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RESEARCH ARTICLE

BMI, Physical Inactivity, and Pap Test Use in Asian Women in the U.S.

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Introduction: In the U.S., limited epidemiologic studies have investigated associations between BMI and physical inactivity and Pap test use among Asian women. The aim was to disentangle associations using data from the Behavioral Risk Factor Surveillance System between 2014 and 2016.

Methods: In the Behavioral Risk Factor Surveillance System, BMI was categorized into four levels (<18.5, 18.5 to <25, 25 to <30, and ≥30) and inactivity was defined as having no physical activity in addition to the individual's regular job during the past month. Analyses were conducted in June 2018. Weighted percentages of covariates were used to descriptively summarize the data. Multivariable logistic regression corrected for sampling weight was used to estimate associations between BMI and inactivity and Pap test use. Subgroup analysis was conducted by income and education.

Results: The analysis included 9,424 women and 59.6% of them had their last Pap test within 3 years. OR in the mutually adjusted model suggested underweight (BMI <18.5 compared with normal weight) was inversely associated with Pap test use within the last 3 years (OR=0.56, 95% CI=0.36, 0.88). Inactivity (compared with activity) was not associated with Pap test use within the last 3 years (OR=0.80, 95% CI=0.60, 1.06). Different association patterns of BMI and inactivity were observed by education.

Conclusions: This study suggests that being underweight, rather than overweight or obesity, is associated with a lower rate of Pap test use in U.S. Asian women. Health interventions to facilitate Pap test use in Asian women should explore other potential targets, not aiming to just prevent obesity or change physical inactivity.

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INTRODUCTION

Cervical cancer is one of the major gynecologic malignancies threatening women's health in the U.S. The Pap test is a screening technique to test for the presence of precancerous or cancerous cervical cells.[1] With the introduction of the Pap test in the 1950s, cervical cancer mortality was significantly reduced in the U.S.[2] The 2012 guidelines of U.S. Preventive Services Task Force recommend women aged 21−65 years should undergo a Pap test every 3 years.[3]

According to Census data in 2016, a total of 5.4% of the U.S. population are Asian.[4] Although Asian women account for a small proportion of the whole U.S. population, major efforts that can increase their use of cervical cancer screening are needed because previous evidence

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indicates that U.S. Asian women have a significantly lower rate of Pap test use compared with white women.[5] For example, by investigating more than 4,000 Asian women in the U.S., Kandula et al.[5] found Asian women were 23% less likely to undergo a Pap test compared with white women.

BMI has been found to be associated with the use of breast, colorectal, and cervical cancer screening among U.S. women.[6−8] A meta-analysis found higher BMI was associated with a lower rate of Pap test use and the effect was more substantial for white women.[8] Other research indicated that higher BMI may impede screening because of embarrassment or disrespect associated with negative body image.[9,10] However, very few studies have specifically investigated how BMI could impact getting a Pap test among Asian women. Asian women compared with white or African American women in the U.S., are socially and physiologically different. For instance, Asian women have a more conservative sexual ideology[11] and have a lower obesity prevalence,[12] suggesting evidence regarding the association between BMI and cervical cancer screening established based on white or African American women may not be applicable to the Asian population. Moreover, previous research found a positive association between high-level physical activity and Pap test use and suggested active women could have a stronger health awareness contributing to the uptake of cervical cancer screening.[13] Physical activity can be a correlate of BMI[14] and a modifiable behavior, which makes it a more direct target for health intervention.

In this study, pooled data from the nationwide Behavioral Risk Factor Surveillance System (BRFSS) between 2014 and 2016 is used to examine associations between BMI and physical inactivity and Pap test use among U.S. Asian women.

METHODS

Study Sample

BRFSS is a U.S. nationwide cross-sectional telephone survey initiated in 1984. The BRFSS collected data from resident adults across all 50 states, District of Columbia, Puerto Rico, U.S. Virgin Islands, Guam, American Samoa, and Palau. Until 2016, a total of 54 states or territories used computer-assisted telephone interview systems to conduct the interview on landlines or cell phones. For those states using an in-house survey, interviewers had received additional training on the BRFSS questionnaire and procedures before the interviews. BRFSS measured self-reported non-identifiable demographic and household information and health-related factors, such as overall health conditions, chronic diseases, injuries, and usage of preventive medical services. Detailed information about BRFSS can be found at www.cdc.gov/brfss/about/index.htm.

