BMJ Open

Acceptability of HPV Self-Testing and Access to Cervical Cancer Screening: A Cross-Sectional Comparison Between Buddhist and Muslim Women in Southern Thailand

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2019-031957
Article Type:	Research
Date Submitted by the Author:	28-May-2019
Complete List of Authors:	Gottschlich, Anna; University of Michigan, School of Public Health Nuntadusit, Thanatta; Prince of Songkla University Faculty of Medicine, Epidemiology Unit Zarins, Katie; University of Michigan, School of Public Health Hada, Manila; University of Michigan, School of Public Health Chooson, Nareerat; Prince of Songkla University Faculty of Medicine, Epidemiology Unit Bilheem, Surichai; Prince of Songkla University Faculty of Medicine, Epidemiology Unit Navakanitworakul, Raphatphorn; Prince of Songkla University Faculty of Medicine, Department of Biomedical Sciences Nittayaboon, Kesara; Prince of Songkla University Faculty of Medicine, Department of Biomedical Sciences Virani, Shama; Prince of Songkla University Faculty of Medicine, Epidemiology Unit Rozek, Laura; University of Michigan, School of Public Health Sriplung, Hutcha; Prince of Songkla University Faculty of Medicine, Epidemiology Unit Meza, Rafael; University of Michigan, School of Public Health
Keywords:	EPIDEMIOLOGY, PUBLIC HEALTH, CERVICAL CANCER, HPV, SELF-COLLECTION TESTING

Acceptability of HPV Self-Testing and Access to Cervical Cancer Screening: A Cross-Sectional Comparison Between Buddhist and Muslim Women in Southern Thailand

Anna Gottschlich[1], Thanatta Nuntadusit[2], Katie R. Zarins[1], Manila Hada[1,4], Nareerat Chooson[2], Surichai Bilheem[2], Raphatphorn Navakanitworakul[3], Kesara Nittayaboon[3], Shama Virani[1,2], Laura S. Rozek[1], Hutcha Sriplung[2], Rafael Meza[1]

Author Affiliations:
[1] School of Public Health, University of Michigan, Ann Arbor, MI
[2] Epidemiology Unit, Faculty of Medicine, Prince of Songkla University, Songkhla, Thailand
[3] Department of Biomedical Sciences, Faculty of Medicine, Prince of Songkla University, Songkhla, Thailand
[4] National Cancer Institute, National Institutes of Health, Bethesda, MD

Corresponding Author:
Rafael Meza, Ph.D.
SPH II, Room 5033, 1415 Washington Heights
Ann Arbor, MI 48109-2029
E-mail: rmeza@umich.edu
Telephone: +1 (734) 763-1946

Word counts: abstract (249), text (3889), tables (6), figures (0), references (31)

Abstract

Background: Cervical cancer rates are higher in low-resourced countries than high, partly due to lower rates of screening. Incidence in Thailand is over three times higher than in the US, even with Thailand's universal health coverage, which includes cervical cancer screening, suggesting that alternative methods are needed to reduce the burden. We investigated barriers to screening, and the use of self-collection HPV testing to reduce rates in Buddhist and Muslim communities in Southern Thailand.

Methods: 267 women from the Buddhist district of Ranot and Muslim district of Na Thawi, Songkhla were recruited in clinics and completed a survey assessing knowledge risk factors of HPV and cervical cancer. Participants were offered an HPV self-collection test and then given a follow-up survey assessing test acceptability. Samples were processed at Prince of Songkhla university and results were returned to participants.

Results: 267 women participated in the study (132 Buddhist, 135 Muslim), 264 (99%) self-collecting. 98% reported comfort and ease, and >70% preferred it to doctor-facilitated cytology. The main predictor of prior screening was religion (92% Buddhist versus 73% Muslim reporting prior Pap). After adjustment with multivariate logistic models, Muslim women had an odds ratio of prior Pap of 0.30 compared to Buddhist (95% CI: 0.12-0.66).

Conclusions: Self-collection HPV testing was highly acceptable across religious groups, suggesting that it could be useful for cervical cancer reduction in this region. Likely, more focus

should be put into educating all populations about the importance of screening to improve cervical cancer screening rates among Thai women.

KEY QUESTIONS

What is already known?

- Cervical cancer rates are significantly higher in low- and middle-income countries than in high-income countries due to lower rates of screening and less access to follow-up care.
- There are difficulties implementing effective cytology screening programs in low resourced settings, leading to the suggested use of self-collected testing for presence of the human papillomavirus (a more highly sensitive and less resource-intense test) in these settings.

What are the new findings?

- Self-collection HPV testing is highly acceptable, and even preferred to standard cervical cancer screening methods, among both Buddhist and Muslim women in the Songkhla region of southern Thailand.
- Muslim women, who have lower rates of cervical cancer screening than their Buddhist counterparts, have an even higher preference for self-collection HPV testing than cytology-based screening.

What do the new findings imply?

- A self-collection HPV testing program could significantly increase rates of cervical cancer screening in this area, particularly among Muslim women who currently have lower rates of screening.
- Self-collection HPV testing, due to its simplicity and the sensitivity of the assay, has the ability to replace the current standard method of cervical cancer screening, improving screening programs worldwide.

ARTICLE SUMMARY

Strengths and limitations of this study

- The Songkhla region of Thailand has a relatively large number of Muslim people living in this region, making it an ideal location to study the differences between Buddhist and Muslim populations.
- Community health volunteers collected the data in participants' native languages and are familiar with the region and the patients.
- The assay used for HPV detection (Hybribio RT-PCR) is highly sensitive.
- All data was self-reported, so it is likely that there was some misreporting either due to social desirability or recall bias.
- Women testing in their own homes may have more testing anxiety in the absence of healthcare workers, causing lower acceptability of the test.

1. Introduction

Cervical cancer is one of the two most common cancer in women in Thailand[1] (along with breast), with age-standardized incidence and mortality rates at 16.2 and 9.0 per 100,000 women, according to the International Agency for Research on Cancer (IARC)'s 2018 GLOBOCAN project.[2] These are approximately three times the rates observed in the United States, where only 6.5 women develop and 1.9 die from cervical cancer, per 100,000.[2] This disparity is seen between low- and middle-income countries (LMICs) and high-income countries (HICs) around the world, and there has yet to be a sufficient intervention to eliminate this inequality. Currently, while cervical cancer is not even in the top 10 most common cancers in HICs, it is the second most common cancer among women in LMICs, where 80% of cervical cancer deaths occur.[3]

Cervical cancer is primarily caused by the human papillomavirus (HPV), a sexually transmitted infection that in most women clears on its own without the knowledge of the infected women.[4,5] However, in some women, infection persists and eventually may cause cervical cancer to develop. Cervical cancer development takes many years, thus allowing for effective screening, prevention, and treatment if detected early.[6]

Today, cervical cancer is considered a preventable disease. This is in large part due to the advent of the Papanicolaou test, developed in the 1940s.[7] This type of cytology-based screening has significantly reduced rates of cervical cancer in HICs but has not had the same effect in LMICs.[8,9] This is likely due to two main issues: less accessibility to this type of testing, as well as issues with the actual test. Cytology-based screening requires both infrastructure and personnel to which many LMICs may not have access.[9,10] Additionally, cytology screening necessitates as many as three visits to be screened and treated[11], which may not be feasible for women in less developed settings. Finally, due to the inherent subjectivity of this type of test,

particularly when samples are evaluated by technicians rather than by pathologists, there is generally low sensitivity in LMICs[12], causing many cases to be missed even if a sample is collected. Thus, many LMICs have moved to visual inspection with acetic acid (VIA) in place of Pap screening. VIA can be performed with minimal infrastructure by a properly trained lay-person, and the screening and treatment can be done in the same visit.[8,11,13,14] However, women still need to be able to attend a clinic to receive this test and equipment needs to be available to perform the treatment. Additionally, the results from VIA are highly dependent on subjective decisions made by the examiner, leading to lower accuracy in some settings.

HPV testing as a primary form of cervical cancer screening is beginning to gain traction in the international community. The FOCAL randomized control trial in Canada found that the use of primary HPV testing, as compared to cytology alone, significantly lowers the likelihood of the development of precancerous lesions among women undergoing cervical cancer screening, due to increased sensitivity and specificity of cytology testing when restricted to only those women who test positive for HPV.[15] To further increase accessibility to screening, some countries are beginning to implement self-collection HPV testing.[16] Women can test themselves, in their own home, by collecting a cervical sample using a provided swab. These swabs can be mailed to a testing facility without any form of climate control.[17] If a woman tests positive for high-risk HPV, then she will need to access follow-up care at a clinic, however if the woman tests negative, she simply needs to be tested periodically (usually in 5-year increments). This can reduce the number of times that women need to travel to clinics for screening or follow-up care, which could eventually also reduce the burden on the health care system.

The rates of cervical cancer in Thailand have been declining since 2002[18–20], when a national cervical cancer screening program was implemented, aiming to screen all women between the

ages of 35 and 60 at 5-year intervals. In 2004, the program added visual inspection with acetic acid to the already existing Pap smear program. There are three public health insurances programs in Thailand, each covering the costs of cervical cancer screening in their benefits package.[1] However, the decline in cervical cancer has been slower than expected, thus calling for improvements in the current screening programs.[18] This is perhaps a result of lower than ideal uptake of cervical cancer screening: a survey conducted in 2009 estimated that only 59.7% of women in Thailand have ever been screened for cervical cancer.[1] This is likely due to low awareness of the importance of screening and embarrassment.[1] Uptake is even lower among the minority Muslim population as compared to the majority Buddhist population in Thailand (46.7% vs 60.4% reporting ever having cervical cancer screening in the 2009 Health and Welfare Survey[1], respectively), perhaps due to reports of embarrassment and wanting to avoid uncovering parts of their bodies during exams, due to the high value that the Muslim religion places on modesty.[1] One previous study investigated the acceptability of self-collection HPV testing in women in Thailand. Acceptability was found to be quite high, but participants were worried about both the cost and the reliability of the results from this type of testing.[21,22] However, no previous studies have specifically looked at women from diverse ethnic groups in Thailand to determine whether HPV self-collection testing is more useful in certain populations than others.

There are documented health disparities between Muslims and Buddhists groups living in Thailand. For example, one study found that Buddhists have, on average, higher rates of prostate cancer, but also longer survival after diagnosis than their Muslim counterparts.[23] Additionally, studies have shown that cervical cancer incidence rates are lower in Muslim communities than Buddhist[24,25], but, to the knowledge of the authors, to date there has been no research done looking at outcomes. However, due to the lower screening rates among Muslim women, it could

be hypothesized that, similar to the results from the prostate cancer study, Muslim women may have poorer survival outcomes than Buddhists after a cervical cancer diagnosis.

In this study we investigated the differences in access to healthcare between Buddhist and Muslim women in Southern Thailand and examine potential predictors of and barriers to accessing screening for cervical cancer. We also assess willingness to use self-collection HPV testing methods and the acceptability of these methods after use.

2. Material and Methods

2.1 Study design and Sampling

The study was designed as a cross-sectional survey, with a maximum of one interaction per participant. Data collection took place in two districts within Songkhla Province of Southern Thailand: Na Thawi, in the southern part of Songkhla Province, and Ranot, in the northern-most region. Each of these districts is religiously homogenous, with Na Thawi and Ranot being predominantly Muslim and Buddhist, respectively. Women were recruited from reproductive health clinics in these districts, half from Na Thawi and half from Ranot. The primary care centers made a list of the target population for screening and distributed the names to health care volunteers. Each volunteer visited 12-15 households and set up appointments with eligible women for screening at public primary care clinics. When women came into the clinics, they were asked by a community health worker whether they would like to participate in the study. If they said yes, they were consented and then enrolled, where a survey was administered, and self-collection HPV testing was offered.

Recruitment took place from July-December in 2017. We aimed to recruit 130 women from each region. Women had to be over the age of 18 to participate, and between the ages of 25 and 60 to participate in the self-collection sampling portion of the study. For the self-collection sampling, women were ineligible to participate if they were pregnant or menstruating, had a previous history of cervical cancer, or had previously had a hysterectomy.

2.2 Data collection tools

Data was collected using a 150-question survey that assessed sexual behavior and practices, known risk factors associated with HPV, and knowledge of HPV infection and its association with cervical cancer. This survey was originally written in English and then translated into Thai by native Thai investigators from Prince of Songkhla University (PSU). This survey has also been translated into other languages for similar studies occurring in other countries.[17] Data were collected using the Qualtrics survey application.[26] Study research assistants read the survey aloud to each participant and recorded her responses on a tablet. At the end of each day, surveys responses were uploaded to a secure server.

Additionally, upon completion of the survey, women were offered a self-collection cervical sample kit to be tested for HPV. The kit (HerSwab)[27] was manufactured by Eve Medical and has previously been shown to be acceptable among other populations.[17] If a woman chose to self-collect, the community health volunteer gave her the kit and an illustrated "Instructions-for-Use" card and explained the sampling procedure. Women then collected a sample in a private room and then returned the swab to the community health volunteer. Samples were transported to the Department of Biomedical Sciences at PSU following collection and stored until testing occurred.

2.3 Lab analysis

Samples were analyzed at the Department of Biomedical Sciences at PSU using a 13 High-risk HPV Real-time PCR kit (Hybribio Limited, Hong Kong), which detects HPV types 16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59, 68.[28] Positive and negative controls were included on each plate, and internal controls were evaluated for each sample. Results were provided to the community health centers in Na Thawi and Ranot, where the community health volunteers were able to coordinate follow-up care for participants. If the HPV results were positive, it was suggested that they receive follow-up care (in the form of a Pap test) from their local health center, and if negative were told to repeat testing in 3 years.

2.4 Statistical analysis

As this is mainly a descriptive study to identify any differences in screening practices between two ethnic groups, all survey questions were examined. These variables were then grouped into 4 areas: demographics, sexual and general health, cervical cancer and HPV, and barriers to health care. Additionally, we compared women who reported having prior cervical cancer screening to women who reported no prior screening, using the same variables mentioned above, with both univariate analyses and multivariate logistic models, adjusted for literacy, age, and number of children as a proxy for previous encounters with healthcare services. Finally, we investigated the acceptability of the self-collection test among women who were willing to use it by asking 4 questions after collection: “How comfortable was the test?”, “How easy was the test?”, “Are you willing to continue to take this test periodically in the future?” and “Do you prefer self-collection or Pap testing?”.

We compared responses between Buddhist and Muslim women using two-sided t-tests and chi-squared tests for continuous and categorical variables, respectively. A similar procedure was used to compare women who had previously been screened for cervical cancer with those who had not. Multivariate logistic models were then run to examine potential predictors for prior screening, after adjusting for confounders. Finally, a descriptive analysis was conducted to assess acceptability of the self-swab test, where an $\alpha < 0.05$ was considered significant. All analyses were conducted using R version 3.4.4.

2.5 Patient and Public Involvement

Participants and the public were first involved at the design and piloting stages of the study. Research questions and outcome measures were developed using prior surveys assessing use of healthcare in other low- and middle-income settings[17] and direct feedback was received from clinic staff. During piloting, feedback was also received from participants and clinic workers. Patients at local health clinics were directly approached by study personnel inviting them to participate in the study and discussing the format and purpose of the study. While participants were not asked about the time required to participate in the research, the post-sampling survey explicitly asked participants about the acceptability and perceptions of self-sampling to assess the burden of the intervention being investigated. To disseminate study results to participants and the community, we plan to conduct education and study dissemination sessions. These will be planned directly in collaboration with community-based clinic personnel and other representatives from the community.

2.6 Ethical approval

Ethical approval was granted by both the University of Michigan (HUM00114785) and the PSU Research Ethics Committee (REC 59-235-18-1). All participants were given oral and printed informed consent before participation. This consent was documented by signature from the participant on the consent form and all consent forms are filed in a locked cabinet at PSU.

3. Results

3.1 Demographics

267 women were recruited from the community health centers in the Ranot (n=132) and Na Thawi (n=135) districts of Songkla Province in southern Thailand. All 132 women from Ranot identified as Buddhist and all 135 from Na Thawi identified as Muslim. The average age of the Buddhist population was 51.3 years, while in the Muslim population it was 49.6 years. There were several statistically significant demographic differences between the Buddhist and Muslim women in the sampled population (Table 1). Buddhist women on average reported higher literacy (96% vs. 81%, $p < 0.001$) and education levels ($p = 0.003$). Additionally, Muslim women were more likely than Buddhist women to be in a common law relationship instead of marriage ($p < 0.001$). However, there were no statistically significant differences in income between the two populations.

