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# Health Interventions and Misuse of Cervical Cancer Screening among Young Women

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**Abstract**: Despite the guidelines for the proper usage of cervical cancer screening, majority of young women misuse the screening methods, which can harm their health. To avoid the misuse, there is a need for empirical evidence to explore effective interventions. Hence, this study investigated the effect of the three health-related intervention and cognitive constructs: a doctor's recommendation, knowledge of human papillomavirus (HPV), and HPV vaccination, on the misuse of three cervical cancer screenings: too-early screening, unnecessary HPV tests, and unnecessary annual Papanicolaou (Pap) tests among young women. This study examined the 2015 National Health Interview Survey (NHIS) collected by the Centers for Disease Control and Prevention (CDC) in the United States (N=1,776). Three types of dependent variables were considered relating to the misuse of cervical cancer screenings based on the U.S. Preventive Services Task Force (USPSTF) guideline. Multinomial logistic regression models were employed to estimate the coefficients, odds ratio, and relative risk ratios. The recommendation of health professionals played a significant role in not only receiving Pap smears at the proper usage, but when improper advice was given, can also induce unnecessary HPV testing and too-early and too-frequent Pap smear screening. HPV vaccination encouraged compliance with the recommendations, including Pap smears alone (without simultaneous HPV testing) and at a proper frequency, while it also induced screening misuse, including unnecessary HPV testing simultaneous with Pap smears. In addition, having heard of HPV increased the likelihood that women underwent Pap smears at a proper frequency while also inducing unnecessary HPV testing and screening overuse. To prevent young women from the misuse of cervical cancer screening, health professionals need to follow the recommendations proposed by experts. Also, public health authorities need to provide precise and correct information about appropriate cancer screening to young women.

**Keywords**: Cervical Cancer, Human Papillomavirus, Papanicolaou, Pap smears, HPV, Multinomial Regression

## 1. Introduction

Although we do not recognize it well, cervical cancer is one of the major diseases that threaten women's health and lives. This cancer is the second leading cause of cancer death and generates nine deaths per week in women aged 20 to 39 years in the United States[1]. The American Cancer Society estimated that 14,480 cases of cervical cancer would be newly diagnosed and 4,290 women would die

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from cervical cancer in the United States in 2019[2].

Cervical cancer is an abnormal growth of the cells of the cervix. There are several risk factors for cervical cancer, such as human papillomavirus (HPV) infection, smoking, age, and family history of cervical cancer. Infection by HPV is the most common risk factor for cervical cancer[3]. Though there is no cure for HPV infection, cervical cancer prevention strategies, including Papanicolaou (Pap) screening can help to provide women with a chance for early detection and treatment of cervical cancer[4].

The U.S. Preventive Services Task Force (USPSTF) released several recommendations for cervical cancer screening for average-risk women in 2012[5][6]. First, the USPSTF recommends "screening for cervical cancer in women age 21 to 65 years with cytology (Pap smear) every 3 years or, for women age 30 to 65 years who want to lengthen the screening interval, screening with a combination of cytology and HPV testing every 5 years." The USPSTF also recommends "against screening for cervical cancer with HPV testing, alone or in combination with cytology, in women younger than age 30 years." In addition, the USPSTF "recommends against screening for cervical cancer in women younger than age 21 years."

Despite this guideline, many health professionals did not follow the recommendation from the USPSTF. For example, a survey of 1,212 physicians revealed that only 31.8% followed the guideline of Pap smear only and only 19.0% followed Pap smear with HPV test[7][8]. Experts have argued that annual Pap tests can harm the recipients' health. A false positive Pap test result led to more-frequent colposcopies, a follow-up procedure which damaged the cervix[9-11]. Also, annual screening does not significantly increase the detection of cervical cancer compared to screening every 3 years because this cancer is relatively slow to develop[5][12]. In addition, most of American women were screened for cervical cancer by the Pap smear test more frequently than recommended; 55% of women with no history of abnormal smears still underwent annual Pap smears[13]. Further, HPV testing for young women could also lead to unnecessary follow-up procedures and increase the medical costs without added benefits. For women younger than age 30 years, the potential harms of screening with HPV testing (alone or in combination with cytology) outweigh the potential benefits. However, for women younger than age 21 years, regardless of sexual history, the harms of screening outweigh the benefits[5][14][15]. Despite many arguments, there are few studies that estimate the effect of various health intervention and cognitive information on the misuse of cervical cancer screening methods, particularly, by using nation-wide survey data. Thus, empirical evidence is necessary to explore which health intervention and cognitive behaviors decrease or increase the misuse of cervical cancer screening.

