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The Impact of Age on Adherence to Cervical Cancer Screening Guidelines

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Abstract

The Impact of Age on Adherence to Cervical Cancer Screening Guidelines

By Siriporn (Amy) Wongsiriroj

Prior to 2012, cervical cancer screening guidelines changed many times, and differed in the initiation, frequency, and discontinuance of cervical cancer screening by recommending organizations. In 2012, cervical cancer screening guidelines from the American Cancer Society/American Society for Colposcopy and Cervical Pathology/American Society for Clinical Pathology (ACS/ASCCP/ASCP), the U.S. Preventive Services Task Force (USPSTF), and the American Congress of Obstetricians and Gynecologists (ACOG) became consistent, recommending women be screened every 3 years, starting at age 21 and stopping at age 65. Using logistic regression, we examined if women's age predicts the adherence to cervical cancer screening guidelines, controlling for demographics, health care use, and health status. Although all women were more likely to adhere to screening guidelines in 2012 than in 2010, we found that women ages 30-49 had 20.6 percentage points higher probability to adhere to guidelines, whereas elderly women had 35.7 percentage points lower probability adhere to guidelines compared to women ages 18-20. Compared to women in the same age group in 2010, adult women were more likely to adhere to cervical cancer screening recommendations in 2012; whereas elderly women had 16.5 percentage points lower probability to adhere to guidelines. Additionally, elderly women had 0.76 percentage point higher probability to overuse screening for 1 year increase in age. Furthermore, we found that among younger women (only women eligible for HPV vaccination), those who completed all 3 doses of HPV vaccines had 8.9 percentage points lower probability to adhere to guidelines compared to those who never vaccinated. These findings indicate that age is an important consideration in understanding whether women will adhere to the new, consistent guidelines

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Introduction

Cervical cancer used to be the leading cause of cancer death among women in the United States [1]. Cervical cancer is mostly caused by two specific types of high-risk human papillomavirus (HPV), HPV-16 and HPV-18, which cause approximately 70% of cervical cancer worldwide. The incidence of cervical cancer decreased significantly since the introduction of the Papanicolaou (Pap) smear, which can detect precancerous lesions before it becomes advanced. In addition to Pap test, HPV vaccines are also highly effective in preventing persistent infections with those two HPV types. However, HPV vaccines cannot protect against all types of HPV and also cannot protect women who are already infected. Therefore, screening still remains the most important method to prevent cervical cancer. Several organizations, such as the American Cancer Society/American Society for Colposcopy and Cervical Pathology/American Society for Clinical Pathology (ACS/ASCCP/ASCP), the U.S. Preventive Services Task Force (USPSTF), and the American Congress of Obstetricians and Gynecologists (ACOG), have developed their own screening recommendations. In 2012, for the first time, all recommendations became consistent. The new recommendations have specific initiation and stopping age to start screening and also have less frequent interval of screening in women 21-29 years of age. Many studies have been conducted to explore the association between age and cervical screening rates internationally, but only few studies looked at an adherence to guidelines in U.S. population. Additionally, no studies have examined the role of age in adherence since the consistent guidelines were enacted.

This study seeks to examine whether age predicts adherence to cervical cancer screening guidelines in adult U.S. women, especially after the guidelines became consistent, and whether getting HPV vaccinations affect adherence to guidelines from the available data.

Literature Review

Cervical Cancer Prevention

Although cervical cancer diagnoses and mortality have decreased considerably in recent years due largely to the pap test, it remains an issue for women, and over 4000 women will die in 2013 from cervical cancer [2]. Even the FDA approval of the first human papillomavirus (HPV) vaccine in 2006 is not expected to eradicate cervical cancer, given that a) only younger women are generally eligible for the vaccines; b) many younger women have not opted for the vaccine; and c) vaccination does not protect against all high risk types of HPV or if women are infected prior to vaccination. Cervical cancer screening, therefore, remains a critical prevention for women's health.

History of cervical cancer screening recommendations

There are three main organizations in the U.S. which develop cervical cancer screening recommendations: the American Cancer Society/American Society for Colposcopy and Cervical Pathology/American Society for Clinical Pathology (ACS/ASCCP/ASCP), the U.S. Preventive Services Task Force (USPSTF), and the American Congress of Obstetricians and Gynecologists (ACOG). Prior to 2012, the organizations did not have consistent guidelines [3-5]. However, in 2012, the recommendations became consistent across all 3 organizations [6-8] with the guidelines stating that women should start Pap test at age of 21, be screened every 3 years, and continue screening until age of 65, except women who have hysterectomy (Table 1).

Table 1: Summary of cervical cancer screening guidelines before 2012

	USPSTF 2003	**ACS 2007**	**ACOG 2009**	**Consistent 2012 Guidelines**
Screening initiation age	Within 3 years of onset of sexual activity or age 21 (whichever came first)	21	21	21
Screening methods and intervals	- Pap test alone at least every 3 years	- Pap test alone every 3 years for all ages - Pap test and HPV test every 5 years for 30-65	- Pap test alone every 2 years for 21-29 - Pap test every 3 years for 30 and older - Pap test and HPV test every 5 years for 30-65	- Pap test alone every 3 years for all age - Pap test and HPV test every 5 years for 30-65
When to stop screening	- Over age 65 with past regular screenings with normal results - Continue to screen women with past history of cervical precancer	Over age 65 with no history of cervical precancer	Discontinue screening between 65-70	Over age 65 with adequate recent screenings with normal results, who are not at high risk for cervical cancer
Screening after hysterectomy with removal of cervix	Discontinue screening if no history of cervical cancer or pre-cancer	Discontinue screening if no history of pre-cancer	Discontinue screening if no history of cervical cancer or pre-cancer	Discontinue screening if no history of cervical cancer or pre-cancer

Adherence to guidelines

Inconsistent guidelines prior to 2012 resulted in both underuse and overuse of cervical cancer screenings. On the one hand, there is great concern about women who do not get screened often enough; on the other, overuse of screening results in unnecessary costs (financial and harm due to false positives) associated with too much screening.

Underuse of cervical cancer screening

Women's attitudes and perceptions played a role as a barrier to cervical cancer screening. Women might be comfortable being tested by a female practitioner. Even if the screener was female, they might fear of embarrassment. Some women were not aware of the test's indications and benefits, or consider themselves not to be at risk of developing cervical cancer [9, 10]

Generally, lower rates of screening were associated with a more advanced stage of disease at diagnosis, which, in turn, was associated with higher mortality. Furthermore, a new worry from the HPV vaccination era after 2006 was that women who had been vaccinated would overestimate sense of security from being vaccinated [11], believing that the vaccine conferred complete protection against cervical cancer, and therefore, not participating in ongoing screening [12]. Literature has shown that among vaccinated women, those with lower education, income and lack of insurance coverage were more likely to forgo recommended screenings and that this educed the probability of an early diagnosis of cervical cancer [13, 14]. It was also expected that this group would not adhere to cervical cancer screening guidelines by being screened too late and also reducing the frequency of their screening. Thus, women who did not adhere to the cervical screening program had more risk of getting cervical cancer compared to adherent women [15].

Overuse of cervical cancer screening

Several studies prior to 2012 have shown that the guideline adherence was low. Providers experienced difficulty implementing the guidelines into practice which might be the reason for

low adherence. A study among primary care providers from 2006-2009 showed that they recommended Pap smear sooner than guideline recommendations, but adherence improved when the recommendation was to repeat screening in one year if there were abnormal results [16]. Furthermore, obstetrician-gynecologists indicated persistent barriers to the adoption of cervical cancer screening guidelines [17]. They followed the 2009 guidelines to begin cervical cancer screening at age 21 years, and appropriately utilized Pap smear and HPV co-testing. However, most physicians recommended women to discontinue screening at age 70 years or after hysterectomy, and recommended annual Pap smear. Moreover, they felt that patients were uncomfortable with extended screening intervals and were concerned that patients would not come for annual exams if Pap smear was not offered.