Measures

In the 2014−2016 BRFSS survey, participants self-reported whether they had a cervical cancer screening and the time elapsed since last screening. The following questions were used for measurement: (1) *A Pap test is a test for cancer of the cervix. Have you ever had a Pap test?* and (2) *How long has it been since you had your last Pap test?* Non-informative answers including *don't know*, *not sure*, and *refused* were treated as missing data and researchers did not perform statistical imputation. According to the 2012 U.S. Preventive Services Task Force screening guideline,[15] participants having Pap tests within the past 3 years were treated as the outcome of interest for the analysis. Although the guideline provides an option that women aged 30−65 years can undergo a Pap test every 5 years accompanied by human papillomavirus test, this approach is more likely to be a human papillomavirus−based strategy; thus, it was not considered as the outcome of interest for the current analysis.[3,15]

In BRFSS, self-reported height and weight without shoes were used to calculate BMI, which is the mathematic value of weight (kg) divided by height (m^2). The BRFSS recorded BMI as an ordinal variable as follows: underweight (<18.5), normal weight (18.5 to <25), overweight (25 to <30), and obesity (≥30). The following question was used to measure physical activity: *During the past month, other than your regular job, did you participate in any physical activities or exercises such as running, calisthenics, golf, gardening, or walking for exercise?* Inactivity was defined as having no physical activity or exercise in addition to a regular job during the past month.

In this study, age was coded as an ordinal variable (18−39, 40−59, and ≥60 years) to reflect young, middle, and late adulthood. Resident regions were categorized into five groups (West, Midwest, South, Northeast, other) by rules used in the U.S. Census Bureau.[16] Income was defined as the annual household income from all sources and reported as U.S. dollars to reflect levels below and above the average income value (<$50,000 and ≥$50,000).[17,18] Education levels were re-categorized as high school or less, attended college or technical school, graduated from college or technical school. Marital status was re-classified as married (married/unmarried couple) and not married (never married/divorced/widowed/separated) because those classified as married could have stronger feelings of obligation to their spouses that impacted screening behaviors.[19]

Participants were asked about healthcare coverage conditions and they were considered as having coverage if they had health insurance, prepaid plans (e.g., HMO), government plans (e.g., Medicare), or Indian Health Service. Alcohol consumption and smoking status were included for analysis because they reflected health lifestyle pattern and could be associated with both BMI/physical activity and healthcare-seeking behaviors. Women having more than seven drinks per week during the past 30 days were regarded as heavy drinkers. Smoking status was categorized as never smoker, current smoker, and former smoker. Major comorbidities including diabetes mellitus, myocardial infarction, coronary heart disease, stroke, chronic kidney disease, and arthritis were also measured via self-report. Participants self-reported history of routine clinical checkups.

All sociodemographic and health-related factors were selected based on previously published articles and a priori knowledge regarding the association between these factors and BMI/physical inactivity and Pap test use.[19−26] No statistical method was used to handle missing data.

Statistical Analysis

The 2014−2016 BRFSS survey used iterative proportional fitting to weight the data. This approach allowed incorporation of cellular telephone survey data and permitted the introduction of more demographic characteristics, which better reflected the sociodemographic composition of each individual state. Numbers of participants and weighted percentages of each variable were used to summarize the data. Pearson's chi-square tests were used to compare distributions of BMI, inactivity, and other covariates by Pap test usage status. Two-sample proportion tests were used to examine if Pap test usage was different by BMI levels or physical inactivity. A logistic regression corrected for sampling weight was used to estimate associations between BMI and inactivity and Pap test use within 3 years. ORs and 95% CIs were used as the effect measure. In the model, women with normal weight (18.5≤BMI<25) or with physical activity were treated as the reference group, respectively. In crude models, only one independent variable (BMI or physical inactivity) was included. In addition to crude models, individually and mutually adjusted models were simultaneously applied for analysis so that the authors could compare ORs of BMI and inactivity in both models and examine if BMI and inactivity could impact each other in relation to screening behaviors in the study population. In individually adjusted models, either BMI or physical inactivity was included; in mutually adjusted models, both BMI and inactivity were included. Both types of models adjusted for other covariates (age, resident region, income, education, insurance, marital status, clinical checkups, alcohol consumption, smoking status, and major comorbidities).