In South Korea, the cervical cancer screening cycle is shorter than that of the United States due to the high incidence of cervical cancer. The National Cancer Center reveals that the prevalence of cervical cancer is about 2.7 per 100,000 people in 2019, which is 3 times that of the United States[16]. The cervical cancer screening, which is paid by the state, is once every 2 years from the age of 20 to 74, and once every 3 years is also fine. After middle age, there is no regular examination, and it is recommended that it is stopped from the age of 74 if there are no more problems for more than 10 years.

Despite the current higher incidence rate of cervical cancer, the health authorities also need to prepare for preventing the misuse of the screening in South Korea. Several studies and health professionals argued that the screening cycle should be longer than the current guideline. The most effective strategy was undergoing a Pap smear test every 3 years Pap between the age of 35 and 65 years for the cervical cancer screening[17]. The number of new cases of cervical cancer decreased by about 33% from 4,487 in 1999 to 2,998 in 2019 due to a recent increase in the accuracy of the test[18]. Thus, the guideline for cervical cancer screening proposed by [19] recommended that the screening including Pap smear is conducted every 3 years for women aged 20 or older without symptoms, which is similar to the guideline of the United States.

Controversies exist regarding the appropriate use of cervical cancer screening, but there is little

research on the factors that influence individuals' screening behaviors. Previous studies have examined cervical cancer, its risk factors, and prevention strategies. Despite evidence-based guidelines and known risks associated with the overuse of the screening, adherence to these guidelines among healthcare professionals remains suboptimal. This article also highlights the high prevalence of cervical cancer in South Korea. Nevertheless, empirical research is necessary to identify factors that influence the appropriate use of preventive screening for cervical cancer in both the United States and South Korea. Such research would provide reliable evidence to inform interventions aimed at promoting appropriate screening behaviors.

Thus, this study investigated which health-related intervention and cognitive constructs—a doctor's recommendation, having heard of HPV, and HPV vaccination—significantly affect misuse of cervical cancer screening and the Pap smear screening decision among women younger than 30. Three types of misuse of screening are considered: (1) Pap smear screening for women aged under 21 (too-early screening), (2) HPV testing for women aged under 30 (unnecessary HPV testing), and (3) annual Pap smear screening (overuse of screening), based on the USPSTF's recommendations for cervical cancer screening. We empirically evaluate the effect of several health-related intervention and cognitive constructs on the misuse of cervical cancer screening was empirically evaluated using binary and multinomial logistic regression models.

The research questions that this study seek to answer are as follows: (1) What is the effect of health-related intervention and cognitive behaviors on the behaviors of young women with regard to cervical cancer screening?; (2) How does failing to adhere to screening guidelines for young women, such as screening frequency and HPV testing, contribute to the misuse of screening methods?; and (3) What policies can be implemented to prevent young women from undergoing inappropriate frequencies and types of screening?

## 2. Research Method

### 2.1 Research Design

In this study, the impact of health interventions and cognitive reactions on cervical cancer screening behaviors using a preventive health model was investigated[20][21]. The model incorporates various factors that may influence an individual's preventive actions, including demographic and socioeconomic characteristics, personal health history, health status, disease information, medication experience, and behavioral alternatives.

To test the research questions, two key predictor variables were focused on: doctor's recommendations and cognitive reactions, which were measured by informal information about cervical cancer and experiences with HPV vaccination. Demographic characteristics as individual characteristics were used to explore how these factors impact screening behaviors.

To achieve the study goals, the National Health Interview Survey (NHIS) dataset was analyzed, which provided the information on various health behaviors and attitudes among individuals in the United States used in this study. Several key variables based on the research questions were selected and refined. An econometric regression model to the data was the applied to examine the relationship between health interventions, cognitive reactions, and screening behaviors.

### 2.2 Dataset

This study analyzed data from the 2015 NHIS, a comprehensive survey that collects information on the health status, health care access, and health behaviors of the U.S. population[22]. The primary aim

of the survey is to monitor health-related trends and issues through the analysis of a wide variety of health-related topics and demographic and socioeconomic characteristics.