Patients were also affected by the frequently changing guidelines. A qualitative study showed that the change in guidelines caused more confusion to the study sample [18]. An example from a change in guidelines in 2003 indicated that fewer adolescents were being screened before sexual initiation, which was consistent with guidelines at that time, but sexually-active young adult women were being screened too early [19]. Moreover, women reported that they preferred screening at least annually and they would try to continue being screened even if their doctors recommended less frequent screening. In addition, they would not stop until after age 80 years [20].

New contribution

The latest available studies in adherence to cervical cancer screening guidelines were conducted and compared to the 2003 guidelines. Since the 2012 convergence of guidelines, it is important to understand whether the consistency in guidelines improves timely and age-appropriate screening. This cross-sectional study aims to examine the factors associated with the adherence to the updated cervical cancer screening guidelines among women in the U.S. population, using 2010 and 2012 Behavioral Risk Factors Surveillance System (BSRFSS), which

is the most recent publicly-available de-identified data available from Centers for Disease Control and Prevention. Results may inform interventions for specific populations to increase adherence and awareness of the benefits of cervical cancer screening.

Methods

Research Questions and Hypotheses

Q1: Does age predict the adherence to cervical cancer screening guidelines?

H1: Women 31-50 years of age are more likely to adhere to guidelines than other age groups.

Q2: Does a history of HPV vaccination predict adherence to cervical cancer screening guidelines?

H2: HPV vaccinated women are more likely to adhere to guidelines than women who are not vaccinated.

Q3: Does age predict overuse of cervical cancer screening among elderly?

H3: As age increases, women are less likely to overuse cervical cancer screening.

Data Source and Samples

The data for this study are from the 2010 and 2012 Behavioral Risk Factors Surveillance System (BRFSS), conducted by the Centers for Disease Control and Prevention (CDC) [21]. The BRFSS conducts both landline telephone and cellular telephone-based surveys to measure behavioral risk factors and preventive health practices for the adult population (18 years of age and older). The BRFSS questionnaires have three parts: the core component, optional CDC modules, and state-added questions. In this study, I used the core section 18 in the 2010 data and the core section 15 in the 2012 data, which asked about breast and cervical cancer screening. I also included the optional module, which specifically asked about adult Human Papilloma Virus in 5 states in 2010 (Connecticut, Massachusetts, Rhode Island, West Virginia, and Wyoming) and 8 states in 2012 (Alabama, Arizona, Connecticut, Delaware, Maine, Massachusetts, Texas, and West Virginia) for a subgroup analysis.

The BRFSS data are publicly-available, de-identified data. This study was reviewed and received exempt approval by Emory Institute Review Board, #IRB00069837 on September 19, 2013.

For the primary research question about whether age predicts the adherence to cervical cancer screening guidelines, the subjects included in this study were all U.S. women 18 years of age or older who participated in the core component survey. For the second research question about whether a history of HPV vaccination predicts adherence to cervical cancer screening guidelines, the study sample was limited to U.S. women 18-49 years of age or older in the states where the HPV vaccination-related questions was asked. For the third research question about whether age predicts overuse of cervical cancer screening among elderly, the subjects were restricted to all U.S. women 66 years of age and above.

Conceptual Framework

Based on the framework of factors influencing patient-centeredness from Mead, N. [22], several factors impact both provider's and patient's behaviors which finally impact health outcome (Figure 1). However, in this study, we only focused on patient factors that affect adherence to cervical cancer screening recommendations. We developed a conceptual framework (Figure 2) to present the association between the changes in cervical cancer screening recommendations that are expected to influence patient-level factors and an adherence to guidelines. The dotted boxes represent unobserved variables, such as provider factors and patient-provider interaction.

Figure 1: Factors influencing patient-centeredness by Mead, N.

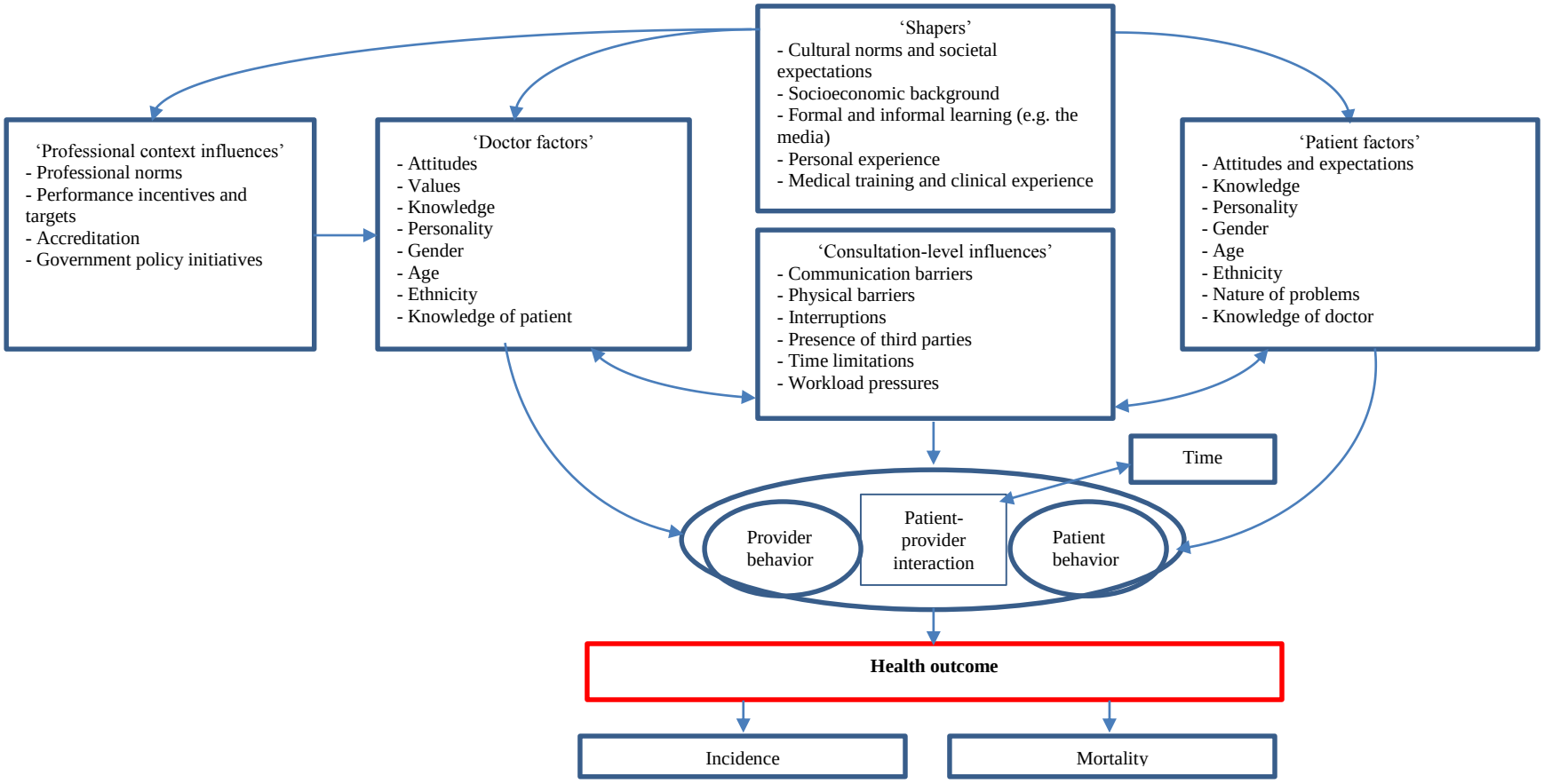
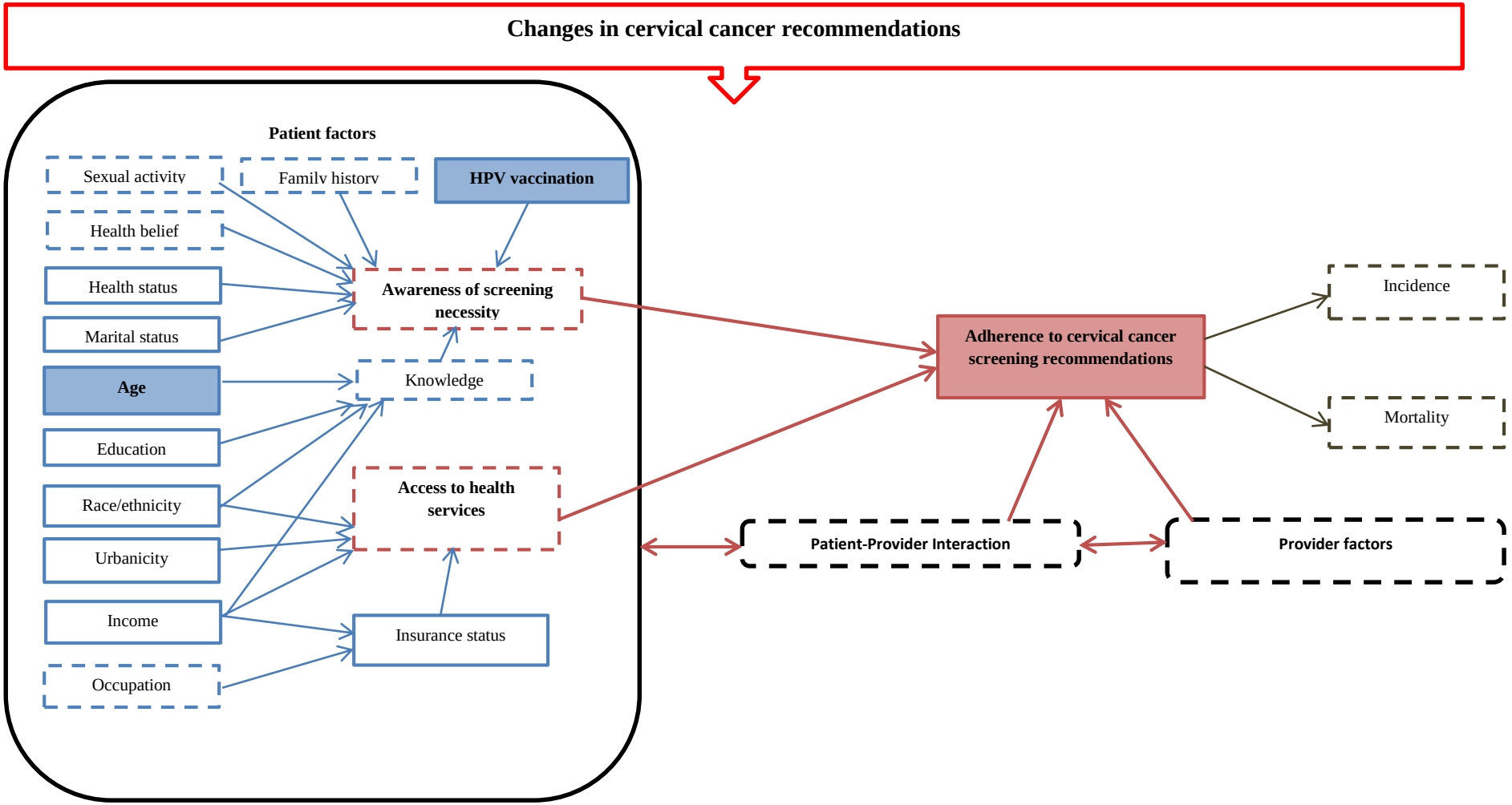