Three sensitivity analyses were conducted. First, older women had a more conservative sexual behavior pattern and were less likely to undergo screening; thus, the analysis was restricted to women aged <70 years (*n*=7,747). Second, the study population was restricted to women without a history of hysterectomy (*n*=7,724) to account for women who could not have a Pap test because of the removal of the uterus. The third analysis restricted the study population to women aged <70 years and without hysterectomy (*n*=6,619).

Because of the potential biological heterogeneity across difference races, alternative cut offs were used to redefine overweight (23 to <27.5) and obesity (≥27.5) according to the WHO's guideline and investigated whether association patterns changed afterwards.[27]

SES may impact healthcare-seeking behaviors, which can be tightly related to Pap test use,[28−31] thus, researchers further investigated whether associations between BMI/inactivity and Pap test use would differ in subgroups defined by annual income and education level in logistic regression models adjusting for the same covariates as the primary analysis. Wald tests were used to investigate whether interaction terms between BMI/inactivity X income or education were statistically significant.

For current analysis, two-sided *p*-values <0.05 were considered to be statistically significant. All statistical analyses were conducted in 2018 using Stata, version 13.0.

RESULTS

Table 1 presents the overall distribution of study characteristics. Among the 9,424 women included for analysis, 5,976 (weighted percentage: 59.6%) had a Pap test during the past 3 years. Most of the study participants (61.2%) were at normal weight and 78.9% of women had physical activities in addition to a regular job. Overall, the majority of participants were aged 18−39 years (49.9%) or lived in the West (43.0%). More than half of the women had annual household income ≥$50,000 (59.3%), had a degree at or above college (51.3%), or self-reported as married (56.5%). A large proportion of participants had healthcare coverage (92.5%) or a clinical checkup in the last year (72.7%). Most women were not heavy drinkers (97.6%) and did not smoke (88.9%). In terms of comorbidity, 79.4% of women had no major comorbidities, 15.9% had one comorbidity, and 4.7% had at least two comorbidities. Pearson's chi-square tests indicated that BMI, inactivity, and other covariates except resident region and alcohol drinking distributed differently between women who had a Pap test within 3 years and those who did not (*p*<0.05).

Two-sample proportion tests showed underweight women were less likely to undergo a Pap test compared with participants of normal weight, whereas women with higher BMI tended to have a higher Pap test use rate. Active women appeared to have a higher Pap test use rate than inactive women (Table 2). In mutually adjusted models, an inverse and significant association with Pap test use was observed with underweight women compared with normal weight women (OR=0.56, 95% CI=0.36, 0.88), and effect measures were almost the same compared with the ORs from individually adjusted model (OR=0.56, 95% CI=0.36, 0.87). Although overweight and obesity were positively associated with Pap test use, the associations were not significant. Inactivity was found to be inversely and nonsignificantly associated with Pap test use in both individually and mutually adjusted models, and effect measures were the same (OR=0.80, 95% CI=0.60, 1.06). Sensitivity analyses did not change the association pattern, and corresponding effect measures in these sensitivity analyses were very similar to those in primary analysis (Table 2). In models using alternative BMI cut offs, underweight was still significantly and inversely associated with Pap test use and there were no significant changes in the overall association patterns (Appendix Table 1, available online).