Two relevant modules were examined for this study: the Sample Adult (SA) module, and the Sample Adult Cancer Control (SACC) module. The SA module investigates health-related issues including physical health condition and cognition. The SACC module, which assesses respondents' knowledge and attitudes related to cancer, cancer-related health behaviors, and cancer screening and risk assessment, is administered every five years, most recently in 2015.

The purpose of the present study was to investigate women's behaviors regarding cervical cancer screening following the 2012 recommendation issued by the US Preventive Services Task Force (USPSTF). The 2015 NHIS dataset was deemed the most appropriate for the study as many healthcare professionals were initially resistant to adopting the recommendation in 2013. Subsequent datasets were also available, but changes in participants' behaviors during adolescence made it difficult to control for important variables related to health behaviors among teenagers.

Sub-samples were considered for each dependent variable. The female sample size was 18,601. For the too-early screening variable, only the portion of the female sample aged 18-20 was included, and missing and "Don't Know/Refused to Answer" (DK/RF) observations were dropped, resulting in a final subsample of 403 respondents. For the combination of HPV test and Pap smear variable, the portion of the female sample aged 21-29 was used, and missing and DK/RF observations were dropped, resulting in a final subsample of 1,978 respondents. For the frequency of Pap smears variable, the portion of the female sample aged 21-29 was included, and missing and DK/RF responses were excluded. High-risk participants were also excluded using the answer to the question, "Have you had a [Pap/Pap or HPV] test in the LAST 3 YEARS where the results were NOT normal?" Observations of "Yes" and DK/RF answers were dropped, resulting in a final subsample of 1,776 respondents for the model of a non-annual Pap smear or annual Pap smear or no Pap smear. These high-risk participants were excluded because their prescribed screening frequency differed from that for the general population. Table 1 presents the descriptive statistics of the variables used in this study for all samples under 29 years old or below, separated by dependent variables.

[Table 1] Descriptive Statistics for Three Cases of Misuse of Cervical Cancer Screening

| Variable | All samples under 29 years old | Misuse Case I | | Misuse Case II | | | Misuse Case III | | |
|---|---|---|---|---|---|---|---|---|---|
| | | No Pap Smear (proper) | Having Pap Smear (over) | No Pap Smear (under) | Pap Smear Only (proper) | Pap with HPV Test (over) | No Pap Smear (under) | Non-Annual Pap smear (proper) | Annual Pap Smear (over) |
| Observation | 2,555 | 227 | 176 | 353 | 817 | 808 | 375 | 953 | 448 |
| (Proportion observation) | | (0.62) | (0.38) | (0.18) | (0.41) | (0.41) | (0.21) | (0.54) | (0.25) |
| Demographics | | | | | | | | | |
| Average Age | 24.26 | 18.95 | 19.28* | 23.81* | 25.39 | 25.53 | 23.95** | 25.04 | 26.04** |
| Proportion Non-white | 0.27 | 0.25 | 0.32 | 0.32** | 0.26 | 0.26 | 0.32** | 0.25 | 0.23 |
| Proportion Married | 0.26 | 0.03 | 0.10** | 0.15** | 0.35 | 0.28* | 0.17** | 0.30 | 0.39** |
| Proportion Employed | 0.64 | 0.41 | 0.60** | 0.63 | 0.65 | 0.71** | 0.63* | 0.68 | 0.67 |
| Health Variables | | | | | | | | | |
| Proportion Flu shot | 0.33 | 0.31 | 0.30 | 0.21** | 0.34 | 0.39* | 0.21** | 0.34 | 0.39* |
| Proportion | 0.43 | 0.43 | 0.47 | 0.38 | 0.43 | 0.45 | 0.38* | 0.44 | 0.44 |