Figure 2: Conceptual Framework



Variables:

Dependent variable 1: Adherence to guidelines

Adherence to guidelines is a dichotomous variable. We defined adherence based on the cervical cancer screening recommendations of that year. In the 2010 data, we used ACOG recommendations in 2009 to categorize women because it was the most recently updated guidelines at that time. In 2012, the guidelines were consistent among the USPSTF, the ACS, and ACOG. We categorized adherence to guidelines into 2 groups (adherence and non-adherence) based on the initiation age, the discontinuation age, the interval of screening, and hysterectomy status (Table 2). For example, in 2012, women were first asked "Have you ever had a Pap test?" and assessed whether they had Pap test (dichotomous yes/no). The interval of screening was assessed by asking the respondents "How long has it been since you had your last Pap test?" If the respondents answered 'Within the past 1, 2, or 3 year(s)', they were considered as 'adherence'. If the respondents answered 'Within past 5 years' or '5 or more years ago', they were considered as 'non-adherence'. The respondents who were 21-65 who never had Pap test were considered as 'non-adherence' as well. Hysterectomy (dichotomous yes/no) was assessed by asking the respondents "Have you had a hysterectomy?"

Table 2: Categorization of adherence variable

2010		**2012**	
Adherence	**Non-adherence**	**Adherence**	**Non-adherence**
Had Pap test - ages 21-29 and every 2 year and no hysterectomy - ages 30-70 and every 3 year and no hysterectomy	*Had Pap test* - ages < 21 or ages > 65 or hysterectomy - ages 21-29 and more than 2 years - ages 30-70 and more than 3 years	*Had Pap test* - ages 21-65 and every 3 year and no hysterectomy	*Had Pap test* - ages < 21 or ages > 65 or hysterectomy - ages 21-65 and more than 3 year

2010		2012	
Adherence	**Non-adherence**	**Adherence**	**Non-adherence**
No Pap test - ages <21 or ages >70 or hysterectomy	*No Pap test* - ages 21-70	*No Pap test* - ages <21 or ages >65 or hysterectomy	*No Pap test* - ages 21-65

Key dependent variable 2: Overuse of Pap test

According to the recommendations that women who are above 65 years of age should discontinue screening, we assume that all screening among them constituted overuse of cervical cancer screening.

Key independent variable 1: Age

We categorized age into 5 age groups based on the changes in the recommendations in 2012.

1) Age of 18-20: Previous recommendations suggested that women who are younger than 21 years of age should be screened if they were sexually active. Since 2012, cervical cancer screening is no longer recommended for women in this age group.

2) Age of 21-29: Previously, women in this age group were recommended to be screened every 2 years. However, the most recent recommendations are stated that women should be screened every 3 years.

3) Age of 30-49: The 2012 recommendations for this age group remain the same from previous versions. Women in this range are more likely to develop cervical cancer. Thus, their behaviors and concerns about women's health might be different from younger women, which might be more likely to get cervical cancer screening.

4) Age of 50-64: Epidemiologic studies show that cervical cancer is developed a median of 15–25 years after HPV infection. Women aged of 50-64 are more likely to have a positive result and might be scared of getting cancer. Therefore, they are more likely to adhere to guidelines.

5) Age of 65 and older: Previously, an upper age of screening was not consistent among the 3 advisory groups. The ACS recommended discontinuation of screening at age 70, but the USPSTF and ACOG recommended at age 65 years. Since 2012, the recommendations consistently suggest that women discontinue screening at age of 65.

Key independent variable 2: HPV vaccination

HPV vaccination was asked among U.S. women 18-49 years of age. This variable was categorized into 3 groups based on the questions "Have you EVER had an HPV vaccination?" and "How many HPV shots did you receive?" (Table 3). This variable was added only in a subgroup analysis.

Table 3: Categorization of HPV vaccination variable

HPV vaccination	Criteria
Complete vaccination	Received 3 shots of HPV vaccination
Partial vaccination	Received 1-2 shots of HPV vaccination
No vaccination	Never had HPV vaccination

Covariates: Demographics, Health care use, and Health status

Year was the year women answered the surveys.

