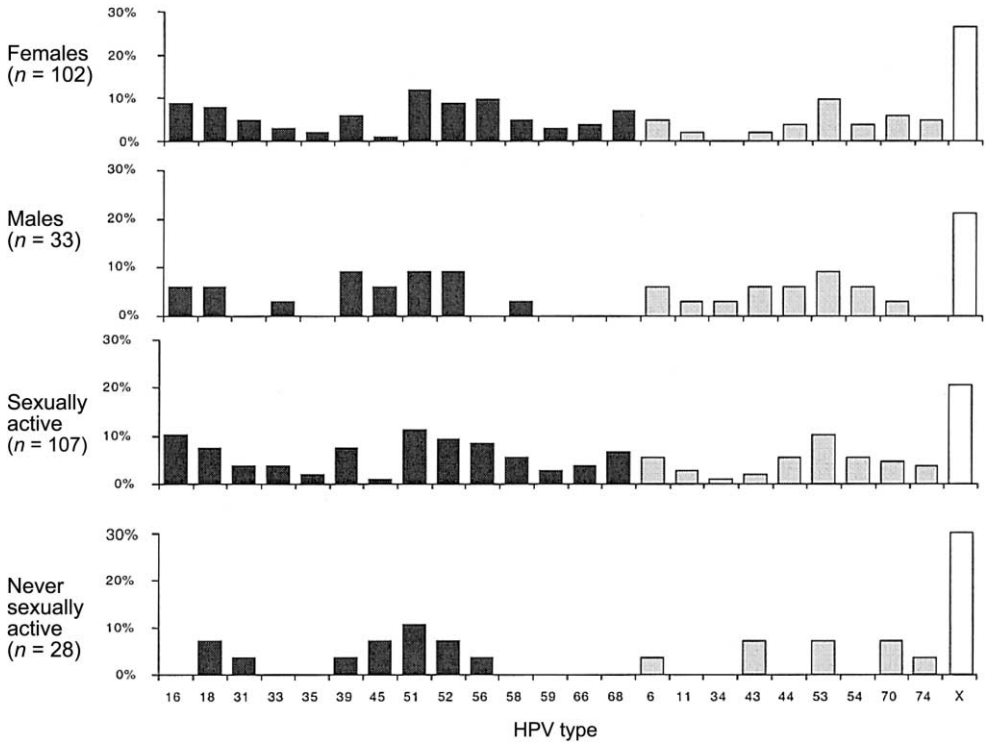

Figure 1. Distribution of high-risk *(dark-gray shaded)* and low-risk *(light-gray shaded)* types of human papillomavirus (HPV), by sex (top 2 graphs) and by sexual activity (bottom 2 graphs)—Busan, South Korea, 2002. The nos. of HPV-positive students are indicated in parentheses. X, undetermined HPV type.

nificant difference between the willingness of HPV-positive students to be inoculated and that of HPV-negative students to be inoculated was found. However, the potential acceptance of such a vaccine was greater in students who reported having had penetrative sexual intercourse (71.7%, sexes combined) than in students who reported never having had penetrative sexual intercourse (56.6%, sexes combined) ($\chi_1^2 = 17.34$; $P < .0001$) (data not shown).

DISCUSSION

We evaluated, for the first time, the prevalence and determinants of HPV infection in university students of both sexes in an Asian country. HPV prevalence in sexually active female students was 39% and was substantially higher than the 11% prevalence in sexually active male students. The distribution of HPV types was similar in both sexes.

In addition to expanding our knowledge of the worldwide distribution of HPV types, our study provides valuable information on the feasibility of surveys and, possibly, of clinical trials that target sexually transmitted diseases (STDs), including HPV infection, in adolescents and young adults in non-Western countries. Because of the open attitude and close collaboration of university authorities and of the Public Health Welfare and Women's Affairs Bureau of Metropolitan Busan, we had access to a large number of students in their schools. Participation among targeted students was high, and the majority of these students (78.8% of females and 83.7% of males) agreed to provide a sample of exfoliated genital cells. Interestingly, after male students were asked to choose between methods of collection during the first 2 class sessions, it became clear that they preferred to have the attending male urologist perform the collection of exfoliated genital cells rather than do it themselves; conversely, female students preferred the self-collection of vaginal cells and almost never asked attending female nurses to assist them. Compliance was high (76.5% of female students and 79.3% of male students), even among students who said that they had not yet engaged in penetrative sexual intercourse. Rather surprisingly, refusals to answer questions about sexual behavior were more frequent, in both sexes, than were refusals to provide genital cell samples, despite the great efforts that were made to assure the confidentiality of the self-administered questionnaire.