| Variable | All samples under 29 years old | Misuse Case I | | Misuse Case II | | | Misuse Case III | | |
|---|---|---|---|---|---|---|---|---|---|
| | | No Pap Smear (proper) | Having Pap Smear (over) | No Pap Smear (under) | Pap Smear Only (proper) | Pap with HPV Test (over) | No Pap Smear (under) | Non-Annual Pap smear (proper) | Annual Pap Smear (over) |
| In bed due to illness | | | | | | | | | |
| Intervention and cognitive constructs | | | | | | | | | |
| Doctor's recommendation | | | | | | | | | |
| (Proportion No) | (0.49) | (0.90) | (0.46**) | (0.76**) | (0.44) | (0.37**) | (0.73**) | (0.45) | (0.39*) |
| Proportion Yes | 0.46 | 0.03 | 0.51** | 0.11** | 0.52 | 0.61** | 0.14** | 0.50 | 0.61** |
| Proportion Didn't see a doctor | 0.05 | 0.07 | 0.03 | 0.13** | 0.04 | 0.02* | 0.13** | 0.05 | 0.00** |
| Proportion Heard about HPV | 0.80 | 0.70 | 0.75* | 0.64** | 0.76 | 0.96** | 0.64** | 0.85 | 0.90** |
| Proportion HPV vaccination | 0.38 | 0.49 | 0.46 | 0.20** | 0.30 | 0.50** | 0.21* | 0.38 | 0.39 |

Misuse Case I represents whether women younger than age 21 years had a Pap smear (too-early Pap smear, overscreening) or no Pap smear (proper screening). Misuse Case II represents whether women aged 21-29 received a Pap smear alone (proper screening) or an HPV test along with a Pap smear (overscreening) or no Pap smear (underscreening). Misuse Case III represents whether women aged 21-29 years had a non-annual Pap smear (proper screening) or an annual Pap smear (overscreening) or no Pap smear (underscreening). Asterisk shows the mean difference between reference and other groups. Reference groups are "No Pap Smear" in Case I, "Pap smear only" in Case II, and "Non-Annual Pap smear" in Case III. **p < 0.01, *p < 0.05.

### 2.3 Variable Measures

In this study, three dependent variables were examined based on the USPSTF guidelines as shown in Table 2. The first variable pertained to whether women younger than 21 years old had received a Pap smear (indicating overscreening or too-early screening) or no Pap smear (proper screening) for Misuse Case I. This variable was determined by the participants' response to the question "Have you EVER HAD a Pap smear or Pap test?" A dichotomous classification was used, with a response of "Yes" being coded as 1 and indicating too-early screening for women aged 18-20, and a response of "No" being coded as 0 and indicating compliance with current recommendations.

[Table 2] The USPSTF Recommendations for Cervical Cancer Screening by Age Group

| Age group | Screening recommendation | |
|---|---|---|
| | Pap smear | HPV test |
| 18 – 20 years | Not recommended | Not recommended |
| 21 – 29 years | Every 3 years | Not recommended |
| 30 – 65 years | Every 3 years | Every 5 years |
| 66 or more years | Not recommended* | Not recommended* |

The USPSTF recommends against screening for cervical cancer in women older than age 65 years who have had adequate prior screening and are not otherwise at high risk for cervical cancer.

The second variable was considered to represent whether women aged 21-29 received a Pap smear alone (proper screening) or an HPV test along with a Pap smear (over screening) or no Pap smear (under screening). The respondents' answer to the question, "An HPV test is sometimes given with the Pap test

for cervical cancer screening. Did you have an HPV test with your most recent Pap?" was coded as 2 if they responded "Yes," representing unnecessary HPV tests for young women aged 21-29, as 1 if they responded "No," representing compliance with the current recommendation, and as 0 if they reported never having received a Pap test.

The last variable was considered to represent whether women aged 21-29 years had a Pap smear in proper frequency (proper screening) or an annual Pap smear (over screening) or no Pap smear (under screening). The respondents' response to the question, "How many Pap tests have you had in the LAST 6 YEARS?" was used to code the variable as 2 if they responded to 6 in the last six years, representing overuse of screening (annual Pap), as 1 if they reported fewer than 6 in the last six years, representing compliance with the recommendation, and 0 if they reported never having received a Pap test. Table 3 summarizes the three misuse cases of interest.

[Table 3] Classification of Dependent Variables by the Misuse Cases

| Misuse Case | Age | Preventive behaviors | | |
|---|---|---|---|---|
| | | Underuse of screening | Compliance with recommendations | Misuse of screening |
| I | 18-20 | - | No screening | Too-early screening |
| II | 21-29 | No screening | Pap smear only | Unnecessary HPV test |
| III | 21-29 | No screening | Proper frequency | Annual Pap |

Three key health-related intervention and cognitive variables were considered in this study. The intervention was whether respondents received a doctor's recommendation to undergo their most recent Pap smear screening, irrespective of their acceptance of the screening recommendation. This intervention was determined based on respondents' answer to the question, "Was your most recent Pap test recommended by a doctor or other health professional?" This variable was coded as 1 if they responded "Yes," 2 if they responded "Did not see a doctor in the last 12 months," and 0 if they said "No." The cognitive variable was whether respondents had heard of HPV before, determined from their response to the question, "Have you ever heard of HPV? HPV stands for human papillomavirus." This variable was dichotomized as 1 if they responded yes, and 0 otherwise. Another cognitive variable was an indicator of HPV vaccination, based on their response to the question, "Have you ever received an HPV shot or vaccine?" This variable was dichotomized as 1 if they responded yes and 0 otherwise.