Demographics consist of race, marital status, education, annual household income, metropolitan statistical area (MSA), smoking status, insurance coverage, and employment status. For the insurance variable, we cannot examine the effect of different insurance types due to the data limitation; however, it does not affect the analysis because all insurance was required by 2012 to provide no-cost sharing preventive care, including cancer screenings under ACA.

Health care use was assessed by when women used the latest breast cancer screening, either mammography or clinical breast examination, and a routine checkup.

Health status consists of 2 factors: general health status and general health conditions. General health status was rated by the respondents, and general health conditions were assessed from whether the respondents had told that they had 5 chronic diseases.

Table 4: Summary of covariates used in the analyses

Covariates	Description
Year	Categorical variable (2010 and 2012)
Demographics	
Race	Categorical variable (White, Black, Asian, American Indian/Alaskan Native, Hispanic, Other)
Marital status	Categorical variable (Married, divorced, widowed, separated, single)
Education	Categorical variable (Less than high school, high school graduate, some college, college graduate)
Annual household income	Categorical variable (Less than $15,000, $15,000-$24,999, $25,000-$34,999, $35,000-$49,999, $50,000 or more, don't know/not sure)
Metropolitan Statistical Area	Dichotomous (In an MSA/Not in an MSA)
Insurance coverage	Dichotomous (yes/no)
Employment status	Dichotomous (yes/no)
Smoking status	Dichotomous (yes/no)
Health care use	
Breast cancer screening	Categorical variable (Within the past year, within the past 2 years, within the past 3 years, within the past 5 years, 5 or more years ago, and never)

Covariates	Description
Health care use (continued)	Categorical variable (Within the past year, within the past 2 years, within the past 5 years, 5 or more years ago, and never)
Routine checkup	
Health status	
General health status	Categorical variable (Excellent, very good, good, fair, poor)
General health conditions	Dichotomous (yes/no) for each disease resulting in 5 variables (Myocardial infarction, coronary heart disease, stroke, asthma, and diabetes)

Statistical Analyses

To examine whether age is associated with adherence to cervical cancer screening guidelines, we conducted a binary logistic regression appropriate because the dependent variable is dichotomous. We obtained the marginal effects and the standard errors from the analyses. In computing the marginal effect, each marginal effect is conditional on the average of the other predictor variables. These marginal effects were interpreted as the likelihood of being adherent in guidelines for each independent variable group compared to the reference group.

Main research question: $\text{Adherence} = \beta_0 + \beta_1(\text{Age group}) + \beta_2(\text{Year}) + \beta_3(\text{Age group*Year}) + \beta_4(\text{Demographics}) + \beta_5(\text{Health care use}) + \beta_6(\text{Health status}) + \varepsilon$

The interaction term between age group and year was included in the model because the changes in new recommendations are varying in the interval of screening in different age groups. For example, the starting age of screening has changed from within 3 years of onset of sexual activity or age 21, whichever came first, to only 21 years of age; while the interval of screening among women 21-29 years of age has changed from every 2 years to every 3 years. Therefore, the new consistent guidelines in 2012 might have different impact for different age groups. Due

to the nonlinear model, we followed the methods used by Buis, M.L. [23] to interpret the marginal effects of interactions.

For the second research question, I added a HPV vaccination variable into the model to examine whether HPV vaccination was associated with adherence to cervical cancer screening guidelines.

Second research question: Adherence = $\beta_0 + \beta_1$ (HPV vaccination) + β_2 (Age group) + β_3 (Year) + + β_4 (Age group*Year) + β_5 (Demographics) + β_6 (Health care use) + β_7 (Health status) + ε

For the third research question, the dependent variable was changed from adherence to cervical cancer screening guidelines to overuse of cervical cancer screening, and the independent variable was changed from age group (category) to age (discrete).

Third research question: Overuse of cervical cancer screening = $\beta_0 + \beta_1$ (Age) + β_2 (Year) + β_3 (Demographics) + β_4 (Health care use) + β_5 (Health status) + ε

All statistical analyses were conducted using the statistical packages STATA 10 [24] and SAS 9.2 [25].

Results

Descriptive characteristics

The summary statistics for our sample are shown in table 5 and compare women who participated in the surveys in 2010 and 2012. The total study sample of 449,847 consists of 245,130 women from 2010 and 204,717 women from 2012.

There are significant differences in several key variables of interest. About 62% of women are categorized into the adherence group in 2010, whereas 57% of women in 2012 are categorized into this group. However, this reduction appears to be driven by elderly women, for whom non-adherence increases significantly in 2012. The percentages of adherence among adults increase in every age group except women ages 21-29.

The percentages of adherence in 2012 demonstrate the same trends as 2010 in some variables. For example, higher education, higher income and better general health status have higher percentages of adherence. However, the percentages of adherence in 2012 are lower than in 2010. Women who live in urban areas, working women, and non-smokers have higher percentages of adherence than those who live in rural areas, unemployed women, and smoker.

Among women 18-49 years of age (N=14,620), women who never had HPV vaccinated or got 1-2 shots of HPV vaccines have higher percentages of adherence to cervical cancer screening guidelines than those who received all 3 shots of HPV vaccines in both years.

Table 5: Weighted descriptive statistics of study sample

	2010	2012
Total samples (N)	**245,130**	**204,717**
Adherence to guidelines	**127,660 (61.76%)**	**100,707 (56.93%)**
	% Adherent to guidelines	
	2010	**2012**
Demographics		
Age group in years, % (SE) †		
18-20	54.14 (1.59)	71.29 (2.04)
21-29	72.09 (0.80)	70.42 (1.38)
30-49	78.99 (0.27)	81.18 (0.38)
50-65	57.52 (0.29)	61.17 (0.37)
66 or above	24.15 (0.25)	14.34 (0.26)
Race, % (SE) †		
White, Non-Hispanic	60.51 (0.20)	54.52 (0.25)
Black, Non-Hispanic	61.00 (0.62)	55.98 (0.81)
Asian	66.25 (1.63)	70.82 (2.05)
American Indian/Alaskan Native	57.58 (1.93)	52.93 (2.53)
Hispanic	69.06 (0.67)	68.08 (0.99)
Other	60.37 (1.34)	56.92 (1.83)
Marital status, % (SE) †		
Single	65.24 (0.58)	67.90 (0.75)
Married	66.61 (0.23)	61.24 (0.30)
Divorced	55.68 (0.49)	51.91 (0.63)
Widowed	28.82 (0.39)	24.50 (042)
Separated	64.26 (1.20)	62.35 (1.60)
Education, % (SE) †		
Did not graduate high school	50.64 (0.70)	46.61 (0.96)
High school graduate	52.64 (0.36)	49.32 (0.47)
Some College	59.48 (0.37)	56.84 (0.45)
College graduate	73.48 (0.28)	69.79 (0.35)
Annual income, % (SE) †		
Less than $15,000	50.84 (0.66)	47.75 (0.90)
$15,000-$24,999	50.65 (0.51)	46.60 (0.68)
$25,000-$34,999	55.48 (0.60)	48.90 (0.83)
$35,000-$49,999	60.37 (0.52)	53.87 (0.68)
$50,000 or more	73.29 (0.28)	69.00 (0.36)
Don’t know/Not sure	51.63 (0.54)	47.68 (0.73)
Metropolitan statistical area, % (SE) †		
In an MSA	63.31 (0.21)	58.61 (0.29)
Not in an MSA	54.63 (0.37)	49.57 (0.40)