The association patterns between BMI/inactivity and Pap test use did not differ by income levels and Wald tests suggest there is no significant interaction. Although effect measures were not statistically significant in subgroup analysis by income, underweight and inactivity showed an inverse association, whereas higher BMI levels showed positive associations (Table 3). Null associations between inactivity and Pap test use were observed among women with lower education levels, but positive and significant associations between inactivity and Pap test use were observed among women with higher

Table 1. Characteristics of 9,424 Asian Women From 2014–2016 BRFSS

Characteristics	Overall (N=9,424)	No Pap test in last 3 years (*n*=3,448, weighted%=40.4)	Pap test in last 3 years (*n*=5,976, weighted%=59.6)	*p*-value[a]
BMI				<**0.01**
<18.5	573 (8.2)	306 (11.9)	267 (5.6)	
18.5 to <25	5,468 (61.2)	2,017 (62.7)	3,451 (60.2)	
25 to <30	2,431 (21.8)	812 (17.9)	1,619 (24.4)	
≥30	952 (8.8)	313 (7.5)	639 (9.7)	
Inactivity[b]				<**0.01**
Not inactive	7,288 (78.9)	2,482 (75.5)	4,806 (81.2)	
Inactive	2,136 (21.1)	966 (24.5)	1,170 (18.8)	
Age at interview, years				<**0.01**
18–39	3,163 (49.9)	1,334 (61.0)	1,829 (42.4)	
40–59	3,046 (31.9)	706 (16.4)	2,340 (42.5)	
≥60	3,110 (18.2)	1,377 (22.6)	1,733 (15.1)	
Resident region				0.15
West	1,693 (43.0)	634 (42.3)	1,059 (43.5)	
Midwest	993 (9.5)	407 (10.9)	586 (8.6)	
South	1,410 (19.6)	507 (19.8)	903 (19.4)	
Northeast	1,377 (21.8)	497 (21.9)	880 (21.7)	
Other[c]	3,951 (6.1)	1,403 (5.1)	2,548 (6.8)	
Annual household income				<**0.01**
<$50,000	3,675 (40.7)	1,682 (54.5)	1,993 (32.7)	
≥$50,000	4,382 (59.3)	1,083 (45.5)	3,299 (67.3)	
Level of education completed[d]				<**0.01**
High school or less	1,865 (21.9)	976 (30.9)	889 (15.9)	
Attended college	2,012 (26.7)	840 (31.7)	1,172 (23.4)	
Graduated from college	5,514 (51.3)	1,615 (37.4)	3,899 (60.7)	
Marital status[e]				<**0.01**
Not married	3,825 (43.5)	1,911 (65.3)	1,914 (28.7)	
Married	5,557 (56.5)	1,523 (34.7)	4,034 (71.3)	
Healthcare coverage				<**0.01**
Had no coverage	682 (7.5)	392 (11.1)	290 (5.1)	
Had coverage	8,711 (92.5)	3,032 (88.9)	5,679 (94.9)	
Had clinical checkup last year				<**0.01**
Had no checkup	2,325 (27.3)	1,111 (34.6)	1,214 (22.4)	
Had checkup	6,999 (72.7)	2,269 (65.4)	4,730 (77.6)	
Heavy alcohol drinking[f]				0.61
Not heavy drinker	9,092 (97.6)	3,333 (97.4)	5,759 (97.7)	
Heavy drinker	228 (2.4)	76 (2.6)	152 (2.3)	

(*continued on next page*)

Table 1. Characteristics of 9,424 Asian Women From 2014–2016 BRFSS (*continued*)

Characteristics	Overall (N=9,424)	No Pap test in last 3 years (*n*=3,448, weighted%=40.4)	Pap test in last 3 years (*n*=5,976, weighted%=59.6)	*p*-value[a]
Smoking status				**0.04**
Never	7,880 (88.9)	2,957 (91.0)	4,923 (87.5)	
Current smoker	461 (3.6)	169 (2.7)	292 (4.1)	
Former smoker	1,071 (7.5)	319 (6.3)	752 (8.3)	
Number of comorbidity[g]				**0.01**
0	6,809 (79.4)	2,403 (80.4)	4,406 (78.7)	
1	1,970 (15.9)	758 (13.3)	1,212 (17.6)	
≥2	645 (4.7)	287 (6.3)	358 (3.7)	

Note: Observations in the column may not equal the overall sample due to missing data. Number of observations and weight percentages (%) were reported for study characteristics. Boldface indicates statistical significance ($p<0.05$).