Table 1. Demographics

Variable	**Total** **N = 267** *Prop (N)* *Mean (SD)*	**Buddhist** **N = 132** *Prop (N)* *Mean (SD)*	**Muslim** **N = 135** *Prop (N)* *Mean (SD)*	**P-value**
Age	50.44 (5.83)	51.27 (6.08)	49.63 (5.48)	0.02*
Literate	0.88 (236)	0.96 (127)	0.81 (109)	<0.001*
Education				0.003*
None	0.06 (15)	0.00 (0)	0.11 (15)	
Primary	0.67 (179)	0.71 (94)	0.63 (85)	
Secondary	0.18 (49)	0.18(24)	0.19 (25)	
Vocational	0.05 (13)	0.06 (8)	0.04 (5)	
Academic College	0.04 (11)	0.05 (6)	0.04 (5)	
Postgraduate	0.00 (0)	0.00 (0)	0.00 (0)	
Civil Status				

Single	0.00 (0)	0.00 (0)	0.00 (0)	<0.001*
Married	0.69 (184)	0.80 (106)	0.58 (78)	
Common Law	0.21 (55)	0.09 (12)	0.32 (43)	
Separated	0.01 (2)	0.02 (2)	0.00 (0)	
Divorced	0.04 (11)	0.04 (5)	0.04 (6)	
Widowed	0.04 (10)	0.02 (3)	0.05 (7)	
Marriage Age	21.26 (5.35)	22.85 (5.98)	19.72 (4.15)	<0.001*
Past Year Income (THB)				0.27
0 – 79,999	0.33 (78)	0.34 (39)	0.31 (39)	
80,000 – 119,999	0.28 (67)	0.31 (35)	0.25 (32)	
120,000 – 179,999	0.18 (44)	0.19 (22)	0.17 (22)	
180,000 or more	0.21 (51)	0.16 (18)	0.26 (33)	

3.2 Sexual and health history

Buddhist and Muslim women appeared to access healthcare differently in these communities (Table 2). Buddhist women reported accessing more medical services and using health services more frequently than Muslim women. Notably, a higher percentage of Buddhist women reported prior Pap screening, as well as more recent screening, than Muslim women (92% vs 73% respectively, $p < 0.001$). Among women who have not been screened for cervical cancer, the most common reported reason for not screening among Buddhist women was no perceived health issues, and thus no reason to seek medical attention (40%), while for Muslim it was either a lack of knowledge that they should be screened or feelings of fear and embarrassment about screening (35% and 41% respectively). Additionally, Buddhist and Muslim women both reported that a doctor telling them they would need the test, and reduced cost of the test would be motivators to getting tested. Finally, Muslim women were less likely to use oral contraceptives (41% vs 67% respectively, $p < 0.001$).

Table 2. Sexual and health history

Variable	**Total** **N = 267** *Prop (N)* *Mean (SD)*	**Buddhist** **N = 132** *Prop (N)* *Mean (SD)*	**Muslim** **N = 135** *Prop (N)* *Mean (SD)*	**P-value**
Health Location				
University Hospital	0.27 (73)	0.34 (45)	0.21 (28)	0.047*
Primary Care Facility	0.99 (264)	1.00 (132)	0.98 (132)	1
Community Health Care Center	0.99 (263)	0.98 (130)	0.99 (133)	0.85

Other (Private Hospital, N = 2; Clinic, N = 83)	0.32 (85)	0.16 (21)	0.47 (64)	<0.001*
Last Health Visit				<0.001*
Less than a month	0.22 (59)	0.30 (40)	0.14 (19)	
1-3 months	0.25 (67)	0.28 (37)	0.22 (30)	
3-6 months	0.13 (35)	0.14 (18)	0.13 (17)	
6 mo-1 year	0.18 (48)	0.15 (20)	0.21 (28)	
1-5 years	0.14 (37)	0.09 (12)	0.19 (25)	
More than 5 years	0.05 (14)	0.01 (1)	0.10 (13)	
Never	0.03 (7)	0.03 (4)	0.02 (3)	
Use Healer	0.18 (49)	0.11 (14)	0.26 (35)	0.002*
Had Pap	0.82 (219)	0.92 (121)	0.73 (98)	<0.001*
Last Pap				0.007*
Less than 6 months	0.07 (16)	0.08 (10)	0.06 (6)	
Less than 1 year	0.30 (66)	0.37 (45)	0.21 (21)	
Less than 5 years	0.42 (91)	0.40 (49)	0.43 (42)	
More than 5 years	0.18 (40)	0.11 (13)	0.28 (27)	
Don't know	0.03 (6)	0.03 (4)	0.02 (2)	
Lifetime Paps				0.005*
1	0.19 (41)	0.12 (15)	0.27 (26)	
2	0.23 (51)	0.19 (23)	0.29 (28)	
3-4	0.39 (86)	0.45 (55)	0.32 (31)	
5 or more	0.18 (39)	0.21 (26)	0.13 (13)	
Don't know	0.01 (2)	0.02 (2)	0.00 (0)	
Main Reason No Pap				0.08*
None/ never thought of it	0.13 (6)	0.10 (1)	0.14 (5)	
Didn't know needed it	0.32 (15)	0.20 (2)	0.35 (13)	
Haven't had any problems	0.15 (7)	0.40 (4)	0.08 (3)	
Too expensive	0.00 (0)	0.00 (0)	0.00 (0)	
Too painful/embarrassing	0.36 (17)	0.20 (2)	0.41 (15)	
Other	0.04 (2)	0.10 (1)	0.03 (1)	
Doctor Motivation				<0.001*
Extremely Likely	0.60 (161)	0.73 (96)	0.48 (65)	
Very Likely	0.15 (40)	0.11 (14)	0.19 (26)	
Somewhat Likely	0.12 (32)	0.09 (12)	0.15 (20)	
Not Very Likely	0.11 (30)	0.08 (10)	0.15 (20)	
Don't know	0.01 (4)	0.00 (0)	0.03 (4)	
Payment Motivation				
Extremely Likely	0.51 (137)	0.64 (85)	0.39 (52)	<0.001*
Very Likely	0.21 (56)	0.17 (22)	0.25 (34)	
Somewhat Likely	0.15 (39)	0.11 (15)	0.18 (24)	
Not Very Likely	0.12 (31)	0.08 (10)	0.16 (21)	
Don't know	0.01 (4)	0.00 (0)	0.03 (4)	
Use Oral Contraceptive	0.54 (141)	0.67 (86)	0.41 (55)	<0.001*

3.3 Acceptability of self-collection

There was an almost universal acceptance of self-collection among this population (Table 3). Ninety-eight percent of women found the test both comfortable and easy, and 100% said they

would be willing to continue to use this test as a preliminary form of cervical cancer screening. Both communities preferred self-swab to Pap testing, with higher preference in Muslim women (79% in Muslim vs 66% in Buddhist, p = 0.02). Buddhist women were more likely to prefer Pap and self-collection co-testing than Muslim women (32% vs 17%, respectively, p=0.02). Both Muslim and Buddhist women prefer testing to be done in a medical setting, but Muslim women are more likely to prefer self-collection to doctor-collection (94% reporting preference for self-collection vs 77%) than Buddhist women.

Table 3. Acceptability of self-collection

Variable	**Total** **N = 267** *Prop (N)* *Mean (SD)*	**Buddhist** **N = 132** *Prop (N)* *Mean (SD)*	**Muslim** **N = 135** *Prop (N)* *Mean (SD)*	**P-value**
Self-Collected Sample	0.99 (264)	0.98 (130)	0.99 (134)	0.62
Comfort				1.00
Comfortable	0.98 (259)	0.98 (128)	0.97 (131)	
Neutral	0.02 (5)	0.02 (2)	0.02 (3)	
Uncomfortable	0.00 (0)	0.00 (0)	0.00 (0)	
Ease				1.00
Easy	0.98 (258)	0.98 (127)	0.97 (131)	
Neutral	0.02 (6)	0.02 (3)	0.02 (3)	
Difficult	0.00 (0)	0.00 (0)	0.00 (0)	
Willing to Retake	1.00 (264)	1.00 (130)	1.00 (134)	1.00
Preference				0.02*
Self-swab kit	0.72 (193)	0.66 (87)	0.79 (106)	
Pap smear	0.03 (7)	0.02 (2)	0.04 (5)	
Both	0.24 (65)	0.32 (42)	0.17 (23)	
Neither	0.01 (2)	0.01 (1)	0.01 (1)	
Test Pref Location				<0.001*
At Home	0.18 (49)	0.04 (10)	0.15 (39)	
At Healthcare Center	0.82 (218)	0.96 (122)	0.85 (96)	
Test Pref Collector				<0.001*
My Health Personnel	0.14 (38)	0.23 (30)	0.06 (8)	
Myself	0.86 (225)	0.77 (100)	0.94 (125)	

3.4 hrHPV positivity

Nearly all of the participants chose to self-collect a sample to be tested for HPV (98% and 99% of Buddhist and Muslim women, respectively). The three women who did not self-collect had a sample collected by a physician, and thus we have HPV results for all 267 participants. Of these women, only 5% (N = 13), 7% of all conclusive tests, tested positive for

hrHPV: 5 Buddhist and 8 Muslim (no statistically significant differences between the two religious groups, shown in table 4).

Table 4. hrHPV test results

Variable	**Total** **N = 264** *Prop (N)* *Mean (SD)*	**Buddhist** **N = 132** *Prop (N)* *Mean (SD)*	**Muslim** **N = 135** *Prop (N)* *Mean (SD)*	**P-value**
hrHPV status				0.71
Positive	0.049 (13)	0.039 (5)	0.059 (8)	
Negative	0.697 (184)	0.713 (92)	0.681 (92)	
Inconclusive	0.254 (67)	0.248 (32)	0.259 (35)	

3.5 Predictors of prior screening

Women who report ever being screened were more likely to be Buddhist than Muslim (55% vs 45%, $p < 0.001$), and on average of a higher education ($p = 0.03$) and literacy level (91% vs 74%, $p = 0.001$), had their sexual debut (21.44 years vs 19.02 years, $p < 0.001$) and married at an older age (21.74 years vs 19.02 years, $p < 0.001$), had higher utilization of healthcare and contraception, and had fewer pregnancies and children than those who report never being screened (Table 5). Additionally, those who reported ever screening had higher rates of knowledge of HPV than those who reported never screening (47% vs 30%, $p = 0.04$). Interestingly there does not appear to be a difference in age for those who report ever versus never screened, as generally older women (who have had more time to access screening) are more likely to have ever screened than younger women.

Ethnicity appears to be the main effect for likelihood to have previously accessed cervical cancer screening (shown in table 6), with Muslim women being significantly less likely to have had prior screening (OR = 0.22, 95% CI = 0.10, 0.45). Variables such as literacy levels, age, and number of children (as a proxy for prior experiences with healthcare services) could confound this relationship, however, multivariate logistic models showed that even after adjusting for

relevant covariates, the association remained statistically significant (OR = 0.30, 95% CI = 0.12, 0.66).

Table 5. Predictors of prior screening

Variable	**Prior Screen N = 219** *Prop (N)* *Mean (SD)*	**No Screen N = 47** *Prop (N)* *Mean (SD)*	**P-value**
Age	50.51 (5.84)	50.04 (5.90)	0.62
Ethnicity			<0.001*
Buddhist	0.55 (121)	0.21 (10)	
Muslim	0.45 (98)	0.79 (37)	
Education			0.03*
None	0.05 (10)	0.11 (5)	
Primary	0.64 (141)	0.79 (37)	
Secondary	0.20 (44)	0.11 (5)	
Vocational	0.06 (13)	0.00 (0)	
Academic College	0.05 (11)	0.00 (0)	
Postgraduate	0.00 (0)	0.00 (0)	
Past Year Income			0.41
0 – 79,999	0.34 (66)	0.29 (12)	
80,000 – 119,999	0.26 (52)	0.33 (14)	
120,000 – 179,999	0.17 (34)	0.24 (10)	
180,000 or more	0.23 (45)	0.14 (6)	
Lifetime Sexual Partners	1.20 (0.61)	1.13 (0.40)	0.34
Marriage Age	21.74 (5.63)	19.02 (3.00)	<0.001*
Literate	0.91 (200)	0.74 (35)	0.001*
Frequency of health visits			0.17
More than 1/week	0.00 (0)	0.00 (0)	
1/week	0.00 (1)	0.00 (0)	
1/month	0.13 (8)	0.06 (3)	
Every 3-6 months	0.46 (101)	0.34 (16)	
1/year	0.21 (47)	0.34 (16)	
Less than 1/year	0.19 (42)	0.26 (12)	
Breast Exam	0.24 (53)	0.09 (4)	0.02*
Mammogram	0.16 (9)	1.00 (4)	0.001*
Use Depo-Provera	0.48 (103)	0.40 (18)	0.41
Use birth control pill	0.56 (121)	0.42 (19)	0.10
Use condom	0.34 (73)	0.11 (5)	0.002*
Number Pregnancies	3.39 (1.72)	4.04 (2.06)	0.05*
Number of children	2.94 (1.38)	3.68 (1.72)	0.01*
Age at first pregnancy	23.69 (5.54)	21.23 (3.74)	<0.001*
Family member with CC	0.04 (8)	0.00 (0)	0.13
Age First Sex	21.44 (5.29)	19.02 (2.72)	<0.001*
Knowledge of HPV	0.47 (102)	0.30 (14)	0.04*

Table 6. Muslim ethnicity (versus Buddhist) as a predictor of prior cervical cancer screening

Model	**Odds Ratio**	**95% Confidence Interval**
Crude	0.22	0.10, 0.45
Adjusted[A]	0.30	0.12, 0.66

[A] Model adjusted for literacy, age, and number of children (as a proxy for previous encounters with healthcare services)

4. Discussion

Our study found hrHPV prevalence of 5%, which is significantly lower than rates of hrHPV seen in many other studies, but similar to studies that have been conducted in Thailand.[29]

Additionally, the findings from this study suggests significant differences in demographics, sexual and health history, and knowledge of HPV and cervical cancer between Buddhist and Muslim women in Songkhla, Thailand. The results demonstrate the high potential and acceptability of self-collection HPV testing as a primary form of cervical cancer screening in these communities. Our results also suggest that, currently, some subpopulations in Thailand may have a more difficult time accessing healthcare than others despite the availability of high quality, universal health care. The Muslim women who participated in our study had lower levels of literacy and education than their Buddhist counterparts, both of which are documented barriers to healthcare accessibility.[1,30] Furthermore, Buddhist women utilized healthcare services and contraceptives more frequently and had higher rates of prior cervical cancer screening than Muslim women. This is likely because Muslim women report lower rates of knowledge of cervical cancer and higher rates of fear and embarrassment resulting from cervical cancer screening. However, our study shows that self-screening is acceptable, and even preferred, in women from both religious groups to other modalities. Self-collection HPV sampling could thus help mitigate the barriers to cervical cancer screening that Muslim women in Thailand encounter: it is private and can be done by a woman in her own home, thus reducing the embarrassment and fear associated with receiving a Pap at a doctor's office.

This study has many strengths that have allowed us to thoroughly investigate accessibility and acceptability of cervical cancer screening across different ethnic groups in southern Thailand. The Songkhla region of Thailand is an ideal location to study the differences between

Buddhist and Muslim populations, as there is a relatively large number of Muslim people living in this region. Additionally, the data was collected by community health volunteers who are familiar with the region, often know the patients personally and interact with them on a regular basis and speak the language fluently. We were also able to collect the data using the Qualtrics app on tablets, thus reducing the chance of data entry errors when moving from paper to computer databases. The self-collection swabs that we chose came with an "Instructions-for-Use" card that was translated into the participants' native language and there was always a research assistant available to answer questions and explain directions during collection, allowing for a better understanding of the collection method. Finally, the assay used for HPV detection (Hybribio RT-PCR) is highly sensitive. However, there are also limitations to this study. All data was self-reported, and since there were questions that were sensitive in nature, it is likely that there was some misreporting either due to social desirability or recall bias. Women may have overreported prior screening if they believed that was the "correct" behavior or they simply may not remember accurately when or if they had received this test. Number of sexual partners may be misreported for similar reasons. Additionally, since all women were recruited from health centers, we may not have a representative sample of the community, although health care utilization is high overall in Thailand.[31] Finally, since women performed the self-swab collection at the clinic, they may have a sense of confidence that there are healthcare workers nearby if anything were to go wrong. Women testing in their own homes may have more testing anxiety in the absence of healthcare workers.

This study provided data showing similar results to other HPV self-collection acceptability studies that have been conducted in Thailand and elsewhere. In our dataset, approximately 80% of women report having ever screened for cervical cancer; a similar percentage was found by

Oranratanaphan.[21] Additionally, we found high rates of acceptability of this type of test, which has been shown by most self-collection studies in countries around the world, including Thailand. For example, Phoolcharoen et al and Oranratanaphan et all found that over 90% and over 80% of the women they asked to self-collect a cervical sample found the test both easy and comfortable, respectively[21,22], similar to what was seen in this study. However, here we show that although acceptability is high across religious groups, there may be some subtle differences to consider. In our study, Buddhist women, who report more access to healthcare and less fear and embarrassment of screening, were more likely to want both self-collection HPV tested as well as healthcare provider-administered cytology-based screenings (also known as co-testing), while Muslim women were much more likely to want only self-screening for HPV, potentially related to differing levels of trust in health care professionals between the groups. These results imply that tailored screening programs may be ideal for settings where there are distinct and differing barriers to screening in different groups of women, such as programs providing access to both HPV testing and Pap smears, with the option of self-collection if desired. Providing more accessible forms of screening to women who are not as likely to have access to traditional forms of screening could increase screening uptake, thus reducing the incidence of and mortality due to cervical cancer.