	%Adherent to guidelines	
	2010	**2012**
Demographics (continued)		
Have health care coverage, % (SE) †		
Yes	62.67 (0.19)	56.24 (0.25)
No	56.07 (0.62)	61.93 (0.89)
Employment, % (SE) †		
Yes	72.02 (0.25)	71.31 (0.33)
No	50.71 (0.28)	44.12 (0.36)
Smoker, % (SE) †		
Yes	56.59 (0.49)	55.92 (0.64)
No	62.70 (0.20)	57.09 (0.27)
Health care use		
Routine checkup visit, % (SE) †		
Within the past year	63.11 (0.21)	55.68 (0.28)
Within the past 2 years	69.79 (0.56)	67.14 (0.68)
Within the past 5 years	51.59 (0.81)	64.39 (1.10)
5 or more years ago	41.08 (0.85)	43.64 (1.15)
Never	55.60 (2.29)	50.98 (2.82)
Any type of breast cancer screening, % (SE) †	53.04 (1.06)	59.42 (1.57)
Within the past year	66.99 (0.21)	58.31 (0.28)
Within the past 2 years	66.48 (0.50)	61.94 (0.64)
Within the past 3 years	54.83 (0.93)	58.15 (1.13)
Within the past 5 years	20.17 (0.96)	51.82 (1.43)
5 or more years ago	18.47 (0.72)	24.29 (0.97)
Never		
Health status		
General health status, % (SE) †		
Excellent	73.95 (0.41)	69.74 (0.52)
Very good	66.76 (0.31)	61.51 (0.40)
Good	56.91 (0.35)	52.57 (0.48)
Fair	47.95 (0.55)	44.90 (0.71)
Poor	37.90 (0.80)	36.71 (1.09)
HPV vaccination, % (SE) †‡		
Never		
Partial vaccination	83.13 (0.79)	78.78 (1.22)
Complete vaccination	72.74 (8.85)	81.13 (6.35)
	68.48 (4.36)	67.98 (3.85)

The figures above are shown in row percentages compared to non-adherence group of each year.

† $p<0.001$

‡The study sample was limited to 18-49 years of age (N=14,620)

Multivariate analysis

Next, we estimate binary logistic regression models to predict the probability of adherence to cervical cancer screening guidelines. The first model includes all variables without the interaction. The results, presented in Table 6, are consistent with the hypothesis that women 30-49 and 21-29 age groups have 15.4 and 7.5 percentage points higher probabilities of adhering to guidelines, compared to women age 18-20 ($p<0.001$), while the elderly group has 48 percentage points lower probability of adhering to guidelines relative to women 18-20 years of age. Women in 2012 have 12.2% points increased probability of adhering to guidelines compared to women in 2010 ($p<0.01$). Consistent with previous research, the probability of adherence is 37.6 percentage points lower in Black women compared to White women; however, the probability of adherence is 61 percentage points higher in Hispanic women compared to White women. Employed and insured women had statistically significant increased probabilities of adherence, while smokers and women who live in rural areas have lower probabilities of adhering to guidelines

Compared to women who never had breast cancer screening, women with recent breast cancer screenings have higher probability to adhere to guidelines, but the likelihood decreases based on how long it has been since the last screening. For example, women with mammogram in the last year are 15.9% points higher probabilities to adhere compared to women who have never had a mammogram, but this decreases to 8.3% points of probabilities for women who reported a mammogram in the last 3 years. Furthermore, women with breast cancer screening 5 or more years ago have 25.4 percentage points lower probabilities of adhering to guidelines. Women who have used any types of health care 5 or more years ago are least likely to adhere to guidelines. Moreover, women who have poorer health status or have chronic diseases are less likely to adhere to screening guidelines, except women with diabetes.

We introduce the interaction of age group and year into the second model because the changes in guidelines affect the age of women being screened. We can see the same associations

between age and adherence to guidelines with stronger magnitudes, except women in 50-65 years of age. The age-year interaction is statistically significant. A more detailed explanation of the interaction terms are below.

Table 6: The marginal effects of age on the adherence to cervical cancer screening guidelines

	Model 1 Simple model	Model 2 Interaction model
Age group		
18-20	Reference	Reference
21-29	0.0746***	0.1390***
	[0.0171]	[0.0176]
30-49	0.1540***	0.2060***
	[0.0161]	[0.0173]
50-65	-0.0870***	-0.0351
	[0.0177]	[0.0194]
66+	-0.4790***	-0.3570***
	[0.0135]	[0.0178]
Year		
2010	Reference	Reference
2012	0.0122**	0.1890***
	[0.0037]	[0.0294]
Interaction		
Age 21-29 x Year 2012	-	-0.2030***
		[0.0377]
Age 30-49 x Year 2012	-	-0.1530***
		[0.0336]
Age 50-65 x Year 2012	-	-0.1510***
		[0.0331]
Age>65 x Year 2012	-	-0.3500***
		[0.0284]
Demographics		
Race		
White, Non-Hispanic	Reference	Reference
Black, Non-Hispanic	-0.0376***	-0.0376***
	[0.0065]	[0.0065]
Asian	-0.00815	-0.0090
	[0.0176]	[0.0177]
American Indian/Alaskan Native	-0.0328	-0.0320
	[0.0189]	[0.0190]
Hispanic	0.0611***	0.0606***
	[0.0077]	[0.0076]
Other	-0.0178	-0.0161
	[0.0125]	[0.0126]
Marital status		
Single	Reference	Reference
Married	0.0050	0.0060
	[0.0065]	[0.0065]
Divorced	-0.0090	-0.0078
	[0.0070]	[0.0070]
Widowed	-0.0101	-0.0093
	[0.0073]	[0.0073]
Separated	0.0117	0.0130

	Model 1 Simple model [0.0117]	Model 2 Interaction model [0.0117]
Demographics		
Education		
Less than high school	Reference	Reference
High school graduate	-0.0024	-0.0024
	[0.0078]	[0.0078]
Some college	-0.0018	-0.0015
	[0.0081]	[0.0081]
College graduate	0.0789***	0.0792***
	[0.0080]	[0.0081]
Income		
Less than $15,000	Reference	Reference
$15,000-$24,999	-0.0044	-0.0047
	[0.0079]	[0.0079]
$25,000-$34,999	-0.0001	-0.0009
	[0.0089]	[0.0089]
$35,000-$49,999	-0.0074	-0.0079
	[0.0086]	[0.0086]
$50,000 or more	0.0155	0.0148
	[0.0085]	[0.0085]
Don't know/Not sure	-0.0100	-0.0107
	[0.0086]	[0.0086]
Metropolitan statistical area (MSA)		
In an MSA	Reference	Reference
Not in an MSA	-0.0444***	-0.0448***
	[0.0038]	[0.0038]
Health care coverage	0.0357***	0.0351***
	[0.0070]	[0.0069]
Employment	0.0336***	0.0342***
	[0.0044]	[0.0044]
Smoker	-0.0355***	-0.0346***
	[0.0053]	[0.0053]
Health care use		
Breast cancer screening		
Within the past year	0.1590***	0.1640***
	[0.0122]	[0.0122]
Within the past 2 years	0.1490***	0.1520***
	0.0105]	[0.0105]
Within the past 3 years	0.0827***	0.0858***
	[0.0132]	[0.0132]
Within the past 5 years	-0.1680***	-0.1660***
	[0.0164]	[0.0165]
5 or more years ago	-0.2450***	-0.2430***
	[0.0153]	[0.0153]
Never	Reference	Reference
Routine check up		
Within past 1 year	0.0542*	0.0512*
	[0.0214]	[0.0217]
Within past 2 years	0.0735***	0.0719***
	[0.0202]	[0.0206]
Within past 5 years	-0.0125	-0.0146
	[0.0224]	[0.0227]
5 or more years ago	-0.0906***	-0.0932***
	[0.0231]	[0.0234]
Never	Reference	Reference