Among students with HPV findings, 25% of females and 57% of males reported having had penetrative sexual intercourse. The median age at first penetrative sexual intercourse for female students was indeed higher than the median age reported in similar investigations of female students or young women in Western countries [16, 17]; it was, however, sub-

Table 2. Odds ratios (ORs) and 95% confidence intervals (CIs) for infection with human papillomavirus (HPV), by age and other selected characteristics, in 672 female students and 381 male students—Busan, South Korea, 2002.

	Female students				Male students			
	No. (%)[a]				No. (%)[a]			
Characteristic	HPV−	HPV+	OR[b] (95% CI)	χ^2_1 for trend (*P*)	HPV−	HPV+	OR[b] (95% CI)	χ^2_1 for trend (*P*)
Age, years								
<18[c]	94	14 (13.0)	1	…	…	…	…	…
18–19	304	51 (14.4)	1.3 (0.6–3.2)	…	91	9 (9.0)	1	…
20–21	127	21 (14.2)	1.0 (0.4–2.6)	…	46	3 (6.1)	0.7 (0.2–2.9)	…
22–23	35	13 (27.1)	1.9 (0.6–6.0)	…	166	11 (6.2)	0.6 (0.2–1.6)	…
⩾24	10	3 (23.1)	2.0 (0.4–11.4)	0.66 (.42)	45	10 (18.2)	1.7 (0.6–5.1)	0.35 (.56)
Cigarette smoking								
Never smoked[c]	386	25 (6.1)	1	…	115	5 (4.2)	1	…
Ever smoked	98	63 (39.1)	3.8 (1.9–7.5)	…	201	26 (11.5)	2.6 (0.8–8.0)	…
Former	42	15 (26.3)	2.5 (1.0–6.3)	…	28	2 (6.7)	1.6 (0.3–9.3)	…
Current	52	41 (44.1)	3.8 (1.7–8.3)	…	157	22 (12.3)	2.7 (0.9–8.8)	…
Alcohol consumption								
Nondrinker or ⩽1 drink/month[c]	223	27 (10.8)	1	…	65	2 (3.0)	1	…
Drinker								
2–3 drinks/month	152	23 (13.1)	0.8 (0.4–1.6)	…	94	5 (5.1)	1.5 (0.3–8.3)	…
⩾1–2 drinks/week	116	34 (22.7)	1.2 (0.6–2.5)	0.18 (.68)	147	20 (12.0)	3.6 (0.8–16.6)	2.73 (.10)
Circumcision								
No	…	…	…	…	40	3 (7.0)	1	…
Yes	…	…	…	…	296	29 (8.9)	1.8 (0.4–8.2)	…
Penetrative sexual intercourse								
No[c]	384	19 (4.7)	1	…	118	9 (7.1)	1	…
Yes	101	64 (38.8)	12.7 (7.2–22.2)	…	194	23 (10.6)	1.6 (0.7–3.8)	…
Not reported	85	19 (18.3)	4.6 (2.3–9.2)	…	36	1 (2.7)	0.4 (0.0–3.3)	…

NOTE. −, negative; +, positive.

[a] Because of missing values, the nos. for some characteristics do not sum to the total no. of male and/or female students.

[b] Includes terms for age and for no. of lifetime sex partners, as appropriate.

[c] Reference category.

stantially lower than the median age at first penetrative sexual intercourse of 23 years that was reported by women 20–74 years of age in the community-based HPV survey that we had conducted in Busan [9].

