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The impact of a health education program on cervical cancer screening uptake: A survey among primary school teachers in Phnom Penh, Cambodia

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Abstract: This study aimed to evaluate the impact of a health education intervention on women's cervical cancer screening uptake. It was conducted using data from the collaborative project by the Cambodian Society of Gynecology and Obstetrics and the Japan Society of Obstetrics and Gynecology to improve cervical cancer services in Cambodia. A prospective observational study was conducted from August 2022 to May 2023, involving 1,538 female teachers from 80 public primary schools in Phnom Penh, Cambodia. A total of 815 participants (intervention group [n = 355] and control group [n = 460]) were eligible for analysis. The intervention group received a tailored health education program and an invitation to register for free cervical cancer screening, while the control group only received the invitation to screening. The intervention group demonstrated a significantly higher screening registration (32.1% *vs.* 18.8%, $p < 0.001$) and uptake (24.1% *vs.* 12.7%, $p < 0.001$) than the control group. When comparing changes in knowledge and attitude between baseline and endline assessments, the intervention group showed a notable improvement in knowledge regarding the causes, symptoms, prevention, and benefits of early detection of cervical cancer. For instance, the proportion of women who recognized human papillomavirus as the cause of cervical cancer significantly increased in the intervention group (baseline: 23.7%, endline: 57.5%, $p < 0.001$), while no significant change was observed in the control group (baseline: 24.4%, endline: 29.1%, $p = 0.101$). In conclusion, the health education program effectively increased cervical cancer screening uptake, knowledge and attitude on cervical cancer. Further improvements in screening uptake may require educational interventions that influence individual health behaviors and systematic encouragement for screening participation.

***Keywords*:** health education, cervical cancer screening, uterine cervical neoplasms, early detection of cancer, Cambodia

Introduction

Cervical cancer is caused by persistent infection with high-risk human papillomavirus (HPV) and is largely preventable with HPV vaccination and screening linked to treatment (*1*). Cervical cancer is the fourth most common cancer in women worldwide, with an estimated 660,000 new cases and 350,000 deaths in 2022. Its incidence and mortality rates are high in low- and middle-income countries as compared with high income countries. The World Health Organization (WHO) reported that this reflects wide disparities due to lack of access to national HPV vaccination, cervical screening and treatment services, and social- and economic-related factors (*2*).

In Cambodia, cervical cancer continues to be the second most common cancer in women with high mortality as most cases are diagnosed at an advanced stage (*3,4*). The estimated age-standardized incidence rate is 15.2 per 100,000 women, and the mortality rate

is 8.1 per 100,000 women in 2022 (*3*). In accordance with the global initiative to eliminate cervical cancer, the Cambodian Ministry of Health is strengthening cervical cancer control, as evidenced by the recent introduction of HPV vaccine into the National Immunization Program for 9-year-old girls in October 2023. The number of health centers offering cervical cancer screening using visual inspection with acetic acid has also increased in all provinces. A population-based survey suggests that the uptake of cervical cancer screening in women aged 30-49 years has slightly increased from 14.7% in 2016 to 20.3% in 2023 (*5,6*). Nevertheless, the rate is far from the global target of 70% (*7*), with the potential reasons including lack of awareness about cervical cancer, low recognition of the concept of cancer prevention and its measures, and limited recommendations from health professionals (*8*).

WHO defines health education as "any combination of learning experiences designed to help individuals and communities improve their health by increasing knowledge, influencing motivation and improving health literacy", and a variety of health education approaches have been reported to improve access to cervical cancer screening in national populations from a range of cultural and economic backgrounds (*9*). A systematic review of seven randomized control trials in 2017 showed that cervical cancer education increased cervical cancer screening rates by more than two-fold (odds ratio: 2.46, 95% confidence interval: 1.88-3.21) (*10*). Another systematic review of 37 articles including quasi-experimental studies concluded that different health education methods such as phone calls, letters, lectures, group discussions, and brochures, used alone or in combination, are effective in modifying cervical cancer screening behavior (*11*).