[a] χ^2 Test was used to compare distributions of variables between women who had and had no Pap test within last 3 years.

[b] Inactivity was defined as having no physical activities or exercises (e.g., running, calisthenics, golf, gardening, or walking for exercise) in addition to regular job during past month.

[c] Other region included Alaska, Hawaii, Guam, Puerto Rico, and Virgin Islands.

[d] College-level education also included graduation from technical school.

[e] Women who were never married, divorced, widowed, or separated were treated as not married. Married women or unmarried couples were treated as married.

[f] Women having more than seven drinks per week during the past 30 days were treated as heavy drinkers.

[g] Comorbidities included diabetes mellitus, stroke, myocardial infarction, coronary heart disease, chronic kidney disease, and arthritis.

BRFSS, Behavioral Risk Factor Surveillance System.

education levels (mutually adjusted OR=0.63, 95% CI=0.45, 0.88); the Wald test suggests a significant interaction between inactivity and education levels in relation to Pap test use (Table 4). Although no significant interaction was identified between BMI and education, effect measures of higher BMI were qualitatively different by education levels; particularly, in the subgroup of higher education, overweight or obese women tended to have a higher rate of Pap test use than normal weight women (Table 4).

DISCUSSION

Unlike previous studies done in the U.S. focusing on women of other race/ethnicity groups, this study did not detect a significantly inverse association between high BMI and Pap test use. Different from these previous studies reporting obesity as a barrier to Pap test,[32,33] this study suggests underweight is inversely associated with Pap test use among Asian women in the U.S. and higher BMI can be positively associated with Pap test use among women with an educational background at or above college level. In this study, inactivity appears to be inversely associated with Pap test use only among women with higher education levels.

Different from the current study, Wee and colleagues[34] reported that overweight and obesity, as compared with normal weight, were inversely associated with Pap test use in the past 3 years in a cross-sectional survey of 5,736 white women in the U.S. In another cross-sectional study conducted in California, Lim et al.[25] found obesity was positively associated with recent Pap test uptake among Latina women (*n*=1,842), whereas an inverse association between underweight and Pap test use was observed among Asian women (*n*=1,759). Cohen and colleagues[33] synthesized 22 studies investigating associations between obesity and Pap test use, and found obesity was a barrier to Pap test use; however, 16 of their included studies focused mainly on white women (more than two thirds of the total sample), suggesting their conclusion may not be applicable to Asian women in the U.S. The current study, along with findings from these previous studies, suggests associations between BMI and Pap test use behaviors are different across race/ethnicity groups. Association between inactivity and Pap test use can also be heterogeneous by race/ethnicity. For example, a Canadian cross-sectional study[35] consisting mainly of white women (89%) found physical inactivity was inversely and significantly associated with having a Pap test within the past 3 years (OR=0.79, 95% CI=0.64, 0.97), which is partially divergent from the current study. Additionally, a study conducted in Switzerland (*n*=7,319) adjusted for BMI and

Table 2. Associations Between BMI/Inactivity and Pap Test in Asian Women in the U.S.