As this study was conducted exclusively in clinics, it still needs to be determined if self-collection HPV testing would function the same at the community level. Thus, a natural step would to be to investigate the feasibility of a community-based self-collection HPV testing program, where women received the swabs and collected the samples in their homes and then returned the swabs to a lab for testing. This type of program could potentially greatly increase

the rates of cervical cancer screening and care in these types of communities, thus reducing the burden of cervical cancer in Thai women.

4.1 Conclusions

In conclusion, while HPV self-collection does appear to be highly acceptable in these communities, with particularly high rates of preferability among Muslim women. Further work should be done to assess the impact and costs of cervical cancer programs including HPV testing and self-collection in Thailand. Due to its simplicity of testing and sensitivity of the assay, HPV self-collection sampling has the potential to replace our current methods for cervical cancer screening.

Acknowledgements

This work was supported by Fogarty International Center (04R25TW009345) (SV), as well as the Center for South East Asian studies, the Office of Global Public Health, and the Global Cancer Initiative at the University of Michigan.

Authorship Contribution Statement

AG: Survey design, analysis design and execution, drafted the manuscript

TN: Data collection, survey design, manuscript review and approval

KZ: Study design, data collection, surveyor training, manuscript review and approval

MH: Study design, questionnaire design and implementation, manuscript review and approval

NC: Data collection, survey design, manuscript review and approval

SB: Data collection, survey design, manuscript review and approval

RN: Laboratory analysis, study design, manuscript review and approval

KN: Laboratory analysis, study design, manuscript review and approval

SV: Study design, questionnaire design and implementation, manuscript review and approval

LR: Study design, questionnaire design and implementation, analysis design, manuscript drafting and approval

HS: Study design, and supervision, questionnaire design and implementation, analysis design, stakeholder engagement, manuscript drafting and approval

RM: Study design and supervision, questionnaire design, analysis design, manuscript drafting and approval, obtained funding for the study

Data sharing statement

Extra data is available by emailing annagott@umich.edu.

References

1. Mukem S, Meng Q, Sriplung H, Tangcharoensathien V. Low Coverage and Disparities of Breast and Cervical Cancer Screening in Thai Women: Analysis of National Representative Household Surveys. *Asian Pac J Cancer Prev*. 2015;16(18):8541-8551.
2. International Agency for Research on Cancer. Global Cancer Observatory.
3. Griffiths M. Screening for cervical cancer in developing countries. *World Heal Organ*. 2002:984. doi:10.4103/0019-509X.64704
4. Walboomers JMM, Jacobs M V., Manos MM, et al. Human papillomavirus is a necessary cause of invasive cervical cancer worldwide. *J Pathol*. 1999;189(1):12-19. doi:10.1002/(SICI)1096-9896(199909)189:1<12::AID-PATH431>3.0.CO;2-F
5. Luciani S, Cabanes A, Prieto-Lara E, Gawryszewski V. Cervical and female breast cancers in the Americas: current situation and opportunities for action. *Bull World Health Organ*. 2013;91(9):640-649. doi:10.2471/BLT.12.116699
6. Vesco K, Whitlock E, Eder M, et al. Screening for Cervical Cancer : A Systematic Evidence Review for the U. S. Preventive Services Task Force. *AHRQ Publ*. 2011;11-05156-E(86):263. doi:AHRQ Publication No. 13-05194-EF-1
7. Fields MM. New cervical cancer screening guidelines: was the annual pap too much of a good thing? *J Adv Pract Oncol*. 2013;4(1):59-64. http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4093371&tool=pmcentrez&rendertype=abstract%5Cnhttp://www.clinicaladvisor.com/features/cervical-cancer-screening-obstetrics-gynecology/article/458991/2/.
8. Sahasrabuddhe V V., Parham GP, Mwanahamuntu MH, Vermund SH. Cervical cancer prevention in low- and middle-income countries: Feasible, affordable, essential. *Cancer Prev Res*. 2012;5(1):11-17. doi:10.1158/1940-6207.CAPR-11-0540
9. Sankaranarayanan R, Budukh AM, Rajkumar R. Effective screening programmes for cervical cancer in low- and middle-income developing countries. *Bull World Health Organ*. 2001;79(10):954-962. doi:10.1590/S0042-96862001001000009
10. Boggan JC, Walmer DK, Henderson G, et al. Vaginal Self-Sampling for Human Papillomavirus Infection as a Primary Cervical Cancer Screening Tool in a Haitian Population. *Sex Transm Dis*. 2015;42(11):655-659. doi:10.1097/OLQ.0000000000000345
11. Ditzian L, David-West G, Maza M, Hartmann B, Shirazian T, Cremer M. Cervical Cancer Screening in Low- and Middle-Income Countries. *Mt Sinai J Med*. 2011;78(53):319-326. doi:10.1002/MSJ
12. Barut MU, Kale A, Kuyumcuoglu U, et al. Analysis of Sensitivity , Specificity , and Positive and Negative Predictive Values of Smear and Colposcopy in Diagnosis of Premalignant and Malignant Cervical Lesions. *Med Sci Monit*. 2015;21:3860-3867. doi:10.12659/MSM.895227
13. Nahar K, Nessa A, Shamim S, Nasrin B, Hossain F, Begum N. Role of VIA in cervical cancer screening in low-resource countries. *Mymensingh Med J*. 2011;20(3):528.
14. African Population and Health Research Center, International Agency for Research on Cancer WHO. Prevention of cervical cancer through screening using visual inspection with acetic acid (VIA) and treatment with cryotherapy. A demonstration project in six African countries: Malawi, Madagascar, Nigeria, Uganda, the United Republic of Tanzania, and Za. *Int Agency Res Cancer*. 2012:33. http://www.who.int/reproductivehealth/publications/cancers/9789241503860/en/.
15. Ogilvie GS, Krajden M, van Niekerk D, et al. HPV for cervical cancer screening (HPV

FOCAL): Complete Round 1 results of a randomized trial comparing HPV-based primary screening to liquid-based cytology for cervical cancer. *Int J Cancer*. 2017;140(2):440-448. doi:10.1002/ijc.30454

16. Chuang LT, Randall TC, Karlan BY. Efforts towards erasing borders in gynecologic cancer? *Gynecol Oncol Reports*. 2017;21(May):5-6. doi:10.1016/j.gore.2017.05.002
17. Gottschlich A, Rivera-Andrade A, Grajeda E, Alvarez C, Montano CM, Meza R. Acceptability of Human Papillomavirus Self-Sampling for Cervical Cancer Screening in an Indigenous Community in Guatemala. *J Glob Oncol*. 2017:JGO.2016.005629. doi:10.1200/JGO.2016.005629
18. Sriplung H, Singkham P, Iamsirithaworn S, Jiraphongsa C, Bilheem S. Success of a Cervical Cancer Screening Program: Trends in Incidence in Songkhla, Southern Thailand, 1989-2010, and Prediction of Future Incidences to 2030. *Asian Pacific J Cancer Prev*. 2014;15(22):10003-10008. doi:10.7314/APJCP.2014.15.22.10003
19. Virani S, Sriplung H, Bilheem S, et al. Effect of the national screening program on malignancy status of cervical cancer in Northern Thailand. *Int J Public Health*. 2018;63(3):377-385. doi:10.1007/s00038-018-1077-7
20. Virani S, Bilheem S, Chansaard W, et al. National and Subnational Population-Based Incidence of Cancer in Thailand : Assessing Cancers with the Highest Burdens. *Cancers (Basel)*. 2017;9(108). doi:10.3390/cancers9080108
21. Oranratanaphan S, Termrungruanglert W, Khemapech N. Acceptability of Self-Sampling HPV Testing Among Thai Women for Cervical Cancer Screening. *Asian Pacific J cancer Prev APJCP*. 2014;15(17):7437-7441. doi:10.7314/APJCP.2014.15.17.7437
22. Phoolcharoen N, Kantathavorn N, Krisorakun W, Taepisitpong C, Krongthong W, Saeloo S. Acceptability of Self-Sample Human Papillomavirus Testing Among Thai Women Visiting a Colposcopy Clinic. *J Community Health*. 2018;43(3):611-615. doi:10.1007/s10900-017-0460-2
23. Alvarez C, Rozek L, Sriplung H. Differences in prostate tumor characteristics and survival among religious groups in southern Thailand. *Cancer Res*. 2017;77(13 Supplement 1):1-9. doi:http://dx.doi.org/10.1158/1538-7445.AM2017-3272
24. Sriplung H, Bilheem S, Kuntipundee T, Geater SL. Differences in cancer incidence among predominantly Muslim and Buddhist subpopulations in Songkhla. *Asian Pacific J Cancer Prev*. 2014;15(22):9979-9983. doi:10.7314/APJCP.2014.15.22.9979
25. Zhao J, Virani S, Sriplung H. Spatiotemporal mapping of cervical cancer incidence highlights need for targeted prevention in Songkhla province, Thailand. *Health Policy Plan*. 2017;32(3):430-436. doi:10.1093/heapol/czw145
26. Qualtrics Software. Qualtrics. Provo, Utah, USA.
27. Herswab Fact Page. Eve Medical Inc. http://www.eve-medical.com/. Accessed September 4, 2017.
28. Hybribio. 13 High-risk HPV Real-time PCR Kit 2017.
29. Sukvirach S, Smith JS, Tunsakul S, et al. Population-Based Human Papillomavirus Prevalence in Lampang and Songkla , Thailand. *J Infect Dis*. 2003;187:1246-1256.
30. Sudore RL, Mehta KM, Simonsick EM, et al. Limited literacy in older people and disparities in health and healthcare access. *J Am Geriatr Soc*. 2006;54(5):770-776. doi:10.1111/j.1532-5415.2006.00691.x
31. Internal Labour Office SPD. *Thailand: Universal Health-Care Coverage Scheme*.; 2016.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	7
Methods			
Study design	4	Present key elements of study design early in the paper	8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	9
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	10
Bias	9	Describe any efforts to address potential sources of bias	8
Study size	10	Explain how the study size was arrived at	9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	10
		(*b*) Describe any methods used to examine subgroups and interactions	na
		(*c*) Explain how missing data were addressed	na
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	na
		(*e*) Describe any sensitivity analyses	na
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	12
		(b) Give reasons for non-participation at each stage	na
		(c) Consider use of a flow diagram	na
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	12
		(b) Indicate number of participants with missing data for each variable of interest	12
Outcome data	15*	Report numbers of outcome events or summary measures	15
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	17

		(*b*) Report category boundaries when continuous variables were categorized	na
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	na
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	na
Discussion			
Key results	18	Summarise key results with reference to study objectives	18
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	19
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	21
Generalisability	21	Discuss the generalisability (external validity) of the study results	21
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	21

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Acceptability of HPV Self-Testing and Access and Barriers to Cervical Cancer Screening: A Cross-Sectional Comparison Between Buddhist and Muslim Women in Southern Thailand

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2019-031957.R1
Article Type:	Research
Date Submitted by the Author:	11-Sep-2019
Complete List of Authors:	Gottschlich, Anna; University of Michigan, School of Public Health Nuntadusit, Thanatta; Prince of Songkla University Faculty of Medicine, Epidemiology Unit Zarins, Katie; University of Michigan, School of Public Health Hada, Manila; University of Michigan, School of Public Health Chooson, Nareerat; Prince of Songkla University Faculty of Medicine, Epidemiology Unit Bilheem, Surichai; Prince of Songkla University Faculty of Medicine, Epidemiology Unit Navakanitworakul, Raphatphorn; Prince of Songkla University Faculty of Medicine, Department of Biomedical Sciences Nittayaboon, Kesara; Prince of Songkla University Faculty of Medicine, Department of Biomedical Sciences Virani, Shama; Prince of Songkla University Faculty of Medicine, Epidemiology Unit Rozek, Laura; University of Michigan, School of Public Health Sriplung, Hutcha; Prince of Songkla University Faculty of Medicine, Epidemiology Unit Meza, Rafael; University of Michigan, School of Public Health
Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Global health, Public health
Keywords:	EPIDEMIOLOGY, PUBLIC HEALTH, CERVICAL CANCER, HPV, SELF-COLLECTION TESTING

Acceptability of HPV Self-Testing and Access and Barriers to Cervical Cancer Screening: A Cross-Sectional Comparison Between Buddhist and Muslim Women in Southern Thailand

Anna Gottschlich[1], Thanatta Nuntadusit[2], Katie R. Zarins[1], Manila Hada[1,4], Nareerat Chooson[2], Surichai Bilheem[2], Raphatphorn Navakanitworakul[3], Kesara Nittayaboon[3], Shama Virani[1,2], Laura S. Rozek[1], Hutcha Sriplung[2], Rafael Meza[1]

Author Affiliations:
[1] School of Public Health, University of Michigan, Ann Arbor, MI
[2] Epidemiology Unit, Faculty of Medicine, Prince of Songkla University, Songkhla, Thailand
[3] Department of Biomedical Sciences, Faculty of Medicine, Prince of Songkla University, Songkhla, Thailand
[4] National Cancer Institute, National Institutes of Health, Bethesda, MD

Corresponding Author:
Rafael Meza, Ph.D.
SPH II, Room 5033, 1415 Washington Heights
Ann Arbor, MI 48109-2029
E-mail: rmeza@umich.edu
Telephone: +1 (734) 763-1946

Word counts: abstract (247), text (3878), tables (6), figures (0), references (38)

Abstract

Background: Cervical cancer rates are higher in low-resourced countries than high, partly due to lower rates of screening. Incidence in Thailand is nearly three times higher than in the US (16.2 vs 6.5 age-standardized incidence), even with Thailand's universal health coverage, which includes screening, suggesting that alternative methods are needed to reduce the burden. We investigated barriers to screening, as well as acceptability of self-collection HPV testing as a primary form of cervical cancer screening among Buddhist and Muslim communities in Southern Thailand.

Methods: 267 women from the Buddhist district of Ranot and Muslim district of Na Thawi, Songkhla were recruited to complete a survey assessing knowledge and risk factors of HPV and cervical cancer. Participants were offered an HPV self-collection test with a follow-up survey assessing acceptability. Samples were processed at Prince of Songkhla University and results were returned to participants.

Results: 267 women participated in the study (132 Buddhist, 135 Muslim), 264 (99%) self-collecting. 98% reported comfort and ease, and >70% preferred it to doctor-facilitated cytology. The main predictor of prior screening was religion (92% Buddhist versus 73% Muslim reporting prior Pap). After adjustment with multivariate logistic models, Muslim women had an odds ratio of prior Pap of 0.30 compared to Buddhist (95% CI: 0.12-0.66).

Conclusions: Self-collection HPV testing was highly acceptable across religious groups, suggesting that it could be beneficial for cervical cancer reduction in this region. Likely, focus

should be put into educating all populations about the importance of screening to improve screening rates among Thai women.

ARTICLE SUMMARY

Strengths and limitations of this study

- The Songkhla region of Thailand has a relatively large number of Muslim people living in this region, making it an ideal location to study the differences between Buddhist and Muslim populations.
- Community health volunteers collected the data in participants' native languages and are familiar with the region and the patients.
- The assay used for HPV detection (Hybribio RT-PCR) is highly sensitive.
- All data was self-reported, so it is likely that there was some misreporting either due to social desirability or recall bias.
- Women testing in their own homes may have more testing anxiety in the absence of healthcare workers, causing lower acceptability of the test.

1. Introduction

Cervical cancer is one of the most common cancers in women in Thailand[1], with age-standardized incidence and mortality rates at 16.2 and 9.0 per 100,000 women[2], approximately three times higher than in the United States (6.5 and 1.9 die per 100,000, respectively[2]). This disparity is seen between low- and middle-income countries (LMICs) and high-income countries (HICs) around the world, and there has yet to be a sufficient intervention to eliminate this inequality. Currently, while cervical cancer is not even in the top 10 most common cancers in HICs, it is the second most common cancer among women in LMICs, where 80% of cervical cancer deaths occur.[3]

Cervical cancer is primarily caused by the human papillomavirus (HPV), a sexually transmitted infection that in most women clears on its own without the knowledge of the infected women.[4,5] However, in some women, infection persists and eventually may cause cervical cancer to develop. Cervical cancer development takes many years, thus allowing for effective screening, prevention, and treatment if detected early.[6]

Today, cervical cancer is considered a preventable disease, in large part due to the Papanicolaou test.[7] This type of cytology-based screening has significantly reduced rates of cervical cancer in HICs but has not had the same effect in LMICs.[8,9] This is likely due to lower accessibility to this type of testing, as well as issues with the actual testing in LMICs. Cytology-based screening requires both infrastructure and personnel to which many LMICs may not have access, as well as potentially multiple visits per patient.[9–11] Additionally, due to the inherent subjectivity of this type of test, particularly when samples are evaluated by technicians rather than by pathologists, there is generally low sensitivity in LMICs[12], causing many cases to be missed even if a sample is collected. Thus, many LMICs have moved to visual inspection with

acetic acid (VIA) in place of Pap screening. VIA can be performed with minimal infrastructure by a properly trained lay-person, and screening and treatment can be done in the same visit.[8,11,13,14] However, visual inspection is also subjective[15], women still need to attend a clinic to receive this test, and equipment needs to be available to perform the treatment.