For demographic factors, the study considered age, race (white or non-white), marital status (married or single), and employment status (employed or not), as well as two health-related indicators, namely the flu shot and staying in bed due to illness during the past twelve months.

### 2.4 Regression Model

Multinomial logistic regression was employed with binary and multiple dependent variables. The estimated model provide a set of probabilities for the $J$ choices with independent variable $\boldsymbol{x}_i$. The probabilities sum to one, $J-1$ parameter vectors determine the $J$ probabilities. The probabilities of being a particular category $j < \mathrm{J}$ are denoted by:

$$p(y_i = j|\boldsymbol{x}_i) = p_{ij} = \frac{\exp(\boldsymbol{x}_i{}'\boldsymbol{\beta}_j)}{1 + \sum_{k=1}^{J-1} \exp(\boldsymbol{x}_i{}'\boldsymbol{\beta}_k)}, \qquad j < J$$

and the probability of being a category $J$ is given by:

$$p(y_i = J|\boldsymbol{x}_i) = p_{ij} = \frac{1}{1 + \sum_{k=1}^{J-1} \exp(\boldsymbol{x}_i{}'\boldsymbol{\beta}_k)}$$

where $\boldsymbol{\beta}$ is the estimates of independent coefficients. If the dependent variable $J$ is selected as a reference category, a logistic transformation of the odds of individual $i$ is computed as follows:

$$\log\left(\frac{p_{ij}}{p_{iJ}}\right) = \boldsymbol{x}_i'\boldsymbol{\beta}_j, \qquad j < J$$

Then, the relative risk ratio against the reference category $J$ is obtained by taking natural logarithms on both sides:

$$\frac{p_{ij}}{p_{iJ}} = \exp\left(\boldsymbol{x}_i'\boldsymbol{\beta}_j\right), \qquad j < J$$

The form of the binomial model can be examined if $J = 1$, from which the estimates and odds ratios are computed when the dependent variable is binary with the same procedures as a multinomial model. The log-likelihood is defined to estimate the coefficients and the relative risk ratios (or odds ratios) as follows:

$$\log L = \sum_{i=1}^{n}\sum_{j=0}^{n} d_{ij}\log(p_{ij})$$

where $d_{ij} = 1$ if a category $j$ is chosen by individual $i$, and $0$ otherwise. Stata 15.0 is used for the maximum likelihood estimation.

## 3. Results

Table 4 shows the descriptive statistics, odds ratios, and relative risk ratios for three dependent variables. Based on these results, several interesting findings were revealed regarding the relationship between health intervention/cognitive constructs and the misuse of cervical cancer screening among young women.

[Table 4] Odds Ratio/Relative Risk Ratio and 95% Confidence Interval for Three Cases of Misuse

| Variables | Misuse Case I | Misuse Case II | | Misuse Case III | |
|---|---|---|---|---|---|
| | Having Pap smear[1] (overscreening) | No Pap smear[2] (underscreening) | Pap with HPV test[2] (overscreening) | No Pap Smear[3] (underscreening) | Annual Pap smear[3] (overscreening) |
| Demographics | | | | | |
| Age | 1.68 [1.24, 2.28] | 0.77 [0.72, 0.82] | 1.06 [1.02, 1.11] | 0.82 [0.78, 0.87] | 1.19 [1.13, 1.25] |
| Non-white | 1.70 [0.98, 2.97] | 1.18 [0.86, 1.61] | 1.09 [0.85, 1.38] | 1.15 [0.85, 1.55] | 0.88 [0.67, 1.16] |
| Married | 3.05 [1.09, 8.52] | 0.46 [0.32, 0.66] | 0.74 [0.58, 0.93] | 0.53 [0.38, 0.75] | 1.17 [0.91, 1.51] |
| Employed | 1.95 [1.18, 3.21] | 0.98 [0.72, 1.32] | 1.14 [0.91, 1.43] | 0.91 [0.68, 1.22] | 0.90 [0.70, 1.17] |
| Health Variables | | | | | |
| Received flu shot | 0.77 [0.44, 1.35] | 0.76 [0.55, 1.06] | 1.15 [0.93, 1.43] | 0.73 [0.53, 1.00] | 1.09 [0.86, 1.40] |
| In bed due to illness | 1.14 [0.69, 1.86] | 0.93 [0.69, 1.24] | 0.99 [0.80, 1.22] | 0.91 [0.69, 1.20] | 0.94 [0.75, 1.19] |
| Intervention and cognitive constructs | | | | | |
| Doctor's recommendation | | | | | |
| (Didn't receive) | | | | | |
| Received | 48.43 | 0.12 | 1.35 | 0.18 | 1.35 |