	Model 1 Simple model	Model 2 Interaction model
Health status		
General health status		
Excellent	Reference	Reference
Very good	-0.0439***	-0.0445***
	[0.0056]	[0.0056]
Good	-0.0917***	-0.0931***
	[0.0060]	[0.0060]
Fair	-0.1140***	-0.1150***
	[0.0075]	[0.0075]
Poor	-0.1650***	-0.1660***
	[0.0100]	[0.0100]
Comorbidities		
Myocardial infarction	-0.0270**	-0.0275**
	[0.0097]	[0.0097]
Coronary heart disease	-0.0421***	-0.0431***
	[0.0088]	[0.0088]
Stroke	-0.0500***	-0.0515***
	[0.0103]	[0.0103]
Asthma	-0.0329***	-0.0330***
	[0.0053]	[0.0052]
Diabetes	0.0086***	0.0084***
	[0.0024]	[0.0024]
Observations	449847	449847

Marginal effects; Standard errors in brackets
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

As defined by Buis et al [23], the marginal effect in our non-linear model is the difference between the expected odds of women within the same age group for 2012 and 2010. The likelihood of adhering to guidelines differs in each age group in each year. Adult women in 2012 have statistically higher probabilities to adhere to guidelines, especially the youngest age group, except women 21-29 years of age which the likelihood of adhering to guidelines does not change. However, we see the opposite result among elderly women in 2012. The marginal effect of year for elderly women is -0.165. (Table 7). Figure 3 shows the patterns of the likelihood of adhering to guidelines in each age group by year.

Table 7: The marginal effects of the interaction term (age group and year) on the adherence to cervical cancer screening guidelines[†]

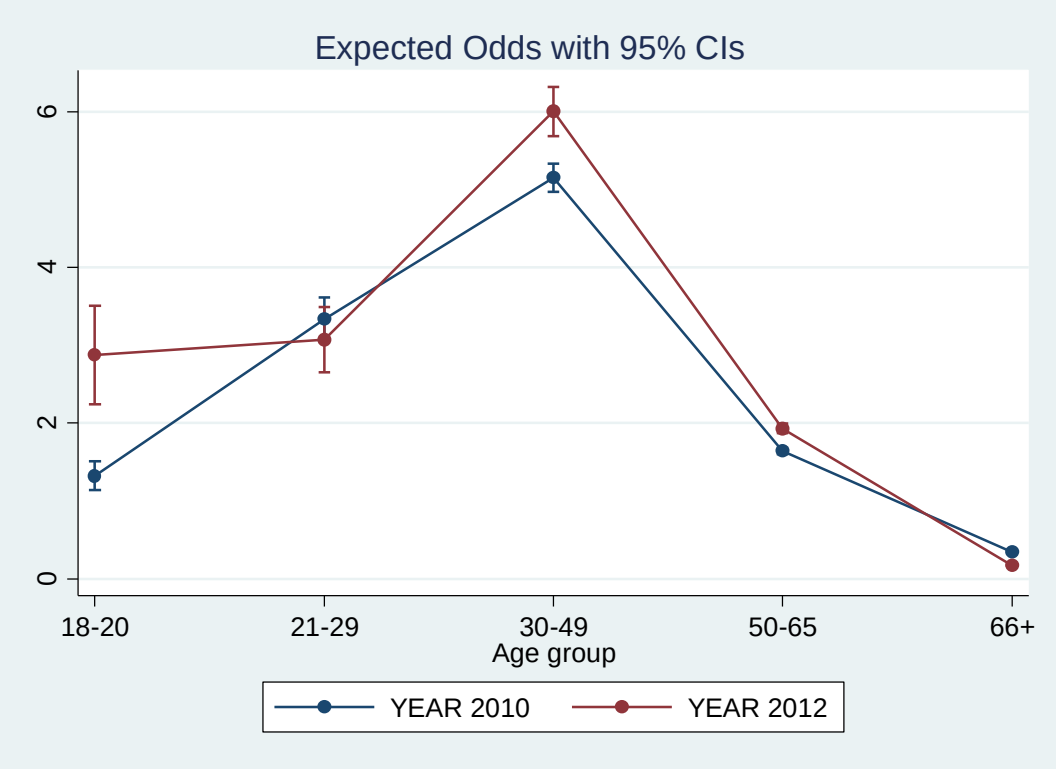
	Adherent to guidelines
Age group	
18-20	1.5461***
	[0.3339]
21-29	-0.2625
	[0.2570]
30-49	0.8530***
	[0.1788]
50-65	0.2877***
	[0.0372]
66 or above	-0.1651***
	[0.0063]

Marginal effects; Standard errors in brackets

[†] The figures above are 2012 compared to 2010 within each age group.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 3: The expected odds of adhering to guidelines by age groups and year among all U.S. women



Subgroup analyses

HPV vaccination

For our second research question, we add another variable about HPV vaccination into the previous model, and also limit the study sample to women age of 18-49 in the states where HPV-related questions were asked (N=14,620). Table 8 presents the impact of HPV vaccination on adherence to cervical cancer screening guidelines. We surprisingly see that women who completed all 3 doses of HPV vaccination demonstrate a 10 percentage points decrease in the probability of adherence compared to women 18-20 years of age who were not vaccinated ($p<0.01$). This becomes somewhat less surprising, when we realize that among non-adherent women who received all 3 doses of HPV vaccination, the majority of them overuse Pap test (83.43% of overuse vs. 16.57% of underuse). Age and year do not affect the adherence to cervical cancer screening guidelines in this subgroup analysis. Also, we do not see any significant impact of other variables except MSA, the use of breast cancer screening, and general health status of women. In model 2, we introduce the interaction between age group and year into the model. Age and year become significantly associated with adherence to guidelines. Women in 2012 have 15.7 percentage points higher in probabilities of adhering to guidelines than women age 18-20 in 2010 ($p<0.01$). The age-year interaction significant lowers on the probability of adherence to guidelines in the age group 30-49. A more detailed explanation of the interaction terms are below.

Table 8: The marginal effects of HPV vaccination on the adherence to cervical cancer screening guidelines

	Model 1 Simple model	Model 2 Interaction model
HPV vaccination		
No vaccination	Reference	Reference
Partial vaccination	-0.0004	0.0089
	[0.0465]	[0.0459]
Completed vaccination	-0.0996**	-0.0891*
	[0.0374]	[0.0371]

	Model 1 Simple model	Model 2 Interaction model
Age group		
18-20	Reference	Reference
21-29	0.0142	0.0900**
	[0.0350]	[0.0345]
30-49	0.0628	0.1930**
	[0.0442]	[0.0636]
Year		
2010	Reference	Reference
2012	0.0045	0.1570*
	[0.0133]	[0.0616]
Interaction		
Age 21-29 x Year 2012		-0.1850
		[0.0997]
Age 30-49 x Year 2012		-0.1700**
		[0.0627]
Demographics		
Race		
White, Non-Hispanic	Reference	Reference
Black, Non-Hispanic	-0.0255	-0.0242
	[0.0277]	[0.0280]
Asian	-0.0782	-0.0822
	[0.0892]	[0.0870]
American Indian/Alaskan Native	-0.0822	-0.0765
	[0.0998]	[0.0994]
Hispanic	0.0212	0.0232
	[0.0227]	[0.0226]
Other	-0.0141	-0.0117
	[0.0385]	[0.0383]
Marital status		
Single	Reference	Reference
Married	-0.0037	-0.0030
	[0.0183]	[0.0184]
Divorced	0.0214	0.0208
	[0.0210]	[0.0211]
Widowed	-0.0167	-0.0160
	[0.0510]	[0.0508]
Separated	-0.0317	-0.0322
	[0.0398]	[0.0398]
Education		
Less than high school	Reference	Reference
High school graduate	-0.0398	-0.0392
	[0.0294]	[0.0298]
Some college	-0.0500	-0.0493
	[0.0301]	[0.0306]
College graduate	0.0555	0.0544
	[0.0303]	[0.0307]