The present study's finding of the prevalence of HPV infection in female students who reported having had penetrative sexual intercourse is one of the highest thus far reported for women <30 years of age [2, 6, 7, 18, 19]. Our finding of the overall HPV prevalence—15.2% in a population in which 60% of the female students reported that they were virgins—is difficult to compare with previous findings, because the majority of investigations of young women either have been restricted to sexually active women [5, 7, 18, 19] or have included a low proportion of virgins [2, 6]. In a study by Winer et al., both the prevalence and the 24-month cumulative incidence of HPV infection in 94 virgins was <2.5% [2].

Furthermore, previous studies of HPV infection in young women have been performed by various PCR-based assays for the detection and genotyping of HPV and by different methods for the collection of exfoliated genital cells. In female university students in the United States, 10.4% of new HPV infections were detected only in the cervix (35.4% in both the vulvo-vaginal region and the cervix; 54.2% in the vulvo-vaginal region only) [2]. Therefore, a greater percentage of HPV infections may be detected in self-collected vaginal specimens than in specimens collected by speculum-guided cervical sampling methods. In addition, after penetrative sexual intercourse with a new partner, HPV DNA may be detected earlier in vulvo-vaginal sites than in the cervix [2].

In the present study, the prevalence of HPV infection in sexually active male students was substantially lower than that reported in a few previous studies [20–22]. However, most studies of HPV prevalence in young men have been conducted among HR groups, such as patients presenting at STD clinics in Europe [20, 21] and the United States [22]. The much lower prevalence of HPV infection in male students versus female students suggests that male students have penetrative sexual intercourse with young women whose risk for HPV infection is very low, whereas female students have penetrative sexual intercourse with men whose risk for HPV infection is higher (probably with men who do not belong to the present study population). Alternatively, lower detection of HPV in male students may be due to lower DNA yields, lower viral loads, and/or more transient infections, relative to female students [23]. Only 37% of male students whose genital samples were negative for β-globin were sexually active. Thus, the prevalence of HPV

Table 3. Odds ratios (ORs) and 95% confidence intervals (CIs) for infection with human papillomavirus (HPV), by various sexual indicators, in 165 sexually active female students and 217 sexually active male students—Busan, South Korea, 2002.

	Female students				Male students			
	No. (%)[a]				No. (%)[a]			
Characteristic	HPV−	HPV+	OR[b] (95% CI)	χ^2_1 for trend (*P*)	HPV−	HPV+	OR[b] (95% CI)	χ^2_1 for trend (*P*)
Lifetime sex partners, no.								
1[c]	59	16 (21.3)	1	…	43	3 (6.5)	1	…
2–3	27	23 (46.0)	3.3 (1.5–7.3)	…	64	5 (7.3)	1.0 (0.2–4.6)	…
⩾4	13	23 (63.9)	6.9 (2.8–16.8)	18.87 (<.001)	83	15 (15.3)	2.4 (0.6–9.0)	2.69 (.10)
Age at first penetrative sexual intercourse, years								
⩾20[3]	28	11 (28.2)	1	…	78	4 (4.9)	1	…
18–19	41	24 (36.9)	1.3 (0.4–4.4)	…	79	14 (15.1)	4.4 (1.2–15.9)	…
<18	30	28 (48.3)	1.3 (0.3–5.4)	0.08 (.78)	34	5 (12.8)	3.6 (0.7–18.4)	2.32 (.13)
Time since first penetrative sexual intercourse, years								
<1[3]	55	18 (24.7)	1	…	32	2 (5.9)	1	…
1–2	33	25 (43.1)	1.5 (0.6–3.4)	…	42	2 (4.6)	0.6 (0.1–5.5)	…
⩾3	11	20 (64.5)	2.4 (0.8–7.6)	2.36 (.12)	117	19 (14.0)	1.6 (0.2–12.5)	0.68 (.41)
Contraceptive method								
None[c]	40	23 (36.5)	1	…	41	2 (4.7)	1	…
Condom	21	8 (27.6)	0.4 (0.1–1.3)	…	77	8 (9.4)	2.3 (0.4–11.6)	…
Withdrawal	18	25 (58.1)	1.9 (0.8–4.8)	…	36	7 (16.3)	4.4 (0.8–24.0)	…
Oral contraceptive	2	2 (50.0)	0.5 (0.0–7.7)	…	…	…	…	…
Frequency of use of contraceptive method								
Never[c]	40	23 (36.5)	1	…	41	2 (4.7)	1	…
Rarely	21	18 (46.2)	1.0 (0.4–2.6)	…	71	12 (14.5)	3.3 (0.7–15.9)	…
Frequently/always	31	20 (39.2)	0.9 (0.4–2.2)	…	50	6 (10.7)	2.6 (0.5–14.3)	…

NOTE. −, negative; +, positive.