| Variables | Misuse Case I | Misuse Case II | | Misuse Case III | |
|---|---|---|---|---|---|
| | Having Pap smear[1] (overscreening) | No Pap smear[2] (underscreening) | Pap with HPV test[2] (overscreening) | No Pap Smear[3] (underscreening) | Annual Pap smear[3] (overscreening) |
| | [20.77, 112.90] | [0.08, 0.18] | [1.09, 1.67] | [0.13, 0.26] | [1.07, 1.72] |
| Didn't see a doctor | 1.06<br>[0.38, 2.93] | 1.75<br>[1.06, 2.91] | 0.73<br>[0.40, 1.35] | 1.63<br>[1.02, 2.59] | 0.10<br>[0.02,0.42] |
| Heard about HPV | 1.34<br>[0.73, 2.45] | 0.73<br>[0.53, 1.02] | 5.62<br>[3.82, 8.27] | 0.44<br>[0.32, 0.61] | 1.63<br>[1.12, 2.39] |
| HPV vaccinated | 0.70<br>[0.40, 1.21] | 0.51<br>[0.36, 0.73] | 1.73<br>[1.39, 2.17] | 0.46<br>[0.33, 0.64] | 1.18<br>[0.91, 1.52] |

Note: Misuse Case I represents whether women younger than age 21 years had a Pap smear (too-early Pap smear, overscreening) or no Pap smear (proper screening) by using odds ratio. Reference category for Case I is "No Pap smear." Misuse Case II represents whether women aged 21-29 received a Pap smear alone (proper screening) or an HPV test along with a Pap smear (overscreening) or no Pap smear (underscreening) by using relative risk ratio. Reference category for Case II is "a Pap smear only." Misuse Case III represents whether women aged 21-29 years had a non-annual Pap smear (proper screening) or an annual Pap smear (overscreening) or no Pap smear (underscreening) by using relative risk ratio. Reference category for Case III is "non-annual Pap smear."

First, a doctor's recommendation regarding Pap smear screening was a significant factor in encouraging women to receive Pap smears at rates and times in line with the current recommendations. The relative risk ratios from the Misuse Case II showed that the relative probability of receiving only a Pap smear was 8.3 (=1/0.12) times higher than that of no Pap smear for young women aged 21-30 if their doctor or other health professional recommended the screening for a 95% confidence interval. Similarly, the relative risk ratios from the Misuse Case III indicated that the relative probability of a proper frequency of the screening was 5.5 (=1/0.18) times higher than that of receiving no Pap smear within six years for them if their doctors or other health professionals recommended the screening for a 95% confidence interval.

However, the doctor's recommendation was also a significant factor in inducing misuse of screening techniques, including HPV testing along with a Pap smear and annual Pap smear screening. The odds ratios from the Misuse Case I showed that the odds of receiving a too-early Pap smear were 48.4 times higher than that of no Pap smear for young women aged 18-20 if their doctors or other health professionals recommended the screening for a 95% confidence interval. The relative risk ratios from the Misuse Case II also showed that the relative probability of preferring HPV testing along with a Pap smear to a Pap smear alone increased by a factor of 1.35 for young women aged 21-29 if their doctors or other health professionals recommended the screening for a 95% confidence interval. Further, the relative risk ratio from the Misuse Case III indicated that the relative probability of the annual Pap smear (not recommended for young women aged 21-29) over a proper frequency of the screening increased by a factor of 1.35 if their doctors, physicians or other health professionals recommended the screening for a 95% confidence interval.