HPV testing has been shown to be a valid cervical cancer screening modality. In particular, the HPV Focal study recently showed that the use of primary HPV testing, as compared to cytology alone, significantly lowers the likelihood of the development of precancerous lesions among women undergoing cervical cancer screening, due to increased sensitivity and specificity of cytology testing when restricted to only those women who test positive for HPV.[16] Thus, countries like the US and UK are now recommending HPV testing as a primary form of cervical cancer screening.[6,15] In addition, some countries are beginning to implement self-collection HPV testing to increase accessibility to screening.[17] Women can test themselves, in their own home, by collecting a cervical sample using a provided swab.[18] If a woman tests positive for high-risk HPV, then she will need to access follow-up care at a clinic, however if the woman tests negative, she simply needs to be tested periodically (usually in 5-year increments). This can reduce the number of times that women need to travel to clinics for screening or follow-up care, which could eventually also reduce the burden on the health care system.

The rates of cervical cancer in Thailand have been declining since 2002[19–21], when a national cervical cancer screening program was implemented, aiming to screen all women between the ages of 35 and 60 at 5-year intervals. In 2004, the program added visual inspection with acetic acid to the already existing Pap smear program. The three public health insurances programs in Thailand cover the costs of cervical cancer screening in their benefits package.[1] However, the decline in cervical cancer has been slower than expected (cervical cancer is still the 2nd most

common cancer among women in Thailand, causing over 10% of new female cases in 2018[22]), thus calling for improvements in the current screening programs.[19] This is largely due to the lower than ideal uptake of cervical cancer screening: a survey conducted in 2009 estimated that only 59.7% of women in Thailand have ever been screened for cervical cancer.[1] Uptake is even lower among the minority Muslim population (making up only 5% of the country) as compared to the majority Buddhist population (94% of the population)[23] in Thailand (e.g. 46.7% vs 60.4% reporting ever having cervical cancer screening in the 2009 Health and Welfare Survey[1], respectively), perhaps due to reports of embarrassment and wanting to avoid uncovering parts of their bodies during exams, due to the high value that the Muslim religion places on modesty.[1] One previous study investigated the acceptability of self-collection HPV testing in women in Thailand. Acceptability was found to be quite high, but participants were worried about both the cost and the reliability of the results from this type of testing.[24,25] However, no previous studies have specifically looked at women from diverse ethnic groups in Thailand to determine whether HPV self-collection testing is more useful in certain populations than others.

In this study we investigated the differences in access and barriers to healthcare between Buddhist and Muslim women in Southern Thailand and examined potential predictors of accessing screening for cervical cancer. We also assess willingness to use and acceptability of self-collection HPV testing methods in these communities.

2. Material and Methods

2.1 Study design and Sampling

The study was designed as a cross-sectional survey, with a maximum of one interaction per participant. Data collection took place in two districts within Songkhla Province of Southern

Thailand: Na Thawi, in the southern part of Songkhla Province, and Ranot, in the northern-most region. Each of these districts is fairly religiously homogenous, with Na Thawi and Ranot being predominantly Muslim and Buddhist, respectively. Women were recruited from lists of the target population for screening provided by reproductive health clinics in these districts, half located in Na Thawi and half in Ranot. The primary care centers made this list by randomly selecting from the entire female population in the province's health office database and then distributed 12-15 names to each health care volunteer, irrespective of the volunteer's religion. The volunteers then visited their assigned households and set up appointments with eligible women for screening at public primary care clinics. When women came into the clinics, they were asked by a community health worker whether they would like to participate in the study. If they said yes, they were consented and then enrolled, after which a survey was administered, and self-collection HPV testing was offered.

Recruitment took place from July-December in 2017. We aimed to recruit 130 women from each region, according to power calculations. Women had to be over the age of 18 to participate, and between the ages of 25 and 60 to participate in the self-collection sampling portion of the study. For the self-collection sampling, women were ineligible to participate if they were pregnant or menstruating, had a previous history of cervical cancer, or had previously had a hysterectomy.

2.2 Data collection tools

Data was collected using a 150-question survey that assessed sexual behavior and practices, known risk factors associated with HPV, and knowledge of HPV infection and its association with cervical cancer. The survey was developed using similar questions to prior studies of health

risk factors,[26,27] and was originally written in English and then translated into Thai by native Thai investigators from Prince of Songkhla University (PSU). This survey has also been translated into other languages for similar studies occurring in other countries.[18] Prior to data collection, the survey was piloted on 10 women, both Buddhist and Muslim, sampled randomly in the Singha Nakhon district. Data were collected using the Qualtrics survey application.[28] Study research assistants read the survey aloud to each participant and recorded her responses on a tablet. At the end of each day, survey responses were uploaded to a secure server.

Additionally, upon completion of the survey, eligible women were offered a self-collection cervical sample kit to be tested for HPV. The kit (HerSwab)[29] was manufactured by Eve Medical and has previously been shown to be acceptable among other populations.[18] If a woman chose to self-collect, the community health volunteer gave her the kit and an illustrated "Instructions-for-Use" card and explained the sampling procedure. Women then collected a sample in a private room and then returned the swab to the community health volunteer. Samples were transported to the Department of Biomedical Sciences at PSU following collection and stored until testing occurred.

2.3 Laboratory analysis

Samples were analyzed at the Department of Biomedical Sciences at PSU using a 13 High-risk HPV Real-time PCR kit (Hybribio Limited, Hong Kong), which detects HPV types 16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59, 68.[30] Positive and negative controls were included on each plate, and internal controls were evaluated for each sample. Results were provided to the community health centers in Na Thawi and Ranot, where the community health volunteers were able to coordinate follow-up care for participants. If the HPV results were positive, it was

suggested that they receive follow-up care (in the form of a Pap test) from their local health center, and if negative were told to repeat testing in 3 years.

2.4 Statistical analysis

As this is mainly a descriptive study to identify any differences in screening practices between two ethnic groups, all survey questions were examined. These variables were then grouped into 4 areas: demographics, sexual and general health, cervical cancer and HPV, and barriers to health care. Additionally, we compared women who reported having prior cervical cancer screening to women who reported no prior screening, using the same variables mentioned above, with both univariate analyses and multivariate logistic models, adjusted for literacy, age, and number of children as a proxy for previous encounters with healthcare services. Finally, we investigated the acceptability of the self-collection test among women who were willing to use it by asking 4 questions after collection: "How comfortable was the test?", "How easy was the test?", "Are you willing to continue to take this test periodically in the future?" and "Do you prefer self-collection or Pap testing?".

We compared responses between Buddhist and Muslim women using two-sided t-tests and chi-squared tests for continuous and categorical variables, respectively. A similar procedure was used to compare women who had previously been screened for cervical cancer with those who had not. Multivariate logistic models were then run to examine potential predictors for prior screening, after adjusting for confounders. Finally, a descriptive analysis was conducted to assess acceptability of the self-swab test, where an $\alpha < 0.05$ was considered significant. All analyses were conducted using R version 3.4.4.

2.5 Patient and Public Involvement

Participants and the public were first involved at the design and piloting stages of the study. Research questions and outcome measures were developed using prior surveys assessing use of healthcare in other low- and middle-income settings[18] and direct feedback was received from clinic staff. During piloting, feedback was also received from participants and clinic workers. Patients at local health clinics were directly approached by study personnel inviting them to participate in the study and discussing the format and purpose of the study. While participants were not asked about the time required to participate in the research, the post-sampling survey explicitly asked participants about the acceptability and perceptions of self-sampling to assess the burden of the intervention being investigated. To disseminate study results to participants and the community, we plan to conduct educational and study dissemination sessions. These will be planned directly in collaboration with community-based clinic personnel and other representatives from the community.

2.6 Ethical approval

Ethical approval was granted by both the University of Michigan (HUM00114785) and the PSU Research Ethics Committee (REC 59-235-18-1). All participants were given oral and printed informed consent before participation. This consent was documented by signature from the participant on the consent form and all consent forms are filed in a locked cabinet at PSU.

3. Results

3.1 Demographics

267 women were recruited from the community health centers in the Ranot (n=132) and Na Thawi (n=135) districts of Songkla Province in southern Thailand. All 132 women from Ranot identified as Buddhist and all 135 from Na Thawi identified as Muslim. The average age of the Buddhist population was 51.3 years, while in the Muslim population it was 49.6 years. There were several statistically significant demographic differences between the Buddhist and Muslim women in the sampled population (Table 1). Buddhist women on average reported higher literacy (96% vs. 81%, $p < 0.001$) and education levels ($p = 0.003$). Additionally, Muslim women were more likely than Buddhist women to be in a common law relationship instead of marriage ($p < 0.001$). However, there were no statistically significant differences in income between the two populations.

Table 1. Demographics

Variable	**Total** **N = 267** *Prop (N)* *Mean (SD)*	**Buddhist** **N = 132** *Prop (N)* *Mean (SD)*	**Muslim** **N = 135** *Prop (N)* *Mean (SD)*	**P-value**
Age	50.44 (5.83)	51.27 (6.08)	49.63 (5.48)	0.02*
Literate	0.88 (236)	0.96 (127)	0.81 (109)	<0.001*
Education				0.003*
None	0.06 (15)	0.00 (0)	0.11 (15)	
Primary	0.67 (179)	0.71 (94)	0.63 (85)	
Secondary	0.18 (49)	0.18(24)	0.19 (25)	
Vocational	0.05 (13)	0.06 (8)	0.04 (5)	
Academic College	0.04 (11)	0.05 (6)	0.04 (5)	
Postgraduate	0.00 (0)	0.00 (0)	0.00 (0)	
Civil Status				
Single	0.00 (0)	0.00 (0)	0.00 (0)	<0.001*
Married	0.69 (184)	0.80 (106)	0.58 (78)	
Common Law	0.21 (55)	0.09 (12)	0.32 (43)	
Separated	0.01 (2)	0.02 (2)	0.00 (0)	
Divorced	0.04 (11)	0.04 (5)	0.04 (6)	
Widowed	0.04 (10)	0.02 (3)	0.05 (7)	
Marriage Age	21.26 (5.35)	22.85 (5.98)	19.72 (4.15)	<0.001*
Past Year Income (THB)				0.27
0 – 79,999	0.33 (78)	0.34 (39)	0.31 (39)	
80,000 – 119,999	0.28 (67)	0.31 (35)	0.25 (32)	
120,000 – 179,999	0.18 (44)	0.19 (22)	0.17 (22)	
180,000 or more	0.21 (51)	0.16 (18)	0.26 (33)	

3.2 Prior access and barriers to healthcare

Buddhist and Muslim women appeared to access healthcare differently in these communities (Table 2). Buddhist women reported accessing more medical services and using health services more frequently than Muslim women. Notably, a higher percentage of Buddhist women reported prior Pap screening (92% vs 73% respectively, $p < 0.001$), as well as more recent screening, than Muslim women. Among women who have not been screened for cervical cancer, the most common reported reason for not screening among Buddhist women was no perceived health issues, and thus no reason to seek medical attention (40%), while for Muslim it was either a lack of knowledge that they should be screened or feelings of fear and embarrassment about screening (35% and 41% respectively). Additionally, Buddhist and Muslim women both reported that a doctor telling them they would need the test, and reduced cost of the test would be motivators to getting tested. Finally, Muslim women were less likely to use oral contraceptives (41% vs 67% respectively, $p < 0.001$).

Table 2. Sexual and health history

Variable	**Total** **N = 267** *Prop (N)* *Mean (SD)*	**Buddhist** **N = 132** *Prop (N)* *Mean (SD)*	**Muslim** **N = 135** *Prop (N)* *Mean (SD)*	**P-value**
Health Location				
University Hospital	0.27 (73)	0.34 (45)	0.21 (28)	0.047*
Primary Care Facility	0.99 (264)	1.00 (132)	0.98 (132)	1
Community Health Care Center	0.99 (263)	0.98 (130)	0.99 (133)	0.85
Other (Private Hospital, N = 2; Clinic, N = 83)	0.32 (85)	0.16 (21)	0.47 (64)	<0.001*
Last Health Visit				<0.001*
Less than a month	0.22 (59)	0.30 (40)	0.14 (19)	
1-3 months	0.25 (67)	0.28 (37)	0.22 (30)	
3-6 months	0.13 (35)	0.14 (18)	0.13 (17)	
6 mo-1 year	0.18 (48)	0.15 (20)	0.21 (28)	
1-5 years	0.14 (37)	0.09 (12)	0.19 (25)	
More than 5 years	0.05 (14)	0.01 (1)	0.10 (13)	
Never	0.03 (7)	0.03 (4)	0.02 (3)	
Use Healer	0.18 (49)	0.11 (14)	0.26 (35)	0.002*
Had Pap	0.82 (219)	0.92 (121)	0.73 (98)	<0.001*
Last Pap				0.007*
Less than 6 months	0.07 (16)	0.08 (10)	0.06 (6)	
Less than 1 year	0.30 (66)	0.37 (45)	0.21 (21)	
Less than 5 years	0.42 (91)	0.40 (49)	0.43 (42)	

More than 5 years	0.18 (40)	0.11 (13)	0.28 (27)	
Don't know	0.03 (6)	0.03 (4)	0.02 (2)	
Lifetime Paps				0.005*
1	0.19 (41)	0.12 (15)	0.27 (26)	
2	0.23 (51)	0.19 (23)	0.29 (28)	
3-4	0.39 (86)	0.45 (55)	0.32 (31)	
5 or more	0.18 (39)	0.21 (26)	0.13 (13)	
Don't know	0.01 (2)	0.02 (2)	0.00 (0)	
Main Reason No Pap				0.08*
None/ never thought of it	0.13 (6)	0.10 (1)	0.14 (5)	
Didn't know needed it	0.32 (15)	0.20 (2)	0.35 (13)	
Haven't had any problems	0.15 (7)	0.40 (4)	0.08 (3)	
Too expensive	0.00 (0)	0.00 (0)	0.00 (0)	
Too painful/embarrassing	0.36 (17)	0.20 (2)	0.41 (15)	
Other	0.04 (2)	0.10 (1)	0.03 (1)	
Doctor Motivation				<0.001*
Extremely Likely	0.60 (161)	0.73 (96)	0.48 (65)	
Very Likely	0.15 (40)	0.11 (14)	0.19 (26)	
Somewhat Likely	0.12 (32)	0.09 (12)	0.15 (20)	
Not Very Likely	0.11 (30)	0.08 (10)	0.15 (20)	
Don't know	0.01 (4)	0.00 (0)	0.03 (4)	
Payment Motivation				
Extremely Likely	0.51 (137)	0.64 (85)	0.39 (52)	<0.001*
Very Likely	0.21 (56)	0.17 (22)	0.25 (34)	
Somewhat Likely	0.15 (39)	0.11 (15)	0.18 (24)	
Not Very Likely	0.12 (31)	0.08 (10)	0.16 (21)	
Don't know	0.01 (4)	0.00 (0)	0.03 (4)	
Use Oral Contraceptive	0.54 (141)	0.67 (86)	0.41 (55)	<0.001*

3.3 Acceptability of self-collection

There was an almost universal acceptance of self-collection among this population (Table 3). Ninety-eight percent of women found the test both comfortable and easy, and 100% said they would be willing to continue to use this test as a preliminary form of cervical cancer screening. Both communities preferred self-swab to Pap testing, with higher preference in Muslim women (79% in Muslim vs 66% in Buddhist, p = 0.02). Among women who reported prior Pap testing, Buddhist women were more likely to prefer Pap and self-collection co-testing than Muslim women (33% vs 19%, respectively, p=0.05), while Muslim women were more likely to prefer self-swab alone (77% vs 64%, p = 0.05). Both Muslim and Buddhist women prefer testing to be

done in a medical setting, but Muslim women are more likely to prefer self-collection to doctor-collection (94% reporting preference for self-collection vs 77%) than Buddhist women.