	Model 1 Simple model	Model 2 Interaction model
Demographics		
Income		
Less than $15,000	Reference	Reference
$15,000-$24,999	0.0189	0.0180
	[0.0270]	[0.0273]
$25,000-$34,999	0.0236	0.0224
	[0.0293]	[0.0295]
$35,000-$49,999	0.0383	0.0339
	[0.0313]	[0.0316]
$50,000 or more	0.0308	0.0290
	[0.0313]	[0.0314]
Don't know/Not sure	-0.0136	-0.0136
	[0.0357]	[0.0357]
Metropolitan statistical area (MSA)		
In an MSA	Reference	Reference
Not in an MSA	-0.0379*	-0.0335*
	[0.0160]	[0.0158]
Health care coverage	-0.0015	-0.0067
	[0.0227]	[0.0223]
Employment	-0.0221	-0.0204
	[0.0151]	[0.0151]
Smoker	-0.0238	-0.0245
	[0.0193]	[0.0195]
Health care use		
Breast cancer screening		
Within the past year	0.1020**	0.1110***
	[0.0316]	[0.0324]
Within the past 2 years	0.0774***	0.0828***
	[0.0229]	[0.0227]
Within the past 3 years	0.0267	0.0328
	[0.0342]	[0.0331]
Within the past 5 years	-0.0903	-0.0901
	[0.0627]	[0.0623]
5 or more years ago	-0.4510***	-0.4380***
	[0.0672]	[0.0683]
Never	Reference	Reference
Routine check up		
Within past 1 year	0.0165	0.0058
	[0.0703]	[0.0656]
Within past 2 years	0.0251	0.0145
	[0.0640]	[0.0633]
Within past 5 years	-0.0741	-0.0850
	[0.0931]	[0.0920]
5 or more years ago	-0.1860	-0.1990
	[0.1161]	[0.1130]
Never	Reference	Reference

	Model 1 Simple model	Model 2 Interaction model
Health status		
General health status		
Excellent	Reference	Reference
Very good	-0.0515*	-0.0492*
	[0.0221]	[0.0217]
Good	-0.0601*	-0.0574*
	[0.0239]	[0.0238]
Fair	-0.1460***	-0.1430***
	[0.0368]	[0.0365]
Poor	-0.1320*	-0.1300*
	[0.0568]	[0.0567]
Comorbidities		
Myocardial infarction	0.0245	0.0255
	[0.0493]	[0.0494]
Coronary heart disease	-0.0265	-0.0267
	[0.0482]	[0.0485]
Stroke	-0.2290*	-0.2250*
	[0.0971]	[0.0958]
Asthma	-0.0277	-0.0244
	[0.0198]	[0.0196]
Diabetes	0.0135	0.0135
	[0.0087]	[0.0086]
Observations	14620	14620

Marginal effects; Standard errors in brackets
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The impact of the interaction term between age group and year is presented in Table 9 and Figure 4. Again, as defined by Buis et al [23], the marginal effect in our non-linear model is the difference between the expected odds of women within the same age group for 2012 and 2010. The marginal effect of year for women aged 18-20 is 2.401, whereas the marginal effect of year for women aged 30-49 is -2.217. These results indicate the variation of adherence to guidelines in 2012 in different ages.

Table 9: The marginal effects of the interaction term (age group and year) on the adherence to cervical cancer screening guidelines[†]

	Adherent to guidelines
Age group	
18-20	2.4055[*]
	[1.0249]
21-29	-1.2178
	[1.0699]
30-49	-2.2165[**]
	[0.7859]

Marginal effects; Standard errors in brackets

[†] The figures above are 2012 compared to 2010 within each age group.

[*] $p < 0.05$, [**] $p < 0.01$, [***] $p < 0.001$

Figure 4: The expected odds of adhering to guidelines by age groups and year among women 18-49 years of age

Overuse of cervical cancer screening

From table 6, we can see that the highest proportion of non-adherence to cervical cancer screening guidelines is among women age of 66 and above. According to the recommendations that women who are above 65 years of age should discontinue screening, we assume that non-adherence among elderly means these women overused cervical cancer screening. For our third research question, we limit the study sample to elderly women who overuse cervical cancer screening (N=151,080). Table 10 presents the results of a binary logistic regression among elderly women to explore the factors associated with overuse of screening. The probability of the overuse of cervical cancer screening is increased by 0.76 percentage points for each additional increase in age. Moreover, women in 2012 have a 10% increase in the probability of overuse Pap test compared to 2010 ($p<0.001$). Similarly to the first findings, the probability of overuse of cervical cancer screening is higher in Hispanic women than in White women; whereas Black women have lower probability to overuse screening as White women. Compared to women who never had breast cancer screening, those who were screened for breast cancer in the last year have a higher probability of overuse cervical cancer screening, while those who had their last breast cancer screening more than 5 years earlier have 18% decrease in the probability of overuse of cervical cancer screening.

Table 10: The predictors associated with the probability of overuse of cervical cancer screening among elderly

	Overuse of cervical cancer screening
Age	0.0076***
	[0.0003]
Year	
2010	Reference
2012	0.0983***
	[0.0034]

	Overuse of cervical cancer screening
Demographics	
Race	
White, Non-Hispanic	Reference
Black, Non-Hispanic	0.0327***
	[0.0066]
Asian	0.0029
	[0.0286]
American Indian/Alaskan Native	0.0207
	[0.0198]
Hispanic	0.0242**
	[0.0092]
Other	0.0302*
	[0.0131]
Marital status	
Single	Reference
Married	0.0271**
	[0.0085]
Divorced	0.0167
	[0.0087]
Widowed	0.0101
	[0.0084]
Separated	0.0435*
	[0.0209]
Education	
Less than high school	Reference
High school graduate	-0.0155*
	[0.0065]
Some college	-0.0166*
	[0.0070]
College graduate	-0.0443***
	[0.0078]
Income	
Less than $15,000	Reference
$15,000-$24,999	0.0094
	[0.0067]
$25,000-$34,999	0.0009
	[0.0076]
$35,000-$49,999	0.0073
	[0.0076]
$50,000 or more	-0.0067
	[0.0082]
Don't know/Not sure	0.0017
	[0.0070]
Metropolitan statistical area (MSA)	
In an MSA	Reference
Not in an MSA	0.0125***
	[0.0036]
Health care coverage	-0.0243
	[0.0169]
Employment	-0.0241***
	[0.0063]
Smoker	-0.0143*

	Overuse of cervical cancer screening
	[0.0064]
Health care use	
Breast cancer screening	
Within the past year	0.0835***
	[0.0142]
Within the past 2 years	0.0251*
	[0.0119]
Within the past 3 years	-0.0233
	[0.0160]
Within the past 5 years	-0.0385*
	[0.0164]
5 or more years ago	-0.1820***
	[0.0202]
Never	Reference
Routine check up	
Within past 1 year	0.0083
	[0.0244]
Within past 2 years	-0.0056
	[0.0249]
Within past 5 years	-0.0009
	[0.0255]
5 or more years ago	-0.0228
	[0.0278]
Never	Reference
Heath status	
General health status	
Excellent	Reference
Very good	0.0086
	[0.0058]
Good	0.0185**
	[0.0058]
Fair	0.0201**
	[0.0066]
Poor	0.0491***
	[0.0073]
Comorbidities	
Myocardial infarction	0.0119
	[0.0064]
Coronary heart disease	0.0181**
	[0.0059]
Stroke	0.0138*
	[0.0066]
Asthma	0.0200***
	[0.0049]
Diabetes	-0.0051*
	[0.0022]
Observations	151080

Marginal effects; Standard errors in brackets
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Discussion

The overall aim of this study is to determine the effects of age on adherence to cervical cancer screening guidelines. The primary results indicate that age does statistically impact women's adherence to cervical cancer screening guidelines. Adult women have higher probabilities to adhere to guidelines compared to women in the same age in 2010, whereas elderly women have lower probabilities to adhere to guidelines in 2012, compared to women in the same age in 2010.