Having heard of HPV was a significant factor in encouraging respondents to receive Pap smears at the proper frequency, but it did not lead to compliance with other testing timelines. The relative risk ratios from the Misuse Case III showed that the relative probability of the proper frequency of the screening was 2.27 (=1/0.44) times higher than that of no Pap smear for young women aged 21-30 if they had ever heard of HPV for a 95% confidence interval. However, it was not a significant factor in compliance with Pap smears alone for young women aged 21-29, and no Pap smear for young women aged 18-20. Similarly, this intervention did not influence all types of the misuse of cervical cancer screenings considered in this study. It significantly affected the decision to receive HPV testing along with a Pap smear and overuse of annual Pap smears, but did not affect too-early screening for young women. The relative risk ratios from the Misuse Case II showed that the relative probability of receiving

HPV testing along with a Pap smear was 5.62 times higher than that of receiving a Pap smear alone for young women aged 21-30 if they had ever heard of HPV. Further, the relative risk ratios from the Misuse Case III showed that the relative probability of receiving annual Pap smear screening was 1.63 times higher than that of a proper interval of screening for the young women if they had ever heard of HPV. However, it was not a significant factor in inducing too-early screening and screening overuse.

Moreover, HPV vaccination was a significant factor in encouraging women to receive Pap smears at the proper rate. In the Misuse Case II, the relative probability of receiving a Pap smear only was 1.96 (=1/0.51) higher than that of receiving no Pap smear test for young women aged 21-30 if they have received HPV vaccination. Similarly, it was observed from the Misuse Case III that the relative probability of receiving a proper frequency of screening was 2.17 (=1/0.46) times higher than that of receiving no Pap test within six years for young women aged 21-29. However, it induced the unnecessary use of HPV testing for young women as the relative probability of receiving an HPV test was 1.73 times higher than that of a Pap smear alone for these women in the Misuse Case II.

In addition, for demographic factors, although all of our sample consisted of young women, the oldest of these women were 1.30 (=1/0.77, Misuse Case II) or 1.22 (=1/0.82, Misuse Case III) times more likely to receive Pap smears following the current recommendations than were the younger women for a 95% confidence interval. However, going against the USPSTF recommendation, they were 1.06 (Misuse Case 2) and 1.19 (Misuse Case III) more likely to have HPV testing along with a Pap smear and annual Pap smear screening for a 95% confidence interval. Married women were 2.17 (=1/0.46, Misuse Case II) or 1.88 (=1/0.53, Misuse Case III) times more likely to receive Pap smears in a way consistent with current recommendations compared to unmarried women for a 95% confidence interval. Employed women were 1.95 times more likely to have too early Pap smear than unemployed women in the Misuse Case I. For health-related variables, indicators of the flu shot and staying in bed due to illness during the past twelve months were not significant predictors for screening for a 95% confidence interval.

## 4. Discussion

A doctor's recommendation, as formal information, represents the correct information regarding testing and screening frequency as methods to prevent and identify cervical cancer. In this case, women rely on the information doctors provide and decide to take cervical cancer screening. By following this recommendation, it is expected that women will perceive the importance of cervical cancer screening and will be more likely to receive it with the frequency as per the current guidelines, compared to those who do not receive such a recommendation. Several studies have shown that intervention by physicians or other health professionals increased patient awareness of the value of preventive cancer screening and the rates at which women complied with screening guidelines[23-26].

However, the source of informal information in the informal female networks, such as a mother's and peers' influence, is more common for American young women[27]. It is not known whether this informal information on screening methods for cervical cancer provides correct information because this source includes unconfirmed information. Thus, this information source is less reliable than formal information.

Although formal information is a better source for proper use of cervical cancer screening than informal information based on reliability, our empirical results suggest that both formal and informal information induce misuse of cervical cancer screening. Informal information induces misuse of cervical cancer screening except for too-early pap smears among women under the age of 21 years, although it would also increase the likelihood to take cervical cancer screening with proper frequency. Formal information reveals a similar result. Formal information encourages American young women to misuse cervical cancer screening even including too-early Pap smears despite a high likelihood to take cervical cancer screening with proper frequency. Thus, it can be argued that information reliability does not play

an important role in preventing American young women from misusing cervical cancer screening.