Table 3. Acceptability of self-collection

Variable	**Total** **N = 267** *Prop (N)* *Mean (SD)*	**Buddhist** **N = 132** *Prop (N)* *Mean (SD)*	**Muslim** **N = 135** *Prop (N)* *Mean (SD)*	**P-value**
Self-Collected Sample	0.99 (264)	0.98 (130)	0.99 (134)	0.62
Comfort				1.00
Comfortable	0.98 (259)	0.98 (128)	0.97 (131)	
Neutral	0.02 (5)	0.02 (2)	0.02 (3)	
Uncomfortable	0.00 (0)	0.00 (0)	0.00 (0)	
Ease				1.00
Easy	0.98 (258)	0.98 (127)	0.97 (131)	
Neutral	0.02 (6)	0.02 (3)	0.02 (3)	
Difficult	0.00 (0)	0.00 (0)	0.00 (0)	
Willing to Retake	1.00 (264)	1.00 (130)	1.00 (134)	1.00
Preference[A]				0.05*
Self-swab kit	0.70 (153)	0.64 (78)	0.77 (75)	
Pap smear	0.03 (6)	0.02 (2)	0.04 (4)	
Both	0.27 (59)	0.33 (40)	0.19 (19)	
Neither	0.00 (1)	0.01 (1)	0.00 (0)	
Test Pref Location				<0.001*
At Home	0.18 (49)	0.04 (10)	0.15 (39)	
At Healthcare Center	0.82 (218)	0.96 (122)	0.85 (96)	
Test Pref Collector				<0.001*
My Health Personnel	0.14 (38)	0.23 (30)	0.06 (8)	
Myself	0.86 (225)	0.77 (100)	0.94 (125)	

[A] Among women who reported ever receiving a Pap test

3.4 hrHPV positivity

Nearly all of the participants chose to self-collect a sample to be tested for HPV (98% and 99% of Buddhist and Muslim women, respectively). The three women who did not self-collect had a sample collected by a physician, and thus we have HPV results for all 267 participants. Of these women, only 5% overall (N = 13) – 7% of all conclusive tests – tested positive for hrHPV: 5 Buddhist and 8 Muslim (no statistically significant differences between the two religious groups, shown in table 4).

Table 4. hrHPV test results

Variable	**Total** **N = 264** *Prop (N)*	**Buddhist** **N = 132** *Prop (N)*	**Muslim** **N = 135** *Prop (N)*	**P-value**

	Mean (SD)	*Mean (SD)*	*Mean (SD)*	
hrHPV status				0.71
Positive	0.049 (13)	0.039 (5)	0.059 (8)	
Negative	0.697 (184)	0.713 (92)	0.681 (92)	
Inconclusive	0.254 (67)	0.248 (32)	0.259 (35)	

3.5 Predictors of prior screening

Women who report ever being screened were more likely to be Buddhist than Muslim (55% vs 45%, $p < 0.001$), were on average of a higher education ($p = 0.03$) and literacy level (91% vs 74%, $p = 0.001$), had a later sexual debut (21.44 years vs 19.02 years, $p < 0.001$), married at an older age (21.74 years vs 19.02 years, $p < 0.001$), had higher utilization of healthcare and contraception, and had fewer pregnancies and children than those who report never being screened (Table 5). Additionally, those who reported ever screening had higher rates of knowledge of HPV than those who reported never screening (47% vs 30%, $p = 0.04$). Interestingly there does not appear to be a difference in age for those who report ever versus never screened, as generally older women (who have had more time to access screening) are more likely to have ever screened than younger women.

Ethnicity appears to be the main effect for likelihood to have previously accessed cervical cancer screening (shown in table 6), with Muslim women being significantly less likely to have had prior screening (OR = 0.22, 95% CI = 0.10, 0.45). Variables such as literacy levels, age, and number of children (as a proxy for prior experiences with healthcare services) could confound this relationship, however, multivariate logistic models showed that even after adjusting for relevant covariates, the association remained significant (OR = 0.30, 95% CI = 0.12, 0.66).

Table 5. Predictors of prior screening

Variable	**Prior Screen N = 219** *Prop (N)* *Mean (SD)*	**No Screen N = 47** *Prop (N)* *Mean (SD)*	**P-value**
Age	50.51 (5.84)	50.04 (5.90)	0.62
Ethnicity			<0.001*

Buddhist	0.55 (121)	0.21 (10)	
Muslim	0.45 (98)	0.79 (37)	
Education			0.03*
None	0.05 (10)	0.11 (5)	
Primary	0.64 (141)	0.79 (37)	
Secondary	0.20 (44)	0.11 (5)	
Vocational	0.06 (13)	0.00 (0)	
Academic College	0.05 (11)	0.00 (0)	
Postgraduate	0.00 (0)	0.00 (0)	
Past Year Income			0.41
0 – 79,999	0.34 (66)	0.29 (12)	
80,000 – 119,999	0.26 (52)	0.33 (14)	
120,000 – 179,999	0.17 (34)	0.24 (10)	
180,000 or more	0.23 (45)	0.14 (6)	
Lifetime Sexual Partners	1.20 (0.61)	1.13 (0.40)	0.34
Marriage Age	21.74 (5.63)	19.02 (3.00)	<0.001*
Literate	0.91 (200)	0.74 (35)	0.001*
Frequency of health visits			0.17
More than 1/week	0.00 (0)	0.00 (0)	
1/week	0.00 (1)	0.00 (0)	
1/month	0.13 (8)	0.06 (3)	
Every 3-6 months	0.46 (101)	0.34 (16)	
1/year	0.21 (47)	0.34 (16)	
Less than 1/year	0.19 (42)	0.26 (12)	
Breast Exam	0.24 (53)	0.09 (4)	0.02*
Mammogram	0.16 (9)	1.00 (4)	0.001*
Use Depo-Provera	0.48 (103)	0.40 (18)	0.41
Use birth control pill	0.56 (121)	0.42 (19)	0.10
Use condom	0.34 (73)	0.11 (5)	0.002*
Number Pregnancies	3.39 (1.72)	4.04 (2.06)	0.05*
Number of children	2.94 (1.38)	3.68 (1.72)	0.01*
Age at first pregnancy	23.69 (5.54)	21.23 (3.74)	<0.001*
Family member with CC	0.04 (8)	0.00 (0)	0.13
Age First Sex	21.44 (5.29)	19.02 (2.72)	<0.001*
Knowledge of HPV	0.47 (102)	0.30 (14)	0.04*

Table 6. Muslim ethnicity (versus Buddhist) as a predictor of prior cervical cancer screening

Model	Odds Ratio	95% Confidence Interval
Crude	0.22	0.10, 0.45
Adjusted[A]	0.30	0.12, 0.66

[A] Model adjusted for literacy, age, and number of children (as a proxy for previous encounters with healthcare services)

4. Discussion

Our study found hrHPV prevalence of 5%, which is significantly lower than rates of hrHPV seen in many other settings, but similar to studies that have been conducted in Thailand.[31]

Additionally, the findings from this study suggests significant differences in demographics, sexual and health history, and knowledge of HPV and cervical cancer between

Buddhist and Muslim women in Songkhla, Thailand. The results demonstrate the high potential and acceptability of self-collection HPV testing as a primary form of cervical cancer screening in these communities. Our results also suggest that, currently, some subpopulations in Thailand may have a more difficult time accessing healthcare than others despite the availability of high quality, universal health care. The Muslim women who participated in our study had lower levels of literacy and education than their Buddhist counterparts, both of which are documented barriers to healthcare accessibility.[1,32] Furthermore, Buddhist women utilized healthcare services and contraceptives more frequently and had higher rates of prior cervical cancer screening than Muslim women. This is likely because Muslim women report lower rates of knowledge of cervical cancer and higher rates of fear and embarrassment resulting from cervical cancer screening. This is consistent with past research that has shown that cultural differences, including language differences, lead to lower rates of access to healthcare among religious minorities in Thailand.[33–37] However, our study shows that self-screening is acceptable, and even preferred, in women from both religious groups to other modalities. While the majority of women still reported a preference for testing in a healthcare setting as opposed to in the home, they also preferred self-testing over doctor-testing. This highlights that it is important to assess not only the acceptability of self-sampling, but the preferred settings for different social groups. Self-collection HPV sampling could thus help mitigate the barriers to cervical cancer screening that Muslim women in Thailand encounter: it is private and can be done by a woman in her own home, thus reducing the embarrassment and fear associated with receiving a Pap at a doctor's office.

This study has many strengths that have allowed us to thoroughly investigate accessibility and acceptability of cervical cancer screening across different ethnic groups in southern

Thailand. The Songkhla region of Thailand is an ideal location to study the differences between Buddhist and Muslim populations, as there is a relatively large number of Muslim people living in this region. Additionally, the data was collected by community health volunteers who are familiar with the region, often know the patients personally and interact with them on a regular basis and speak the language fluently. We were also able to collect the data using the Qualtrics app on tablets, thus reducing the chance of data entry errors when moving from paper to computer databases. The self-collection swabs that we chose came with an "Instructions-for-Use" card that was translated into the participants' native language and there was always a research assistant available to answer questions and explain directions during collection, allowing for a better understanding of the collection method. Finally, the assay used for HPV detection (Hybribio RT-PCR) is highly sensitive. However, there are also limitations to this study. All data was self-reported, and since there were questions that were sensitive in nature, it is likely that there was some misreporting either due to social desirability or recall bias. Women may have overreported prior screening if they believed that was the "correct" behavior or they simply may not remember accurately when or if they had received this test. Number of sexual partners may be misreported for similar reasons. Additionally, since participation in the study occurred in health centers, we may not have a representative sample of the community if certain groups chose not to come to the clinics, although in general, health care utilization is high overall in Thailand.[38] Finally, since women performed the self-swab collection at the clinic, they may have a sense of confidence that there are healthcare workers nearby if anything were to go wrong. Women testing in their own homes may have more testing anxiety in the absence of healthcare workers.

This study provided data showing similar results to other HPV self-collection acceptability studies that have been conducted in Thailand and elsewhere. In our dataset, approximately 80% of women report having ever screened for cervical cancer; a similar percentage was found by Oranratanaphan.[24] Additionally, we found high rates of acceptability of this type of test, which has been shown by most self-collection studies in countries around the world, including Thailand. For example, Phoolcharoen et al and Oranratanaphan et al found that over 90% and over 80% of the women they asked to self-collect a cervical sample found the test both easy and comfortable, respectively[24,25], similar to what was seen in this study. However, here we show that although acceptability is high across religious groups, there may be some subtle differences to consider. In our study, Buddhist women, who report more access to healthcare and less fear and embarrassment of screening, were more likely to want both self-collection HPV tested as well as healthcare provider-administered cytology-based screenings (also known as co-testing), while Muslim women were much more likely to want only self-screening for HPV, potentially related to differing levels of trust in health care professionals between the groups. These results imply that tailored screening programs may be ideal for settings where there are distinct and differing barriers to screening in different groups of women, such as programs providing access to both HPV testing and Pap smears, with the option of self-collection if desired. Providing more accessible forms of screening to women who are not as likely to have access to traditional forms of screening could increase screening uptake, thus reducing the incidence of and mortality due to cervical cancer.

As this study was conducted exclusively in clinics, it still needs to be determined if self-collection HPV testing would function the same at the community level. Thus, a natural step would to be to investigate the feasibility of a community-based self-collection HPV testing

program, where women received the swabs and collected the samples in their homes and then returned the swabs to a lab for testing. This type of program could potentially greatly increase the rates of cervical cancer screening and care in these types of communities, thus reducing the burden of cervical cancer in Thai women.

4.1 Conclusions

HPV self-collection appears to be highly acceptable in these communities, with particularly high rates of preferability among Muslim women. Further work should be done to assess the impact and costs of cervical cancer programs including HPV testing and self-collection in Thailand. Due to its simplicity of testing and sensitivity of the assay, HPV self-collection sampling has the potential to replace our current methods for cervical cancer screening.

Authorship Contribution Statement

AG: Survey design, analysis design and execution, drafted the manuscript

TN: Data collection, survey design, manuscript review and approval

KZ: Study design, data collection, surveyor training, manuscript review and approval

MH: Study design, questionnaire design and implementation, manuscript review and approval

NC: Data collection, survey design, manuscript review and approval

SB: Data collection, survey design, manuscript review and approval

RN: Laboratory analysis, study design, manuscript review and approval

KN: Laboratory analysis, study design, manuscript review and approval

SV: Study design, questionnaire design and implementation, manuscript review and approval

LR: Study design, questionnaire design and implementation, analysis design, manuscript drafting and approval

HS: Study design, and supervision, questionnaire design and implementation, analysis design, stakeholder engagement, manuscript drafting and approval

RM: Study design and supervision, questionnaire design, analysis design, manuscript drafting and approval, obtained funding for the study

Data sharing statement

Extra data is available by emailing annagott@umich.edu.

Funding statement

We acknowledge funding from the University of Michigan School of Public Health (U-M SPH), the U-M SPH Office of Global Public Health, the U-M Center for South East Asian Studies, the U-M Global Cancer Initiative, and the Fogarty International Center (04R25TW009345). Research reported in this publication was also supported by the National Cancer Institutes of Health under Award Number P30CA046592. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Competing interest statement

There are no competing interests to declare.

References

1. Mukem S, Meng Q, Sriplung H, Tangcharoensathien V. Low Coverage and Disparities of Breast and Cervical Cancer Screening in Thai Women: Analysis of National Representative Household Surveys. *Asian Pac J Cancer Prev*. 2015;16(18):8541-8551.
2. International Agency for Research on Cancer. Global Cancer Observatory.
3. Griffiths M. Screening for cervical cancer in developing countries. *World Heal Organ*. 2002:984. doi:10.4103/0019-509X.64704
4. Walboomers JMM, Jacobs M V., Manos MM, et al. Human papillomavirus is a necessary cause of invasive cervical cancer worldwide. *J Pathol*. 1999;189(1):12-19. doi:10.1002/(SICI)1096-9896(199909)189:1<12::AID-PATH431>3.0.CO;2-F
5. Luciani S, Cabanes A, Prieto-Lara E, Gawryszewski V. Cervical and female breast cancers in the Americas: current situation and opportunities for action. *Bull World Health Organ*. 2013;91(9):640-649. doi:10.2471/BLT.12.116699
6. Vesco K, Whitlock E, Eder M, et al. Screening for Cervical Cancer : A Systematic Evidence Review for the U. S. Preventive Services Task Force. *AHRQ Publ*. 2011;11-05156-E(86):263. doi:AHRQ Publication No. 13-05194-EF-1
7. Fields MM. New cervical cancer screening guidelines: was the annual pap too much of a good thing? *J Adv Pract Oncol*. 2013;4(1):59-64. http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4093371&tool=pmcentrez&rendertype=abstract%5Cnhttp://www.clinicaladvisor.com/features/cervical-cancer-screening-obstetrics-gynecology/article/458991/2/.
8. Sahasrabuddhe V V., Parham GP, Mwanahamuntu MH, Vermund SH. Cervical cancer prevention in low- and middle-income countries: Feasible, affordable, essential. *Cancer Prev Res*. 2012;5(1):11-17. doi:10.1158/1940-6207.CAPR-11-0540
9. Sankaranarayanan R, Budukh AM, Rajkumar R. Effective screening programmes for cervical cancer in low- and middle-income developing countries. *Bull World Health Organ*. 2001;79(10):954-962. doi:10.1590/S0042-96862001001000009
10. Boggan JC, Walmer DK, Henderson G, et al. Vaginal Self-Sampling for Human Papillomavirus Infection as a Primary Cervical Cancer Screening Tool in a Haitian Population. *Sex Transm Dis*. 2015;42(11):655-659. doi:10.1097/OLQ.0000000000000345
11. Ditzian L, David-West G, Maza M, Hartmann B, Shirazian T, Cremer M. Cervical Cancer Screening in Low- and Middle-Income Countries. *Mt Sinai J Med*. 2011;78(53):319-326. doi:10.1002/MSJ
12. Barut MU, Kale A, Kuyumcuoglu U, et al. Analysis of Sensitivity , Specificity , and Positive and Negative Predictive Values of Smear and Colposcopy in Diagnosis of Premalignant and Malignant Cervical Lesions. *Med Sci Monit*. 2015;21:3860-3867. doi:10.12659/MSM.895227
13. Nahar K, Nessa A, Shamim S, Nasrin B, Hossain F, Begum N. Role of VIA in cervical cancer screening in low-resource countries. *Mymensingh Med J*. 2011;20(3):528.
14. African Population and Health Research Center, International Agency for Research on Cancer WHO. Prevention of cervical cancer through screening using visual inspection with acetic acid (VIA) and treatment with cryotherapy. A demonstration project in six African countries: Malawi, Madagascar, Nigeria, Uganda, the United Republic of Tanzania, and Za. *Int Agency Res Cancer*. 2012:33. http://www.who.int/reproductivehealth/publications/cancers/9789241503860/en/.
15. Moses E, Pedersen HN, Mitchell SM, et al. Uptake of community-based, self-collected

HPV testing vs. visual inspection with acetic acid for cervical cancer screening in Kampala, Uganda: Preliminary results of a randomised controlled trial. *Trop Med Int Heal*. 2015;20(10):1355-1367. doi:10.1111/tmi.12549