[a] Because of missing values, the nos. for some characteristics do not sum to the total no. of male and/or female students.

[b] Includes terms for age and for no. of lifetime sex partners, as appropriate.

[c] Reference category.

infection in the male students would have been slightly lower if all genital samples from them had been β-globin positive.

The most significant risk factor for HPV detection was the reporting of multiple lifetime sex partners, a finding congruent with that of a previous study [24]; in male students, however, the association was weaker than that in female students and did not reach statistical significance. The risk factors of years since first penetrative sexual intercourse and of alcohol consumption (among males only) showed direct, but not statistically significant, associations with HPV detection. Contraceptive methods were used by a minority of study participants, and therefore their influence on HPV detection is unclear. Cigarette smoking was associated with HPV prevalence, and the association was statistically significant in female students. Cigarette-smoking status may be an indicator of HR sexual behavior, especially in women, and the adjustment for number of lifetime sex partners may not have been sufficient; however, it has been reported that smoking decreases the probability of clearing HR HPV infection [25] and that smoking is a well-established risk factor for squamous cell carcinoma of the cervix [26].

The majority of the male students in the present study population reported having been circumcised, almost always at puberty. Contrary to previous evidence that circumcision decreases the risk of penile HPV infection in middle-aged men [27], circumcision was unrelated to HPV detection in genital samples in our study.

Finally, HPV prevalence was not negligible in students who had not yet had penetrative sexual intercourse, a finding suggesting that sexual activity was underreported and/or that HPV transmission does occur via nonpenetrative sexual contact [2]. In sexually active students of both sexes, HR HPV types were greatly predominant versus LR HPV types, and a broad range of HPV types were detected, including several unknown types. HPV 16 and 18, the 2 types that are present in the vaccines that are currently being used in ongoing phase III trials [28], were found in 2.5% of female students and in 1.0% of male students, in either single or multiple infections. HPV 16 was not detected in students who had not yet had penetrative sexual intercourse.

In conclusion, our study shows that female university students in South Korea start having penetrative sexual intercourse later than do their Western peers but that, once they begin, HPV prevalence quickly rises to levels very comparable to those found in college students in the United States and northern Europe. The high participation rate by young women and men in the present study indicates that similar populations may be targeted for future clinical trials of prophylactic vaccines against

HPV. Institutions of higher education in South Korea are a favorable environment in which to deal with such sensitive issues as STDs and to recruit a diverse population of sexually active and non–sexually active individuals.

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APPENDIX

Human papillomavirus (HPV) types, by sex, identified in 35 students infected with multiple HPV types—Busan, South Korea, 2002.

Combinations of HPV types	No. of students	
	Females	Males
6, **35**	1	…
6, 34, **39**	…	1
6, **33, 52,** 70	1	…
11, **39**	…	1
11, **68/73**	1	…
11, **18,** 44	1	…
16, 52	2	…
16, 53	1	…
16, 58	1	…
16, 31, 33	1	…
16, 39, 68/73	1	…
18, 53	1	…
18, 66	1	…
18, 59, 68/73	1	…
18, 31, 33, 52, 59, 66	1	…
31, 66	1	…
31, **52, 68/73**	1	…
31, 53, **56,** 74	1	…
35, 58	1	…
39, 51	1	1
39, 54	1	…
43, 44	1	…
43, **56,** 74	1	…
44, 53	…	1
44, **56**	1	…
45, 56, 74	1	…
51, 53	1	…
51, 59	1	…
51, 74	1	…
51, 68/73, 70	1	…
52, 53	1	…
52, 58	1	…
53, 70	1	…
Total	31	4

NOTE. High-risk types are in boldface.

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