Variable	Screening,Weighted % (95% CI)	Crude model,OR (95% CI)	Individually adjusted model,[a]OR (95% CI)	Mutually adjusted model,[b]OR (95% CI)
Overall sample, *n*	—	9,424	7,815	7,815
BMI				
<18.5	41.0 (31.8, 50.8)[d]	0.49 (0.32, 0.74)	0.56 (0.36, 0.87)	0.56 (0.36, 0.88)
18.5 to <25 (ref)	58.7 (55.7, 61.6)	1	1	1
25 to <30	66.9 (62.1, 71.2)[d]	1.42 (1.12, 1.80)	1.13 (0.85, 1.48)	1.12 (0.85, 1.48)
≥30	65.8 (57.7, 73.1)	1.36 (0.94, 1.96)	1.24 (0.78, 2.00)	1.27 (0.80, 2.03)
Inactivity[c]				
Not inactive (ref)	61.4 (58.7, 63.9)	1	1	1
Inactive	53.2 (48.2, 58.0)[d]	0.71 (0.57, 0.90)	0.80 (0.60, 1.06)	0.80 (0.60, 1.06)
Women aged <70 years, *n*	—	7,747	6,529	6,529
BMI				
<18.5	43.1 (33.5, 53.3)[d]	0.50 (0.33, 0.77)	0.56 (0.35, 0.88)	0.56 (0.36, 0.88)
18.5 to <25 (ref)	60.1 (57.0, 63.1)	1	1	1
25 to <30	69.2 (64.3, 73.7)[d]	1.50 (1.16, 1.93)	1.12 (0.83, 1.51)	1.12 (0.83, 1.50)
≥30	67.7 (59.0, 75.4)	1.40 (0.94, 2.08)	1.26 (0.75, 2.12)	1.28 (0.76, 2.13)
Inactivity[c]				
Not inactive (ref)	62.8 (60.0, 65.5)	1	1	1
Inactive	56.0 (50.8, 61.0)[d]	0.75 (0.59, 0.95)	0.81 (0.60, 1.09)	0.82 (0.61, 1.10)
Women without hysterectomy, *n*	—	7,724	6,424	6,424
BMI				
<18.5	39.1 (30.1, 49.0)[d]	0.43 (0.28, 0.66)	0.57 (0.35, 0.92)	0.58 (0.36, 0.93)
18.5 to <25 (ref)	59.7 (56.5, 62.8)	1	1	1
25 to <30	69.8 (64.7, 74.5)[d]	1.56 (1.20, 2.04)	1.17 (0.85, 1.61)	1.17 (0.85, 1.61)
≥30	71.0 (62.5, 78.2)[d]	1.65 (1.10, 2.48)	1.43 (0.81, 2.52)	1.47 (0.84, 2.55)
Inactivity[c]				
Not inactive (ref)	63.0 (60.2, 65.7)	1	1	1
Inactive	53.7 (48.3, 59.1)[d]	0.68 (0.53, 0.88)	0.76 (0.56, 1.05)	0.76 (0.56, 1.05)
Women aged <70 years and without hysterectomy, *n*	—	6,619	5,599	5,599
BMI				
<18.5	40.7 (31.3, 50.7)[d]	0.45 (0.29, 0.69)	0.56 (0.34, 0.91)	0.57 (0.35, 0.92)
18.5 to <25 (ref)	60.5 (57.2, 63.6)	1	1	1
25 to <30	71.7 (66.5, 76.4)[d]	1.66 (1.25, 2.19)	1.18 (0.85, 1.66)	1.18 (0.84, 1.66)
≥30	72.2 (63.3, 79.6)[d]	1.69 (1.10, 2.60)	1.44 (0.78, 2.66)	1.46 (0.80, 2.68)

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Table 2. Associations Between BMI/Inactivity and Pap Test in Asian Women in the U.S. (*continued*)

Variable	Screening, Weighted % (95% CI)	Crude model, OR (95% CI)	Individually adjusted model,[a] OR (95% CI)	Mutually adjusted model,[b] OR (95% CI)
Inactivity[c]				
Not inactive (ref)	63.9 (61.0, 66.6)	1	1	1
Inactive	55.9 (50.3, 61.3)[d]	0.72 (0.55, 0.93)	0.75 (0.54, 1.05)	0.76 (0.55, 1.06)

Note: OR and 95% CI were calculated from logistic regression corrected for sampling weight in BRFSS.
[a]Individually adjusted model adjusted for BMI or inactivity separately and included other covariates in Table 1 (age, region, income, education, marital status, healthcare coverage, clinical checkup, alcohol consumption, smoking status, and comorbidity).
[b]Mutually adjusted model adjusted for BMI and inactivity in one model and included other covariates in Table 1 (age, region, income, education, marital status, healthcare coverage, clinical checkup, alcohol consumption, smoking status, and comorbidity).
[c]Inactivity was defined as having no physical activities or exercises (e.g., running, calisthenics, golf, gardening, or walking for exercise) in addition to regular job during past month.
[d]Two-sample proportion test indicated a significant difference with reference group in aspects of screening rates.
BRFSS, Behavioral Risk Factor Surveillance System.

physical inactivity simultaneously and observed obesity and physical inactivity were both inversely and significantly associated with cervical cancer screening,[22] which further supports the potential that BMI and physical inactivity may impact screening behaviors differently between white and Asian women.