16. Ogilvie GS, Krajden M, van Niekerk D, et al. HPV for cervical cancer screening (HPV FOCAL): Complete Round 1 results of a randomized trial comparing HPV-based primary screening to liquid-based cytology for cervical cancer. *Int J Cancer*. 2017;140(2):440-448. doi:10.1002/ijc.30454
17. Chuang LT, Randall TC, Karlan BY. Efforts towards erasing borders in gynecologic cancer? *Gynecol Oncol Reports*. 2017;21(May):5-6. doi:10.1016/j.gore.2017.05.002
18. Gottschlich A, Rivera-Andrade A, Grajeda E, Alvarez C, Montano CM, Meza R. Acceptability of Human Papillomavirus Self-Sampling for Cervical Cancer Screening in an Indigenous Community in Guatemala. *J Glob Oncol*. 2017:JGO.2016.005629. doi:10.1200/JGO.2016.005629
19. Sriplung H, Singkham P, Iamsirithaworn S, Jiraphongsa C, Bilheem S. Success of a Cervical Cancer Screening Program: Trends in Incidence in Songkhla, Southern Thailand, 1989-2010, and Prediction of Future Incidences to 2030. *Asian Pacific J Cancer Prev*. 2014;15(22):10003-10008. doi:10.7314/APJCP.2014.15.22.10003
20. Virani S, Sriplung H, Bilheem S, et al. Effect of the national screening program on malignancy status of cervical cancer in Northern Thailand. *Int J Public Health*. 2018;63(3):377-385. doi:10.1007/s00038-018-1077-7
21. Virani S, Bilheem S, Chansaard W, et al. National and Subnational Population-Based Incidence of Cancer in Thailand : Assessing Cancers with the Highest Burdens. *Cancers (Basel)*. 2017;9(108). doi:10.3390/cancers9080108
22. Globocan. Thailand Cancer Fact Sheet. *Int Agency Res Cancer*. 2018.
23. Bureau of Democracy Human Rights and Labor. International Religious Freedom Report 2005. US Department of State.
24. Oranratanaphan S, Termrungruanglert W, Khemapech N. Acceptability of Self-Sampling HPV Testing Among Thai Women for Cervical Cancer Screening. *Asian Pacific J cancer Prev APJCP*. 2014;15(17):7437-7441. doi:10.7314/APJCP.2014.15.17.7437
25. Phoolcharoen N, Kantathavorn N, Krisorakun W, Taepisitpong C, Krongthong W, Saeloo S. Acceptability of Self-Sample Human Papillomavirus Testing Among Thai Women Visiting a Colposcopy Clinic. *J Community Health*. 2018;43(3):611-615. doi:10.1007/s10900-017-0460-2
26. Staff U. UNC Family Health Study Survey. 2010.
27. Organizacion Mundial de Salud. *Manual de Vigilancia STEPS de La OMS: El Método STEPwise de La OMS Para La Vigilancia de Los Factores de Riesgo de Las Enfermedades Crónicas*.; 2006. http://goo.gl/06Th0Y.
28. Qualtrics Software. Qualtrics. Provo, Utah, USA.
29. Herswab Fact Page. Eve Medical Inc. http://www.eve-medical.com/. Accessed September 4, 2017.
30. Hybribio. 13 High-risk HPV Real-time PCR Kit 2017.
31. Sukvirach S, Smith JS, Tunsakul S, et al. Population-Based Human Papillomavirus Prevalence in Lampang and Songkla , Thailand. *J Infect Dis*. 2003;187:1246-1256.
32. Sudore RL, Mehta KM, Simonsick EM, et al. Limited literacy in older people and disparities in health and healthcare access. *J Am Geriatr Soc*. 2006;54(5):770-776. doi:10.1111/j.1532-5415.2006.00691.x

33. Alvarez C, Rozek L, Sriplung H. Differences in prostate tumor characteristics and survival among religious groups in southern Thailand. *Cancer Res*. 2017;77(13 Supplement 1):1-9. doi:http://dx.doi.org/10.1158/1538-7445.AM2017-3272
34. Che Y, You J, Zhou S, et al. Comparison of survival rates between Chinese and thai patients with breast cancer. *Asian Pacific J Cancer Prev*. 2014;15(15):6029-6033. doi:10.7314/APJCP.2014.15.15.6029
35. Kerdpon D, Sriplung H. Factors related to advanced stage oral squamous cell carcinoma in southern Thailand. *Oral Oncol*. 2001;37(3):216-221. doi:10.1016/S1368-8375(00)00067-1
36. Khwankong S, Sriplung H, Kerdpon D. Knowledge and Health Belief Attitudes of Oral Cancer and Its Screening Among At-Risk Southern Thai Muslims. *J Cancer Educ*. 2018;33(3):615-621. doi:10.1007/s13187-016-1150-y
37. Muangpaisan T, Sriplung H. Social and geographic predictors of cancer survival: A role for a population-based cancer registry in cancer control. *Asian Pacific J Cancer Prev*. 2000;1(4):319-323.
38. Internal Labour Office SPD. *Thailand: Universal Health-Care Coverage Scheme*.; 2016.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	7
Methods			
Study design	4	Present key elements of study design early in the paper	8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	9
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	10
Bias	9	Describe any efforts to address potential sources of bias	8
Study size	10	Explain how the study size was arrived at	9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	10
		(*b*) Describe any methods used to examine subgroups and interactions	na
		(*c*) Explain how missing data were addressed	na
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	na
		(*e*) Describe any sensitivity analyses	na
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	12
		(b) Give reasons for non-participation at each stage	na
		(c) Consider use of a flow diagram	na
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	12
		(b) Indicate number of participants with missing data for each variable of interest	12
Outcome data	15*	Report numbers of outcome events or summary measures	15
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	17

		(*b*) Report category boundaries when continuous variables were categorized	na
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	na
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	na
Discussion			
Key results	18	Summarise key results with reference to study objectives	18
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	19
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	21
Generalisability	21	Discuss the generalisability (external validity) of the study results	21
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	21

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Barriers to Cervical Cancer Screening and Acceptability of HPV Self-Testing: A Cross-Sectional Comparison Between Ethnic Groups in Southern Thailand

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2019-031957.R2
Article Type:	Research
Date Submitted by the Author:	01-Oct-2019
Complete List of Authors:	Gottschlich, Anna; University of Michigan, School of Public Health Nuntadusit, Thanatta; Prince of Songkla University Faculty of Medicine, Epidemiology Unit Zarins, Katie; University of Michigan, School of Public Health Hada, Manila; University of Michigan, School of Public Health Chooson, Nareerat; Prince of Songkla University Faculty of Medicine, Epidemiology Unit Bilheem, Surichai; Prince of Songkla University Faculty of Medicine, Epidemiology Unit Navakanitworakul, Raphatphorn; Prince of Songkla University Faculty of Medicine, Department of Biomedical Sciences Nittayaboon, Kesara; Prince of Songkla University Faculty of Medicine, Department of Biomedical Sciences Virani, Shama; Prince of Songkla University Faculty of Medicine, Epidemiology Unit Rozek, Laura; University of Michigan, School of Public Health Sriplung, Hutcha; Prince of Songkla University Faculty of Medicine, Epidemiology Unit Meza, Rafael; University of Michigan, School of Public Health
Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Global health, Public health
Keywords:	EPIDEMIOLOGY, PUBLIC HEALTH, CERVICAL CANCER, HPV, SELF-COLLECTION TESTING

Barriers to Cervical Cancer Screening and Acceptability of HPV Self-Testing: A Cross-Sectional Comparison Between Ethnic Groups in Southern Thailand

Anna Gottschlich[1], Thanatta Nuntadusit[2], Katie R. Zarins[1], Manila Hada[1,4], Nareerat Chooson[2], Surichai Bilheem[2], Raphatphorn Navakanitworakul[3], Kesara Nittayaboon[3], Shama Virani[1,2], Laura S. Rozek[1], Hutcha Sriplung[2], Rafael Meza[1]

Author Affiliations:
[1] School of Public Health, University of Michigan, Ann Arbor, MI
[2] Epidemiology Unit, Faculty of Medicine, Prince of Songkla University, Songkhla, Thailand
[3] Department of Biomedical Sciences, Faculty of Medicine, Prince of Songkla University, Songkhla, Thailand
[4] National Cancer Institute, National Institutes of Health, Bethesda, MD

Corresponding Author:
Rafael Meza, Ph.D.
SPH II, Room 5033, 1415 Washington Heights
Ann Arbor, MI 48109-2029
E-mail: rmeza@umich.edu
Telephone: +1 (734) 763-1946

Word counts: abstract (247), text (3931), tables (6), figures (0), references (38)

Abstract

Background: Cervical cancer rates are higher in low-resourced countries than high, partly due to lower rates of screening. Incidence in Thailand is nearly three times higher than in the US (16.2 vs 6.5 age-standardized incidence), even with Thailand's universal health coverage, which includes screening, suggesting that alternative methods are needed to reduce the burden. We investigated barriers to screening, as well as acceptability of self-collection HPV testing as a primary form of cervical cancer screening among Buddhist and Muslim communities in Southern Thailand.

Methods: 267 women from the Buddhist district of Ranot and Muslim district of Na Thawi, Songkhla were recruited to complete a survey assessing knowledge and risk factors of HPV and cervical cancer. Participants were offered an HPV self-collection test with a follow-up survey assessing acceptability. Samples were processed at Prince of Songkhla University and results were returned to participants.

Results: 267 women participated in the study (132 Buddhist, 135 Muslim), 264 (99%) self-collecting. 98% reported comfort and ease, and >70% preferred it to doctor-facilitated cytology. The main predictor of prior screening was religion (92% Buddhist versus 73% Muslim reporting prior Pap). After adjustment with multivariate logistic models, Muslim women had an odds ratio of prior Pap of 0.30 compared to Buddhist (95% CI: 0.12-0.66).

Conclusions: Self-collection HPV testing was highly acceptable across religious groups, suggesting that it could be beneficial for cervical cancer reduction in this region. Likely, focus

should be put into educating all populations about the importance of screening to improve screening rates among Thai women.

ARTICLE SUMMARY

Strengths and limitations of this study

- The Songkhla region of Thailand has a relatively large number of Muslim people living in this region, making it an ideal location to study the differences between Buddhist and Muslim populations.
- Community health volunteers collected the data in participants' native languages and are familiar with the region and the patients.
- The assay used for HPV detection (Hybribio RT-PCR) is highly sensitive.
- All data was self-reported, so it is likely that there was some misreporting either due to social desirability or recall bias.
- Women testing in their own homes may have more testing anxiety in the absence of health care workers, causing lower acceptability of the test.

1. Introduction

Cervical cancer is one of the most common cancers in women in Thailand[1], with age-standardized incidence and mortality rates at 16.2 and 9.0 per 100,000 women[2], approximately three times higher than in the United States (6.5 and 1.9 die per 100,000, respectively[2]). This disparity is seen between low- and middle-income countries (LMICs) and high-income countries (HICs) around the world, and there has yet to be a sufficient intervention to eliminate this inequality. Currently, while cervical cancer is not even in the top 10 most common cancers in HICs, it is the second most common cancer among women in LMICs, where 80% of cervical cancer deaths occur.[3]

Cervical cancer is primarily caused by the human papillomavirus (HPV), a sexually transmitted infection that in most women clears on its own without the knowledge of the infected women.[4,5] However, in some women, infection persists and eventually may cause cervical cancer to develop. Cervical cancer development takes many years, thus allowing for effective screening, prevention, and treatment if detected early.[6]

Today, cervical cancer is considered a preventable disease, in large part due to the Papanicolaou test.[7] This type of cytology-based screening has significantly reduced rates of cervical cancer in HICs but has not had the same effect in LMICs.[8,9] This is likely due to lower accessibility to this type of testing, as well as issues with the actual testing in LMICs. Cytology-based screening requires both infrastructure and personnel to which many LMICs may not have access, as well as potentially multiple visits per patient.[9–11] Additionally, due to the inherent subjectivity of this type of test, particularly when samples are evaluated by technicians rather than by pathologists, there is generally low sensitivity in LMICs[12], causing many cases to be missed even if a sample is collected. Thus, many LMICs have moved to visual inspection with

acetic acid (VIA) in place of Pap screening. VIA can be performed with minimal infrastructure by a properly trained lay-person, and screening and treatment can be done in the same visit.[8,11,13,14] However, visual inspection is also subjective[15], women still need to attend a clinic to receive this test, and equipment needs to be available to perform the treatment.

HPV testing has been shown to be a valid cervical cancer screening modality, and some countries are now recommending it as a primary form of screening.[6,15] In particular, studies have shown that the use of primary HPV testing, as compared to cytology alone, significantly lowers the likelihood of the development of precancerous lesions among women undergoing cervical cancer screening, due to increased sensitivity and specificity of cytology testing when restricted to only those women who test positive for HPV.[16] In addition, some countries are beginning to implement self-collection HPV testing to increase accessibility to screening.[17] Women can test themselves, in their own home, by collecting a cervical sample using a provided swab.[18] If a woman tests positive for high-risk HPV, then she will need to access follow-up care at a clinic, however if the woman tests negative, she simply needs to be tested periodically (usually in 5-year increments). This can reduce the number of times that women need to travel to clinics for screening or follow-up care, which could eventually also reduce the burden on the health care system.

The rates of cervical cancer in Thailand have been declining since 2002[19–21], when a national cervical cancer screening program was implemented, aiming to screen all women between the ages of 35 and 60 at 5-year intervals. In 2004, the program added visual inspection with acetic acid to the already existing Pap smear program. The three public health insurances programs in Thailand cover the costs of cervical cancer screening in their benefits package.[1] However, the decline in cervical cancer has been slower than expected (cervical cancer is still the 2nd most

common cancer among women in Thailand, causing over 10% of new female cases in 2018[22]), thus calling for improvements in the current screening programs.[19] This is largely due to the lower than ideal uptake of cervical cancer screening: a survey conducted in 2009 estimated that only 59.7% of women in Thailand have ever been screened for cervical cancer.[1] Uptake is even lower among the minority Muslim population (making up only 5% of the country) as compared to the majority Buddhist population (94% of the population)[23] in Thailand (e.g. 46.7% vs 60.4% reporting ever having cervical cancer screening in the 2009 Health and Welfare Survey[1], respectively), perhaps due to reports of embarrassment and wanting to avoid uncovering parts of their bodies during exams, due to the high value that the Muslim religion places on modesty.[1] One previous study investigated the acceptability of self-collection HPV testing in women in Thailand. Acceptability was found to be quite high, but participants were worried about both the cost and the reliability of the results from this type of testing.[24,25] However, no previous studies have specifically looked at women from diverse ethnic groups in Thailand to determine whether HPV self-collection testing is more useful in certain populations than others.

In this study we investigated the differences in access and barriers to cervical cancer screening between Buddhist and Muslim women in Southern Thailand and examined potential screening predictors. We also assess willingness to use and acceptability of self-collection HPV testing methods in these communities.

2. Material and Methods

2.1 Study design and Sampling

The study was designed as a cross-sectional survey, with a maximum of one interaction per participant. Data collection took place in two districts within Songkhla Province of Southern

Thailand: Na Thawi, in the southern part of Songkhla Province, and Ranot, in the northern-most region. Each of these districts is fairly religiously homogenous, with Na Thawi and Ranot being predominantly Muslim and Buddhist, respectively. Women were recruited from lists of the target population for screening provided by reproductive health clinics in these districts, half located in Na Thawi and half in Ranot. The primary care centers made this list by randomly selecting from the entire female population in the province's health office database and then distributed 12-15 names to each health care volunteer, irrespective of the volunteer's religion. The volunteers then visited their assigned households and set up appointments with eligible women for screening at public primary care clinics. When women came into the clinics, they were asked by a community health worker whether they would like to participate in the study. If they said yes, they were consented and then enrolled, after which a survey was administered, and self-collection HPV testing was offered.

Recruitment took place from July-December in 2017. We aimed to recruit 130 women from each region, according to power calculations. Women had to be over the age of 18 to participate, and between the ages of 25 and 60 to participate in the self-collection sampling portion of the study. For the self-collection sampling, women were ineligible to participate if they were pregnant or menstruating, had a previous history of cervical cancer, or had previously had a hysterectomy.

2.2 Data collection tools

Data was collected using a 150-question survey that assessed sexual behavior and practices, known risk factors associated with HPV, and knowledge of HPV infection and its association with cervical cancer. The survey was developed using similar questions to prior studies of health

risk factors,[26,27] and was originally written in English and then translated into Thai by native Thai investigators from Prince of Songkhla University (PSU). This survey has also been translated into other languages for similar studies occurring in other countries.[18] Prior to data collection, the survey was piloted on 10 women, both Buddhist and Muslim, sampled randomly in the Singha Nakhon district. Data were collected using the Qualtrics survey application.[28] Study research assistants read the survey aloud to each participant and recorded her responses on a tablet. At the end of each day, survey responses were uploaded to a secure server.

Additionally, upon completion of the survey, eligible women were offered a self-collection cervical sample kit to be tested for HPV. The kit (HerSwab)[29] was manufactured by Eve Medical and has previously been shown to be acceptable among other populations.[18] If a woman chose to self-collect, the community health volunteer gave her the kit and an illustrated "Instructions-for-Use" card and explained the sampling procedure. Women then collected a sample in a private room and then returned the swab to the community health volunteer. Samples were transported to the Department of Biomedical Sciences at PSU following collection and stored until testing occurred.