The unexpected result could be due to the fact that physicians and other health professionals frequently fail to follow the standard USPSTF guidelines regarding when to start screening, screening frequency, and HPV testing for American young women. Although USPSTF recommended new guidelines for a longer duration between pap smears, most physicians still recommend pap smear testing intervals more frequently than the USPSTF recommends for American young women[8]. When receiving this faulty advice, American young women are more likely to misuse screening methods for cervical cancer, which induces financial burdens and psychological problems for individuals and society. It also encourages women younger than 30 years of age to choose HPV testing along with a Pap smear. Our results reveal that physicians and other health providers still recommend HPV testing to women younger than 30 years of age, and suggest HPV testing at the same time as a Pap smear because of a combination of concern about cervical cancer and the convenience of the HPV test, a testing pattern inconsistent with USPSTF guidelines. This guideline is not widely implemented in practice among American young women. Thus, expert groups and public health authorities should consider the misuse of HPV testing among women younger than 30 years of age.

Another issue from the estimation result is the effect of HPV vaccination on prevention behaviors around cervical cancer, which is still controversial. An empirical study argued that American young women who had received the HPV vaccine did not have more knowledge of HPV and prevention methods than unvaccinated women[28]. In contrast, another study argued that women who received HPV vaccination possessed a high level of knowledge and intention to undergo a Pap smear[29]. The empirical analysis supports the argument that HPV vaccination plays an important role in familiarizing women with the significance of proper preventive care for HPV and cervical cancer. If a woman receives the HPV vaccine, this process is likely to make her consider the danger of cervical cancer and find relevant preventive care to reduce her likelihood of cervical cancer. Thus, HPV vaccination could play an important role in improving the number of women who receive Pap smears at the appropriate frequency.

## 5. Conclusion

Overall, this study aimed to contribute to the growing body of research on cervical cancer screening and identify potential areas for future intervention and policy development. This study examined how three health-related interventions and cognitive factors - a doctor's recommendation, knowledge of HPV, and receiving the HPV vaccine - affected the misuse of three types of cervical cancer screening (too-early screening, unnecessary HPV tests, and annual Papanicolaou (Pap) tests) among young women. Health professionals' recommendations were found to have a significant impact on whether women received Pap smears correctly or not. If they were given incorrect advice, it could lead to unnecessary HPV testing and improper Pap smear screening. HPV vaccination increased compliance with recommendations for Pap smears without simultaneous HPV testing and at the correct frequency, but it also led to screening misuse, such as unnecessary HPV testing during Pap smears. Moreover, being aware of HPV increased the likelihood of women undergoing Pap smears at the correct frequency but also led to unnecessary HPV testing and screening overuse.

To prevent young women from undergoing inappropriate types and frequencies of cervical cancer screening, three types of policies are recommended. First, expert groups and public health authorities should provide precise and correct information about appropriate cancer screening to women. Based on the proper information, educational programs providing such information in high school and college by health educators would be a proper conduit to achieve the proper cervical cancer screening. The policy for physicians and other health professionals should ensure that they follow the established guidelines for cervical cancer screening when making suggestions regarding screening to their patients. Second for

this purpose, health officials or insurers need to establish an automated warning system that appears when doctors claim insurance for inappropriate cervical cancer screening. Finally, it is recommended to enforce doctors to provide information about proper screening methods recommended by the USPSTF and obtain patients' agreement by signature whenever they take Pap smears or HPV tests. Providing screening recommendations when women get HPV shots would be a good idea for young women.

This article addresses the need for more empirical research on the factors that influence individuals' adherence to guidelines for cervical cancer screening. Despite evidence-based guidelines and known risks associated with overuse of screening, healthcare professionals still do not consistently follow them. The article expects the importance of identifying factors that influence appropriate screening behavior to develop effective interventions. Also, there is insufficient research on the misuse of cervical cancer screening in South Korea. Conducting a survey and corresponding research is crucial to examine health interventions aimed at protecting young women from cervical cancer and addressing any instances of screening misuse in South Korea.

In this study, two limitations are identified that may affect the interpretation of the results and the subsequent suggestions for further research. Firstly, the dataset used in this study was collected in the United States, meaning that the results cannot be directly applied to policy in South Korea. Thus, data collection in South Korea is necessary to provide relevant results for policy implementation. Secondly, the dataset used in this study was cross-sectional, which restricts the ability to examine trends in preventive behaviors and endogeneity. Therefore, a rigorous regression model that reflects the longitudinal nature of the data must be constructed and estimated to address these limitations.

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