Effect measures of BMI and physical inactivity were almost the same in individually and mutually adjusted models, suggesting a weak association between BMI and physical inactivity in the data. Because of this, other factors associated with being underweight should be considered as the intervention target. For example, being underweight may indicate the existence of unfavorable health conditions.[36] Although most up-to-date screening techniques are non-invasive or minimally invasive, being underweight can increase the risk of post-test adverse outcomes if participants have an overall unfavorable health condition.[37] This will cause technical difficulty for healthcare providers, increase resistance of patients, and finally obstruct use of the Pap test.[38] Although the analysis considered six common types of comorbidities in statistical adjustment, some diseases associated with underweight (e.g., osteoporosis) were not measured by BRFSS and researchers cannot rule out how these illnesses impacted Pap test use in the data.

The mechanisms why association patterns for BMI and inactivity are different by education levels are not very clear; however, the authors have a few speculations. First, overweight or obese women with higher education levels can have a stronger awareness of unhealthy conditions and be more likely to use preventive medical services. Second, previous research suggests that obesity could be an indicator of good acculturation in high-income countries, although results are not consistent.[39,40] Thus, there could be the potential that highly educated Asian women with higher BMI may communicate more fluently and confidently with healthcare providers and use preventive services because of favorable acculturation, whereas factors associated with higher BMI in women with less education might be independent of good acculturation. Third, it is possible low-level education, as well as inactivity, can negatively impact screening behaviors,[41] but its magnitude may be much stronger than inactivity. Thus, the association between inactivity and Pap test use cannot be identified among less educated women.

This study has several merits in design and analysis. First, this is a nationwide survey with a large sample size, which ensures analytic precision. Second, analyses with further restrictive criteria or alternative BMI cut offs helped the examination of the robustness of associations identified in primary analysis. In addition, subgroup analyses by socioeconomic conditions help to

Table 3. Associations Between BMI/Inactivity and Pap Test in Subgroups Defined by Income Levels

Variable	Annual income <$50,000 (*n*=3,561)[a]			Annual income ≥$50,000 (*n*=4,254)[a]			*p*-value$_{int}$[d]	*p*-value$_{int}$[e]
	n[a]	AOR (95% CI)[b]	AOR (95% CI)[c]	*n*[a]	AOR (95% CI)[b]	AOR (95% CI)[c]		
BMI							0.73	0.71
<18.5	243	0.55 (0.27, 1.11)	0.55 (0.28, 1.11)	200	0.61 (0.35, 1.06)	0.63 (0.36, 1.09)		
18.5 to <25 (ref)	1,965	1	1	2,539	1	1		
25 to <30	952	1.00 (0.69, 1.45)	0.99 (0.68, 1.45)	1,113	1.31 (0.87, 1.98)	1.30 (0.86, 1.97)		
≥30	401	1.32 (0.74, 2.37)	1.37 (0.77, 2.44)	402	1.18 (0.61, 2.29)	1.21 (0.64, 2.27)		
Inactivity[f]							0.64	0.79
Not inactive (ref)	2,561	1	1	3,509	1	1		
Inactive	1,000	0.78 (0.55, 1.10)	0.77 (0.54, 1.09)	745	0.71 (0.46, 1.09)	0.73 (0.48, 1.12)		

Note: OR and 95% CI were calculated from logistic regression corrected for sampling weight in BRFSS.
[a]Only numbers of observations in multivariable models were reported.
[b]OR and 95% CI was calculated in individually adjusted model. Covariates in the model were age, region, education, marital status, healthcare coverage, clinical checkup, alcohol consumption, smoking status, and comorbidity.
[c]OR and 95% CI was calculated in mutually adjusted model. Covariates in the model were age, region, education, marital status, healthcare coverage, clinical checkup, alcohol consumption, smoking status, and comorbidity.
[d]Wald test was used to examine the interaction term between BMI/inactivity and income. The test was conducted for individually adjusted model.
[e]Wald test was used to examine the interaction term between BMI/inactivity and income. The test was conducted for mutually adjusted model.
[f]Inactivity was defined as having no physical activities or exercises (e.g., running, calisthenics, golf, gardening, or walking for exercise) in addition to regular job during past month.
BRFSS, Behavioral Risk Factor Surveillance System; int, interaction test.

identify potential heterogeneity associated with education levels.