2.3 Laboratory analysis

Samples were analyzed at the Department of Biomedical Sciences at PSU using a 13 High-risk HPV Real-time PCR kit (Hybribio Limited, Hong Kong), which detects HPV types 16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59, 68.[30] Positive and negative controls were included on each plate, and internal controls were evaluated for each sample. Results were provided to the community health centers in Na Thawi and Ranot, where the community health volunteers were able to coordinate follow-up care for participants. If the HPV results were positive, it was

suggested that they receive follow-up care (in the form of a Pap test) from their local health center, and if negative were told to repeat testing in 3 years.

2.4 Statistical analysis

As this is mainly a descriptive study to identify any differences in screening practices between two ethnic groups, all survey questions were examined. These variables were then grouped into 4 areas: demographics, sexual and general health, cervical cancer and HPV, and health care access. Additionally, we compared women who reported having prior cervical cancer screening to women who reported no prior screening, using the same variables mentioned above, with both univariate analyses and multivariate logistic models, adjusted for literacy, age, and number of children as a proxy for previous encounters with health care services. Finally, we investigated the acceptability of the self-collection test among women who were willing to use it by asking 4 questions after collection: "How comfortable was the test?", "How easy was the test?", "Are you willing to continue to take this test periodically in the future?" and "Do you prefer self-collection or Pap testing?".

We compared responses between Buddhist and Muslim women using two-sided t-tests and chi-squared tests for continuous and categorical variables, respectively. A similar procedure was used to compare women who had previously been screened for cervical cancer with those who had not. Multivariate logistic models were then run to examine potential predictors for prior screening, after adjusting for confounders. Finally, a descriptive analysis was conducted to assess acceptability of the self-swab test, where an $\alpha < 0.05$ was considered significant. All analyses were conducted using R version 3.4.4.

2.5 Patient and Public Involvement

Participants and the public were first involved at the design and piloting stages of the study. Research questions and outcome measures were developed using prior surveys assessing use of health care in other low- and middle-income settings[18] and direct feedback was received from clinic staff. During piloting, feedback was also received from participants and clinic workers. Patients at local health clinics were directly approached by study personnel inviting them to participate in the study and discussing the format and purpose of the study. While participants were not asked about the time required to participate in the research, the post-sampling survey explicitly asked participants about the acceptability and perceptions of self-sampling to assess the burden of the intervention being investigated. To disseminate study results to participants and the community, we plan to conduct educational and study dissemination sessions. These will be planned directly in collaboration with community-based clinic personnel and other representatives from the community.

2.6 Ethical approval

Ethical approval was granted by both the University of Michigan (HUM00114785) and the PSU Research Ethics Committee (REC 59-235-18-1). All participants were given oral and printed informed consent before participation. This consent was documented by signature from the participant on the consent form and all consent forms are filed in a locked cabinet at PSU.

3. Results

3.1 Demographics

267 women were recruited from the community health centers in the Ranot (n=132) and Na Thawi (n=135) districts of Songkla Province in southern Thailand. All 132 women from Ranot identified as Buddhist and all 135 from Na Thawi identified as Muslim. The average age of the Buddhist population was 51.3 years, while in the Muslim population it was 49.6 years. There were several statistically significant demographic differences between the Buddhist and Muslim women in the sampled population (Table 1). Buddhist women on average reported higher literacy (96% vs. 81%, $p < 0.001$) and education levels ($p = 0.003$). Additionally, Muslim women were more likely than Buddhist women to be in a common law relationship instead of marriage ($p < 0.001$). However, there were no statistically significant differences in income between the two populations.

Table 1. Demographics

Variable	**Total** **N = 267** *Prop (N)* *Mean (SD)*	**Buddhist** **N = 132** *Prop (N)* *Mean (SD)*	**Muslim** **N = 135** *Prop (N)* *Mean (SD)*	**P-value**
Age	50.44 (5.83)	51.27 (6.08)	49.63 (5.48)	0.02*
Literate	0.88 (236)	0.96 (127)	0.81 (109)	<0.001*
Education				0.003*
None	0.06 (15)	0.00 (0)	0.11 (15)	
Primary	0.67 (179)	0.71 (94)	0.63 (85)	
Secondary	0.18 (49)	0.18(24)	0.19 (25)	
Vocational	0.05 (13)	0.06 (8)	0.04 (5)	
Academic College	0.04 (11)	0.05 (6)	0.04 (5)	
Postgraduate	0.00 (0)	0.00 (0)	0.00 (0)	
Civil Status				
Single	0.00 (0)	0.00 (0)	0.00 (0)	<0.001*
Married	0.69 (184)	0.80 (106)	0.58 (78)	
Common Law	0.21 (55)	0.09 (12)	0.32 (43)	
Separated	0.01 (2)	0.02 (2)	0.00 (0)	
Divorced	0.04 (11)	0.04 (5)	0.04 (6)	
Widowed	0.04 (10)	0.02 (3)	0.05 (7)	
Marriage Age	21.26 (5.35)	22.85 (5.98)	19.72 (4.15)	<0.001*
Past Year Income (THB)				0.27
0 – 79,999	0.33 (78)	0.34 (39)	0.31 (39)	
80,000 – 119,999	0.28 (67)	0.31 (35)	0.25 (32)	
120,000 – 179,999	0.18 (44)	0.19 (22)	0.17 (22)	
180,000 or more	0.21 (51)	0.16 (18)	0.26 (33)	

3.2 Prior access to health care and barriers to screening

Buddhist and Muslim women appeared to access health care differently in these communities (Table 2). Buddhist women reported accessing more medical services and using health services more frequently than Muslim women. Notably, a higher percentage of Buddhist women reported prior Pap screening (92% vs 73% respectively, $p < 0.001$), as well as more recent screening, than Muslim women. Among women who have not been screened for cervical cancer, the most common reported reason for not screening among Buddhist women was no perceived health issues, and thus no reason to seek medical attention (40%), while for Muslim it was either a lack of knowledge that they should be screened or feelings of fear and embarrassment about screening (35% and 41% respectively). Additionally, Buddhist and Muslim women both reported that a doctor telling them they would need the test, and reduced cost of the test would be motivators to getting tested. Finally, Muslim women were less likely to use oral contraceptives (41% vs 67% respectively, $p < 0.001$).

Table 2. Sexual and health history

Variable	**Total** **N = 267** *Prop (N)* *Mean (SD)*	**Buddhist** **N = 132** *Prop (N)* *Mean (SD)*	**Muslim** **N = 135** *Prop (N)* *Mean (SD)*	**P-value**
Health Location				
University Hospital	0.27 (73)	0.34 (45)	0.21 (28)	0.047*
Primary Care Facility	0.99 (264)	1.00 (132)	0.98 (132)	1
Community Health Care Center	0.99 (263)	0.98 (130)	0.99 (133)	0.85
Other (Private Hospital, N = 2; Clinic, N = 83)	0.32 (85)	0.16 (21)	0.47 (64)	<0.001*
Last Health Visit				<0.001*
Less than a month	0.22 (59)	0.30 (40)	0.14 (19)	
1-3 months	0.25 (67)	0.28 (37)	0.22 (30)	
3-6 months	0.13 (35)	0.14 (18)	0.13 (17)	
6 mo-1 year	0.18 (48)	0.15 (20)	0.21 (28)	
1-5 years	0.14 (37)	0.09 (12)	0.19 (25)	
More than 5 years	0.05 (14)	0.01 (1)	0.10 (13)	
Never	0.03 (7)	0.03 (4)	0.02 (3)	
Use Healer	0.18 (49)	0.11 (14)	0.26 (35)	0.002*
Had Pap	0.82 (219)	0.92 (121)	0.73 (98)	<0.001*
Last Pap				0.007*
Less than 6 months	0.07 (16)	0.08 (10)	0.06 (6)	
Less than 1 year	0.30 (66)	0.37 (45)	0.21 (21)	
Less than 5 years	0.42 (91)	0.40 (49)	0.43 (42)	

More than 5 years	0.18 (40)	0.11 (13)	0.28 (27)	
Don't know	0.03 (6)	0.03 (4)	0.02 (2)	
Lifetime Paps				0.005*
1	0.19 (41)	0.12 (15)	0.27 (26)	
2	0.23 (51)	0.19 (23)	0.29 (28)	
3-4	0.39 (86)	0.45 (55)	0.32 (31)	
5 or more	0.18 (39)	0.21 (26)	0.13 (13)	
Don't know	0.01 (2)	0.02 (2)	0.00 (0)	
Main Reason No Pap				0.08*
None/ never thought of it	0.13 (6)	0.10 (1)	0.14 (5)	
Didn't know needed it	0.32 (15)	0.20 (2)	0.35 (13)	
Haven't had any problems	0.15 (7)	0.40 (4)	0.08 (3)	
Too expensive	0.00 (0)	0.00 (0)	0.00 (0)	
Too painful/embarrassing	0.36 (17)	0.20 (2)	0.41 (15)	
Other	0.04 (2)	0.10 (1)	0.03 (1)	
Doctor Motivation				<0.001*
Extremely Likely	0.60 (161)	0.73 (96)	0.48 (65)	
Very Likely	0.15 (40)	0.11 (14)	0.19 (26)	
Somewhat Likely	0.12 (32)	0.09 (12)	0.15 (20)	
Not Very Likely	0.11 (30)	0.08 (10)	0.15 (20)	
Don't know	0.01 (4)	0.00 (0)	0.03 (4)	
Payment Motivation				
Extremely Likely	0.51 (137)	0.64 (85)	0.39 (52)	<0.001*
Very Likely	0.21 (56)	0.17 (22)	0.25 (34)	
Somewhat Likely	0.15 (39)	0.11 (15)	0.18 (24)	
Not Very Likely	0.12 (31)	0.08 (10)	0.16 (21)	
Don't know	0.01 (4)	0.00 (0)	0.03 (4)	
Use Oral Contraceptive	0.54 (141)	0.67 (86)	0.41 (55)	<0.001*

3.3 Acceptability of self-collection

There was an almost universal acceptance of self-collection among this population (Table 3). Ninety-eight percent of women found the test both comfortable and easy, and 100% said they would be willing to continue to use this test as a preliminary form of cervical cancer screening. Both communities preferred self-swab to Pap testing, with higher preference in Muslim women (79% in Muslim vs 66% in Buddhist, p = 0.02). Among women who reported prior Pap testing, Buddhist women were more likely to prefer Pap and self-collection co-testing than Muslim women (33% vs 19%, respectively, p=0.05), while Muslim women were more likely to prefer self-swab alone (77% vs 64%, p = 0.05). Both Muslim and Buddhist women prefer testing to be

done in a medical setting, but Muslim women are more likely to prefer self-collection to doctor-collection (94% reporting preference for self-collection vs 77%) than Buddhist women.

Table 3. Acceptability of self-collection

Variable	**Total** **N = 267** *Prop (N)* *Mean (SD)*	**Buddhist** **N = 132** *Prop (N)* *Mean (SD)*	**Muslim** **N = 135** *Prop (N)* *Mean (SD)*	**P-value**
Self-Collected Sample	0.99 (264)	0.98 (130)	0.99 (134)	0.62
Comfort				1.00
Comfortable	0.98 (259)	0.98 (128)	0.97 (131)	
Neutral	0.02 (5)	0.02 (2)	0.02 (3)	
Uncomfortable	0.00 (0)	0.00 (0)	0.00 (0)	
Ease				1.00
Easy	0.98 (258)	0.98 (127)	0.97 (131)	
Neutral	0.02 (6)	0.02 (3)	0.02 (3)	
Difficult	0.00 (0)	0.00 (0)	0.00 (0)	
Willing to Retake	1.00 (264)	1.00 (130)	1.00 (134)	1.00
Preference[A]				0.05*
Self-swab kit	0.70 (153)	0.64 (78)	0.77 (75)	
Pap smear	0.03 (6)	0.02 (2)	0.04 (4)	
Both	0.27 (59)	0.33 (40)	0.19 (19)	
Neither	0.00 (1)	0.01 (1)	0.00 (0)	
Test Pref Location				<0.001*
At Home	0.18 (49)	0.04 (10)	0.15 (39)	
At Health care Center	0.82 (218)	0.96 (122)	0.85 (96)	
Test Pref Collector				<0.001*
My Health Personnel	0.14 (38)	0.23 (30)	0.06 (8)	
Myself	0.86 (225)	0.77 (100)	0.94 (125)	

[A] Among women who reported ever receiving a Pap test

3.4 hrHPV positivity

Nearly all of the participants chose to self-collect a sample to be tested for HPV (98% and 99% of Buddhist and Muslim women, respectively). The three women who did not self-collect had a sample collected by a physician, and thus we have HPV results for all 267 participants. Of these women, only 5% overall (N = 13) – 7% of all conclusive tests – tested positive for hrHPV: 5 Buddhist and 8 Muslim (no statistically significant differences between the two religious groups, shown in table 4).

Table 4. hrHPV test results

Variable	**Total** **N = 264** *Prop (N)*	**Buddhist** **N = 132** *Prop (N)*	**Muslim** **N = 135** *Prop (N)*	**P-value**

	Mean (SD)	*Mean (SD)*	*Mean (SD)*	
hrHPV status				0.71
Positive	0.049 (13)	0.039 (5)	0.059 (8)	
Negative	0.697 (184)	0.713 (92)	0.681 (92)	
Inconclusive	0.254 (67)	0.248 (32)	0.259 (35)	

3.5 Predictors of prior screening

Women who report ever being screened were more likely to be Buddhist than Muslim (55% vs 45%, $p < 0.001$), were on average of a higher education ($p = 0.03$) and literacy level (91% vs 74%, $p = 0.001$), had a later sexual debut (21.44 years vs 19.02 years, $p < 0.001$), married at an older age (21.74 years vs 19.02 years, $p < 0.001$), had higher utilization of health care and contraception, and had fewer pregnancies and children than those who report never being screened (Table 5). Additionally, those who reported ever screening had higher rates of knowledge of HPV than those who reported never screening (47% vs 30%, $p = 0.04$). Interestingly there does not appear to be a difference in age for those who report ever versus never screened, as generally older women (who have had more time to access screening) are more likely to have ever screened than younger women.

Ethnicity appears to be the main effect for likelihood to have previously accessed cervical cancer screening (shown in table 6), with Muslim women being significantly less likely to have had prior screening (OR = 0.22, 95% CI = 0.10, 0.45). Variables such as literacy levels, age, and number of children (as a proxy for prior experiences with health care services) could confound this relationship, however, multivariate logistic models showed that even after adjusting for relevant covariates, the association remained significant (OR = 0.30, 95% CI = 0.12, 0.66).

Table 5. Predictors of prior screening

Variable	**Prior Screen N = 219** *Prop (N)* *Mean (SD)*	**No Screen N = 47** *Prop (N)* *Mean (SD)*	**P-value**
Age	50.51 (5.84)	50.04 (5.90)	0.62
Ethnicity			<0.001*

Buddhist	0.55 (121)	0.21 (10)	
Muslim	0.45 (98)	0.79 (37)	
Education			0.03*
None	0.05 (10)	0.11 (5)	
Primary	0.64 (141)	0.79 (37)	
Secondary	0.20 (44)	0.11 (5)	
Vocational	0.06 (13)	0.00 (0)	
Academic College	0.05 (11)	0.00 (0)	
Postgraduate	0.00 (0)	0.00 (0)	
Past Year Income			0.41
0 – 79,999	0.34 (66)	0.29 (12)	
80,000 – 119,999	0.26 (52)	0.33 (14)	
120,000 – 179,999	0.17 (34)	0.24 (10)	
180,000 or more	0.23 (45)	0.14 (6)	
Lifetime Sexual Partners	1.20 (0.61)	1.13 (0.40)	0.34
Marriage Age	21.74 (5.63)	19.02 (3.00)	<0.001*
Literate	0.91 (200)	0.74 (35)	0.001*
Frequency of health visits			0.17
More than 1/week	0.00 (0)	0.00 (0)	
1/week	0.00 (1)	0.00 (0)	
1/month	0.13 (8)	0.06 (3)	
Every 3-6 months	0.46 (101)	0.34 (16)	
1/year	0.21 (47)	0.34 (16)	
Less than 1/year	0.19 (42)	0.26 (12)	
Breast Exam	0.24 (53)	0.09 (4)	0.02*
Mammogram	0.16 (9)	1.00 (4)	0.001*
Use Depo-Provera	0.48 (103)	0.40 (18)	0.41
Use birth control pill	0.56 (121)	0.42 (19)	0.10
Use condom	0.34 (73)	0.11 (5)	0.002*
Number Pregnancies	3.39 (1.72)	4.04 (2.06)	0.05*
Number of children	2.94 (1.38)	3.68 (1.72)	0.01*
Age at first pregnancy	23.69 (5.54)	21.23 (3.74)	<0.001*
Family member with CC	0.04 (8)	0.00 (0)	0.13
Age First Sex	21.44 (5.29)	19.02 (2.72)	<0.001*
Knowledge of HPV	0.47 (102)	0.30 (14)	0.04*

Table 6. Muslim ethnicity (versus Buddhist) as a predictor of prior cervical cancer screening

Model	Odds Ratio	95% Confidence Interval
Crude	0.22	0.10, 0.45
Adjusted[A]	0.30	0.12, 0.66

[A] Model adjusted for literacy, age, and number of children (as a proxy for previous encounters with health care services)

4. Discussion

Our study found hrHPV prevalence of 5%, which is significantly lower than rates of hrHPV seen in many other settings, but similar to studies that have been conducted in Thailand.[31]

Additionally, the findings from this study suggests significant differences in demographics, sexual and health history, and knowledge of HPV and cervical cancer between

Buddhist and Muslim women in Songkhla, Thailand. The results demonstrate the high potential and acceptability of self-collection HPV testing as a primary form of cervical cancer screening in these communities. Our results also suggest that, currently, some subpopulations in Thailand may have a more difficult time accessing health care than others despite the availability of high quality, universal health care. The Muslim women who participated in our study had lower levels of literacy and education than their Buddhist counterparts, both of which are documented barriers to health care accessibility.[1,32] Furthermore, Buddhist women utilized health care services and contraceptives more frequently and had higher rates of prior cervical cancer screening than Muslim women. This is likely because Muslim women report lower rates of knowledge of cervical cancer and higher rates of fear and embarrassment resulting from cervical cancer screening. This is consistent with past research that has shown that cultural differences, including language differences, lead to lower rates of access to health care among religious minorities in Thailand.[33–37] However, our study shows that self-screening is acceptable, and even preferred, in women from both religious groups to other modalities. While the majority of women still reported a preference for testing in a health care setting as opposed to in the home, they also preferred self-testing over doctor-testing. This highlights that it is important to assess not only the acceptability of self-sampling, but the preferred settings for different social groups. Self-collection HPV sampling could thus help mitigate the barriers to cervical cancer screening that Muslim women in Thailand encounter: it is private and can be done by a woman in her own home, thus reducing the embarrassment and fear associated with receiving a Pap at a doctor's office.