It is not surprising that women ages 21-49 have higher probability to adhere to guidelines, because women in this range are more likely to be sexually active, get married, and be adult women of childbearing age. Thus, they might have more concern about reproductive health than other groups [26, 27]. Interestingly, the results show the significant impact of the changes of initiation age on adherence to guidelines among younger adult women. This is possibly because the new recommendations have an exact recommended age of 21 years old, and this may serve to reduce confusion about when to start screening. Moreover, the recommendations in 2012 among women 31-65 years of age do not change from the previous version. Therefore, adherence among these age groups probably increases over time. However, we cannot see a significant change in adherence among women age of 21-29, an age range for which the recommended screening frequency changed from over 2 years to every 3 year.

Moreover, in accordance with the new recommendations that women who are above 65 years of age should discontinue screening, we assume that non-adherence among elderly means these women overused cervical cancer screening. From the finding in this study, the highest proportion of non-adherence to cervical cancer screening guidelines is among elderly women. The possible explanation is that women in this group might have abnormal Pap results in the past, which require continuing screenings. However, this is likely to be only a small proportion of the population since the percentage of abnormal Pap test results decreased with increasing age [28].

In contrast to previous research, Hispanic women in this study have higher probabilities to adhere to guidelines. This is possibly because physicians recognize racial disparities in preventive healthcare utilization; thus, they might pay more attention to vulnerable populations. As a result, Hispanic women might receive advice and be screened at appropriate intervals. However, we have not seen the same result in Black women. The language issue might be another barrier to Hispanic women [29], so that women who do not speak English are less likely to contradict providers on requesting unnecessary services.

Since the majority of the study sample reported a routine checkup visit and/or breast cancer screening, it is reasonable to assume that they are more likely to meet and discuss with their physicians about other women's health problem, including cervical cancer. Thus, they are more likely to be screened. Moreover, the frequency of breast cancer screening is highly associated with adherence to cervical cancer screening guidelines. Women who received breast cancer screening might have more concerned about women's health; therefore, they are more likely to have Pap test than those who did not have breast cancer screening. Moreover, when the obstetricians/gynecologists conduct Pap test and are the primary referring sources for mammograms, women are more likely to get both screenings.

The finding that women who completed three doses of HPV vaccination are least likely to adhere to guidelines is interesting. While it could be that fully vaccinated women overestimate the protective effect of HPV vaccines, it is notable that the large majority of fully vaccinated women demonstrated over, not underuse of screening. It is also worth noting that HPV vaccination was first introduced in 2006, so that the number of women who are eligible to have completed HPV vaccination was much smaller than those who had never vaccinated. Future research should continue to examine this relationship as increasing numbers of women become vaccinated. It would also be interesting to qualitatively explore the reasons for non-adherence among these women.

Clinical and Policy Implications

One attempt to reduce the burden of cervical cancer is to detect and treat patients in early stages. Three main organizations are involved in developing cervical cancer screening recommendations; however, prior to 2012, inconsistent guidelines may have confused both providers and patients regarding appropriate screening intervals. In this study, we have seen that women who are in the age at risk of developing cervical cancer are most likely to adhere to guidelines; whereas elderly women are most likely to overuse cervical cancer screening. Furthermore, the new recommendations in 2012 have different impact on different age group. From public health standpoint, it is important to clearly communicate to patients and providers what recommendations have been changed, and ensure that both patients and providers get updated, relevant information on when and how often women should be screened to be most helpful for them to follow the guidelines.

Disparity still exists among some populations since they still are less likely to adhere to guidelines. Policy makers should be more focus on Black women and women who live in rural areas. Frequent and watchful follow up or patient navigation will be needed among these women, as well as providing patient education to increase their awareness and to acknowledge the benefits of cervical cancer screening will increase adherence.

Limitations

This study is the first study to examine an adherence to cervical cancer screening guidelines after the recommendations became consistent in 2012. Also, we use the most recent publicly available and nationally representative data, so that the results could be generalized to all US women.

However, we recognize that this study has some limitations. Since this study is a cross-sectional study, we cannot establish temporal precedence, and, therefore, causality. For example, this cross-sectional study cannot determine whether women got a hysterectomy before or after they were screened. Our judgment is that anyone reporting a hysterectomy should not be

screened. Therefore, some respondents who had hysterectomy after screening could be categorized into the wrong group.

Moreover, we cannot categorize adherence into ‘underuse,’ ‘appropriate use,’ and ‘overuse’ due to the limitations of the data. For example, we decided to use conservative method to apply the recommendations for an average population, such that we assume that women should discontinue screening at age 65 and cannot account for individuals who may have legitimate reasons to continue to screen. Therefore, elderly women who had Pap test were considered as ‘non-adherent,’ or specifically ‘over-users’ in this study. Also, the questionnaire required respondents to answer when they had their last Pap test. Thus, any respondent answered ‘within the past year’ or ‘within the past 2 years’ might overuse Pap test. Based on these limitations, our estimates may be away from the null if the respondents were screened every 1-2 years, or we may underestimate the likelihood of adherence among elderly.

Future Research

A next step to this study is to evaluate the effect of the recommendation changes on adherence from both patient and provider perspectives. Patient-level factor, as measured in this study, is only one component of the decision making process. In addition, several patient factors, including demographics, past Pap test results, knowledge and attitudes can influence patient’s behaviors to use cervical cancer screening. These unobserved variables also impact adherence to cervical cancer screening recommendations. Moreover, the changes in guidelines require additional counseling time so that providers can explain these changes to patients. Further study to assess whether an increase in counseling time affects provider’s behavior, which ultimately affect quality and quantity of patients treated, is interesting since provider do not get any reimbursement for counseling time. So, for future research, we should other patient factors and also provider factors to expand the analysis.

In addition, future studies should have a sufficient interval of data collection in a cohort study so that one can accurately categorize adherence. For example, since the guidelines

recommend women to be screened every 3 years, the duration of study should be at least 4 years to collect information in two consecutive uses of Pap test. Also, the assessment of adherence will be more accurate if the duration of study is longer since adherence is related to patient's behavior.

Although this study used nationally representative data, the sample size of HPV vaccinated women was relatively small relative to the total sample. A research can examine an adherence to cervical cancer screening among this group, with an increase in sample size, since the number of women who completed 3 shots of HPV vaccines is expected to increase every year. Additionally, a qualitative study among non-adherent women who completed HPV vaccination is also interesting. Therefore, policy makers can understand the problems and barriers of non-adherence.

Conclusion

This study indicates that women in different ages do not equally adhere to cervical screening guidelines. Women aged 30-49 are most likely to adhere to guidelines, whereas elderly women are least likely to adhere. Specifically, as age increases, elderly women are more likely to overuse of cervical cancer screening. Moreover, women who completed all 3 shots of HPV vaccines are least likely to adhere to guidelines. Rather than a general emphasis by policy makers in increasing screening rates across the board for all ages, that attention should be focused on adherence to cervical cancer screening guidelines. Patient education and provider's training on the new consolidated guidelines can increase cervical cancer screening in timely and age-appropriate manners, which create the efficient use of screening.

These findings suggest that women's age and the use of HPV vaccines are associated with adherence to cervical cancer screening guidelines on the patient level. Future research including provider factors will provide broader understanding of adherence to guidelines. In addition to provider factors, future research on adherence to cervical cancer screening guidelines focusing on HPV vaccinated women might be an area of interest since there will be more women with completed HPV vaccines.

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