Limitations

The study has several limitations. First, this is a cross-sectional study and there is no clear temporal relation between Pap test use and other health indicators, which may cause bias or reverse causation in the model. Additionally, the vague temporality can cause unnecessary exclusion in sensitivity analysis; for example, women having a Pap test a long time ago but undergoing hysterectomy recently might have been inappropriately excluded. Second, more than 99% of BRFSS was conducted in English or Spanish, which precluded Asian women without language proficiency and could compromise representativeness.

Table 4. Associations Between BMI/Inactivity and Pap Test in Subgroups Defined by Education Levels

Variable	Less than college level (*n*=3,074)[a]			At or above college level (*n*=4,741)[a]			*p*-value$_{int}$[d]	*p*-value$_{int}$[e]
	n[a]	AOR (95% CI)[b]	AOR (95% CI)[c]	*n*[a]	AOR (95% CI)[b]	AOR (95% CI)[c]		
BMI							0.28	0.21
<18.5	182	0.48 (0.21, 1.10)	0.48 (0.21, 1.11)	261	0.61 (0.37, 1.02)	0.64 (0.39, 1.05)		
18.5 to <25 (ref)	1,663	1	1	2,841	1	1		
25 to <30	838	0.93 (0.59, 1.44)	0.92 (0.59, 1.44)	1,227	1.35 (0.97, 1.86)	1.34 (0.96, 1.86)		
≥30	391	0.87 (0.43, 1.75)	0.88 (0.44, 1.74)	412	2.11 (1.31, 3.40)	2.19 (1.38, 3.47)		
Inactivity[f]							0.04	0.04
Not inactive (ref)	2,187	1	1	3,883	1	1		
Inactive	887	0.94 (0.61, 1.43)	0.95 (0.62, 1.44)	858	0.62 (0.44, 0.88)	0.63 (0.45, 0.88)		

Note: OR and 95% CI were calculated from logistic regression corrected for sampling weight in BRFSS.
[a]Only numbers of observations in multivariable models were reported.
[b]OR and 95% CI was calculated in individually adjusted model. Covariates in the model were age, region, income, marital status, healthcare coverage, clinical checkup, alcohol consumption, smoking status, and comorbidity.
[c]OR and 95% CI was calculated in mutually adjusted model. Covariates in the model were age, region, income, marital status, healthcare coverage, clinical checkup, alcohol consumption, smoking status, and comorbidity.
[d]Wald test was used to examine the interaction term between BMI/inactivity and education. The test was conducted for individually adjusted model.
[e]Wald test was used to examine the interaction term between BMI/inactivity and education. The test was conducted for mutually adjusted model.
[f]Inactivity was defined as having no physical activities or exercises (e.g., running, calisthenics, golf, gardening, or walking for exercise) in addition to regular job during past month.
BRFSS, Behavioral Risk Factor Surveillance System; int, interaction test.

CONCLUSIONS

Underweight, rather than overweight or obesity, can be the potential barrier to cervical cancer screening among Asian women in the U.S., which is different from findings of previous epidemiologic studies focusing on other race/ethnicity groups. Health practitioners should try to explore mechanisms explaining the relationship between underweight and screening behaviors among U.S. Asian women. Overall, changing physical inactivity may not increase Pap test use among U.S. Asian women, but it can be a potential target of intervention among highly educated subgroups. In the future, to avoid inherent limitations of cross-sectional surveys, researchers should establish large cohort studies for further investigation.

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SUPPLEMENTAL MATERIAL

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