This study has many strengths that have allowed us to thoroughly investigate accessibility and acceptability of cervical cancer screening across different ethnic groups in southern

Thailand. The Songkhla region of Thailand is an ideal location to study the differences between Buddhist and Muslim populations, as there is a relatively large number of Muslim people living in this region. Additionally, the data was collected by community health volunteers who are familiar with the region, often know the patients personally and interact with them on a regular basis and speak the language fluently. We were also able to collect the data using the Qualtrics app on tablets, thus reducing the chance of data entry errors when moving from paper to computer databases. The self-collection swabs that we chose came with an "Instructions-for-Use" card that was translated into the participants' native language and there was always a research assistant available to answer questions and explain directions during collection, allowing for a better understanding of the collection method. Finally, the assay used for HPV detection (Hybribio RT-PCR) is highly sensitive. However, there are also limitations to this study. All data was self-reported, and since there were questions that were sensitive in nature, it is likely that there was some misreporting either due to social desirability or recall bias. Women may have overreported prior screening if they believed that was the "correct" behavior or they simply may not remember accurately when or if they had received this test. Number of sexual partners may be misreported for similar reasons. Additionally, since participation in the study occurred in health centers, we may not have a representative sample of the community if certain groups chose not to come to the clinics, although in general, health care utilization is high overall in Thailand.[38] Finally, since women performed the self-swab collection at the clinic, they may have a sense of confidence that there are health care workers nearby if anything were to go wrong. Women testing in their own homes may have more testing anxiety in the absence of health care workers.

This study provided data showing similar results to other HPV self-collection acceptability studies that have been conducted in Thailand and elsewhere. In our dataset, approximately 80% of women report having ever screened for cervical cancer; a similar percentage was found by Oranratanaphan.[24] Additionally, we found high rates of acceptability of this type of test, which has been shown by most self-collection studies in countries around the world, including Thailand. For example, Phoolcharoen et al and Oranratanaphan et al found that over 90% and over 80% of the women they asked to self-collect a cervical sample found the test both easy and comfortable, respectively[24,25], similar to what was seen in this study. However, here we show that although acceptability is high across religious groups, there may be some subtle differences to consider. In our study, Buddhist women, who report more access to health care and less fear and embarrassment of screening, were more likely to want both self-collection HPV tested as well as health care provider-administered cytology-based screenings (also known as co-testing), while Muslim women were much more likely to want only self-screening for HPV, potentially related to differing levels of trust in health care professionals between the groups. These results imply that tailored screening programs may be ideal for settings where there are distinct and differing barriers to screening in different groups of women, such as programs providing access to both HPV testing and Pap smears, with the option of self-collection if desired. Providing more accessible forms of screening to women who are not as likely to have access to traditional forms of screening could increase screening uptake, thus reducing the incidence of and mortality due to cervical cancer.

As this study was conducted exclusively in clinics, it still needs to be determined if self-collection HPV testing would function the same at the community level. Thus, a natural step would be to investigate the feasibility of a community-based self-collection HPV testing

program, where women receive swabs and collect samples at homes and then samples are transferred to labs for testing. This type of program could potentially greatly increase the rates of cervical cancer screening across certain communities.

However, improvement of screening alone will not improve health outcomes if women who receive abnormal results do not have access to follow-up care. Thus, it is vital to study linkage to treatment for those who screen positive.

4.1 Conclusions

HPV self-collection appears to be highly acceptable in these communities, with particularly high rates of preferability among Muslim women. Further work should be done to assess the impact and costs of cervical cancer programs including HPV testing and self-collection in Thailand. Due to the simplicity of testing and sensitivity of the assay, HPV self-collection sampling has the potential to improve screening across many different populations, complementing, or even replacing in some settings, our current methods for cervical cancer screening.

Authorship Contribution Statement

AG: Survey design, analysis design and execution, drafted the manuscript

TN: Data collection, survey design, manuscript review and approval

KZ: Study design, data collection, surveyor training, manuscript review and approval

MH: Study design, questionnaire design and implementation, manuscript review and approval

NC: Data collection, survey design, manuscript review and approval

SB: Data collection, survey design, manuscript review and approval

RN: Laboratory analysis, study design, manuscript review and approval

KN: Laboratory analysis, study design, manuscript review and approval

SV: Study design, questionnaire design and implementation, manuscript review and approval

LR: Study design, questionnaire design and implementation, analysis design, manuscript drafting and approval

HS: Study design, and supervision, questionnaire design and implementation, analysis design, stakeholder engagement, manuscript drafting and approval

RM: Study design and supervision, questionnaire design, analysis design, manuscript drafting and approval, obtained funding for the study

Data sharing statement

Extra data is available by emailing annagott@umich.edu.

Funding statement

We acknowledge funding from the University of Michigan School of Public Health (U-M SPH), the U-M SPH Office of Global Public Health, the U-M Center for South East Asian Studies, the U-M Global Cancer Initiative, and the Fogarty International Center (04R25TW009345). Research reported in this publication was also supported by the National Cancer Institutes of Health under Award Number P30CA046592. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Competing interest statement

There are no competing interests to declare.

References

1. Mukem S, Meng Q, Sriplung H, Tangcharoensathien V. Low Coverage and Disparities of Breast and Cervical Cancer Screening in Thai Women: Analysis of National Representative Household Surveys. *Asian Pac J Cancer Prev*. 2015;16(18):8541-8551.
2. International Agency for Research on Cancer. Global Cancer Observatory.
3. Griffiths M. Screening for cervical cancer in developing countries. *World Heal Organ*. 2002:984. doi:10.4103/0019-509X.64704
4. Walboomers JMM, Jacobs M V., Manos MM, et al. Human papillomavirus is a necessary cause of invasive cervical cancer worldwide. *J Pathol*. 1999;189(1):12-19. doi:10.1002/(SICI)1096-9896(199909)189:1<12::AID-PATH431>3.0.CO;2-F
5. Luciani S, Cabanes A, Prieto-Lara E, Gawryszewski V. Cervical and female breast cancers in the Americas: current situation and opportunities for action. *Bull World Health Organ*. 2013;91(9):640-649. doi:10.2471/BLT.12.116699
6. Vesco K, Whitlock E, Eder M, et al. Screening for Cervical Cancer : A Systematic Evidence Review for the U. S. Preventive Services Task Force. *AHRQ Publ*. 2011;11-05156-E(86):263. doi:AHRQ Publication No. 13-05194-EF-1
7. Fields MM. New cervical cancer screening guidelines: was the annual pap too much of a good thing? *J Adv Pract Oncol*. 2013;4(1):59-64. http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4093371&tool=pmcentrez&rendertype=abstract%5Cnhttp://www.clinicaladvisor.com/features/cervical-cancer-screening-obstetrics-gynecology/article/458991/2/.
8. Sahasrabuddhe V V., Parham GP, Mwanahamuntu MH, Vermund SH. Cervical cancer prevention in low- and middle-income countries: Feasible, affordable, essential. *Cancer Prev Res*. 2012;5(1):11-17. doi:10.1158/1940-6207.CAPR-11-0540
9. Sankaranarayanan R, Budukh AM, Rajkumar R. Effective screening programmes for cervical cancer in low- and middle-income developing countries. *Bull World Health Organ*. 2001;79(10):954-962. doi:10.1590/S0042-96862001001000009
10. Boggan JC, Walmer DK, Henderson G, et al. Vaginal Self-Sampling for Human Papillomavirus Infection as a Primary Cervical Cancer Screening Tool in a Haitian Population. *Sex Transm Dis*. 2015;42(11):655-659. doi:10.1097/OLQ.0000000000000345
11. Ditzian L, David-West G, Maza M, Hartmann B, Shirazian T, Cremer M. Cervical Cancer Screening in Low- and Middle-Income Countries. *Mt Sinai J Med*. 2011;78(53):319-326. doi:10.1002/MSJ
12. Barut MU, Kale A, Kuyumcuoglu U, et al. Analysis of Sensitivity , Specificity , and Positive and Negative Predictive Values of Smear and Colposcopy in Diagnosis of Premalignant and Malignant Cervical Lesions. *Med Sci Monit*. 2015;21:3860-3867. doi:10.12659/MSM.895227
13. Nahar K, Nessa A, Shamim S, Nasrin B, Hossain F, Begum N. Role of VIA in cervical cancer screening in low-resource countries. *Mymensingh Med J*. 2011;20(3):528.
14. African Population and Health Research Center, International Agency for Research on Cancer WHO. Prevention of cervical cancer through screening using visual inspection with acetic acid (VIA) and treatment with cryotherapy. A demonstration project in six African countries: Malawi, Madagascar, Nigeria, Uganda, the United Republic of Tanzania, and Za. *Int Agency Res Cancer*. 2012:33. http://www.who.int/reproductivehealth/publications/cancers/9789241503860/en/.
15. Moses E, Pedersen HN, Mitchell SM, et al. Uptake of community-based, self-collected

HPV testing vs. visual inspection with acetic acid for cervical cancer screening in Kampala, Uganda: Preliminary results of a randomised controlled trial. *Trop Med Int Heal*. 2015;20(10):1355-1367. doi:10.1111/tmi.12549

16. Ogilvie GS, Krajden M, van Niekerk D, et al. HPV for cervical cancer screening (HPV FOCAL): Complete Round 1 results of a randomized trial comparing HPV-based primary screening to liquid-based cytology for cervical cancer. *Int J Cancer*. 2017;140(2):440-448. doi:10.1002/ijc.30454
17. Chuang LT, Randall TC, Karlan BY. Efforts towards erasing borders in gynecologic cancer? *Gynecol Oncol Reports*. 2017;21(May):5-6. doi:10.1016/j.gore.2017.05.002
18. Gottschlich A, Rivera-Andrade A, Grajeda E, Alvarez C, Montano CM, Meza R. Acceptability of Human Papillomavirus Self-Sampling for Cervical Cancer Screening in an Indigenous Community in Guatemala. *J Glob Oncol*. 2017:JGO.2016.005629. doi:10.1200/JGO.2016.005629
19. Sriplung H, Singkham P, Iamsirithaworn S, Jiraphongsa C, Bilheem S. Success of a Cervical Cancer Screening Program: Trends in Incidence in Songkhla, Southern Thailand, 1989-2010, and Prediction of Future Incidences to 2030. *Asian Pacific J Cancer Prev*. 2014;15(22):10003-10008. doi:10.7314/APJCP.2014.15.22.10003
20. Virani S, Sriplung H, Bilheem S, et al. Effect of the national screening program on malignancy status of cervical cancer in Northern Thailand. *Int J Public Health*. 2018;63(3):377-385. doi:10.1007/s00038-018-1077-7
21. Virani S, Bilheem S, Chansaard W, et al. National and Subnational Population-Based Incidence of Cancer in Thailand : Assessing Cancers with the Highest Burdens. *Cancers (Basel)*. 2017;9(108). doi:10.3390/cancers9080108
22. Globocan. Thailand Cancer Fact Sheet. *Int Agency Res Cancer*. 2018.
23. Bureau of Democracy Human Rights and Labor. International Religious Freedom Report 2005. US Department of State.
24. Oranratanaphan S, Termrungruanglert W, Khemapech N. Acceptability of Self-Sampling HPV Testing Among Thai Women for Cervical Cancer Screening. *Asian Pacific J cancer Prev APJCP*. 2014;15(17):7437-7441. doi:10.7314/APJCP.2014.15.17.7437
25. Phoolcharoen N, Kantathavorn N, Krisorakun W, Taepisitpong C, Krongthong W, Saeloo S. Acceptability of Self-Sample Human Papillomavirus Testing Among Thai Women Visiting a Colposcopy Clinic. *J Community Health*. 2018;43(3):611-615. doi:10.1007/s10900-017-0460-2
26. Staff U. UNC Family Health Study Survey. 2010.
27. Organizacion Mundial de Salud. *Manual de Vigilancia STEPS de La OMS: El Método STEPwise de La OMS Para La Vigilancia de Los Factores de Riesgo de Las Enfermedades Crónicas*.; 2006. http://goo.gl/06Th0Y.
28. Qualtrics Software. Qualtrics. Provo, Utah, USA.
29. Herswab Fact Page. Eve Medical Inc. http://www.eve-medical.com/. Accessed September 4, 2017.
30. Hybribio. 13 High-risk HPV Real-time PCR Kit 2017.
31. Sukvirach S, Smith JS, Tunsakul S, et al. Population-Based Human Papillomavirus Prevalence in Lampang and Songkla , Thailand. *J Infect Dis*. 2003;187:1246-1256.
32. Sudore RL, Mehta KM, Simonsick EM, et al. Limited literacy in older people and disparities in health and healthcare access. *J Am Geriatr Soc*. 2006;54(5):770-776. doi:10.1111/j.1532-5415.2006.00691.x

33. Alvarez C, Rozek L, Sriplung H. Differences in prostate tumor characteristics and survival among religious groups in southern Thailand. *Cancer Res*. 2017;77(13 Supplement 1):1-9. doi:http://dx.doi.org/10.1158/1538-7445.AM2017-3272
34. Che Y, You J, Zhou S, et al. Comparison of survival rates between Chinese and thai patients with breast cancer. *Asian Pacific J Cancer Prev*. 2014;15(15):6029-6033. doi:10.7314/APJCP.2014.15.15.6029
35. Kerdpon D, Sriplung H. Factors related to advanced stage oral squamous cell carcinoma in southern Thailand. *Oral Oncol*. 2001;37(3):216-221. doi:10.1016/S1368-8375(00)00067-1
36. Khwankong S, Sriplung H, Kerdpon D. Knowledge and Health Belief Attitudes of Oral Cancer and Its Screening Among At-Risk Southern Thai Muslims. *J Cancer Educ*. 2018;33(3):615-621. doi:10.1007/s13187-016-1150-y
37. Muangpaisan T, Sriplung H. Social and geographic predictors of cancer survival: A role for a population-based cancer registry in cancer control. *Asian Pacific J Cancer Prev*. 2000;1(4):319-323.
38. Internal Labour Office SPD. *Thailand: Universal Health-Care Coverage Scheme*.; 2016.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	7
Methods			
Study design	4	Present key elements of study design early in the paper	8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	9
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	10
Bias	9	Describe any efforts to address potential sources of bias	8
Study size	10	Explain how the study size was arrived at	9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	10
		(*b*) Describe any methods used to examine subgroups and interactions	na
		(*c*) Explain how missing data were addressed	na
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	na
		(*e*) Describe any sensitivity analyses	na
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	12
		(b) Give reasons for non-participation at each stage	na
		(c) Consider use of a flow diagram	na
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	12
		(b) Indicate number of participants with missing data for each variable of interest	12
Outcome data	15*	Report numbers of outcome events or summary measures	15
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	17

		(*b*) Report category boundaries when continuous variables were categorized	na
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	na
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	na
Discussion			
Key results	18	Summarise key results with reference to study objectives	18
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	19
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	21
Generalisability	21	Discuss the generalisability (external validity) of the study results	21
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	21

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.