In Cambodia, previous articles about educational intervention for cervical cancer screening are limited to practice reports, and none have quantitatively examined the effect of health education on women's cervical cancer screening uptake (*12,13*). Between 2019 and 2024, a collaborative project by the Cambodian Society of Gynecology and Obstetrics (SCGO) and the Japan Society of Obstetrics and Gynecology (JSOG) was conducted to improve the quality of cervical cancer services, including health education, screening, and treatment, by targeting female primary school teachers in Phnom Penh city, the capital of Cambodia. Primary school teachers were set as the target because they are potential key influencers of HPV vaccination at schools (*14*). As a part of this project, we developed a tailored health education program.

This study aimed to evaluate the impact of this health education program on cervical cancer screening test uptake. We also examined the changes in the women's knowledge and attitude about cervical cancer before and after the health education program. The findings of this study could help improve future approaches to the national cervical cancer control program.

Participants and Methods

Study design

A multi-institutional, prospective observational study. This study was conducted using data from the aforementioned project in Phnom Penh City, the capital of Cambodia.

Participants

The project site, Phnom Penh city, contained 157 primary schools with 4,094 primary school teachers, of whom 2,935 were women, under 14 district education offices in 2022. The project defined the number of beneficiaries as half of all female teachers at the project site due to budget limitations and feasibility. Therefore, we randomly selected half of all schools as the target schools and invited all female teachers in those schools to participate in this study and those who agreed to participate were included. For cervical cancer screening, we limited women to those aged 30 years old and above and who ever had sexual contact.

Randomization

The unit of randomization was primary school. Random sequence numbers were generated using Excel software. First, half of the schools under each district education office were randomly selected as target schools using the generated random numbers. Then, the selected 80 target schools were again allocated by simple randomization to the intervention group or control group. This random allocation was conducted by a Japanese researcher blind to the group assignment and was concealed from the school representatives, as the control group were also given the opportunity to receive the same health education program after completion of the trial.

Intervention

The educational materials of the program (*i.e.*, PowerPoint lecture slide and booklet) were developed by the SCGO and JSOG based on the results of a small telephone interview survey conducted prior to study initiation (*8*). These included epidemiology of cervical cancer in Cambodia, female anatomy, what cervical cancer is (cause, risk factors, signs and symptoms, prevention methods, treatment, benefits of early detection), available sites for screening, and the cost was free of charge. In addition, information was provided on what to do when the screening result is positive or negative actions taken in case of positive and negative screening results. To ensure that the health education materials were understandable and

actionable, we piloted their use among 30 female primary school teachers in cooperation with the Phnom Penh Municipality Department of Education, Youth and Sports (PPMDoEYS) using a checklist made based on the Patient Education Materials Assessment Tool (*15*).

The health education program was then designed in consultation with PPMDoEYS. It included a 30-minute PowerPoint-based lecture by a gynecologist member of the SCGO along with an information booklet on cervical cancer and screening, 30 minutes of group work on key questions around cervical cancer screening, and a 20-minute question and answer session, which altogether lasted for 2 hours, including a recess. The program was conducted four times over two days, during which the teachers in the intervention group could attend any time between their teaching responsibilities (approximately 200 women per time). The women were then given the booklet on cervical cancer and screening to read at home.

Baseline and endline questionnaire

A questionnaire was used to evaluate knowledge, attitude, and practice (KAP) on cervical cancer. It was developed by the authors in English based on previous studies (*16,17*). This English original was translated into the local language, then back-translated into English to check for consistency, and the final version of the questionnaire was piloted on some teachers (Supplemental File, *https://www.ghmopen.com/site/supplementaldata.html?ID=99*). The questions on knowledge asked about the cause, symptoms, prevention methods, and benefits of early detection in single or multiple-choice formats. For attitudes, the perception of cervical cancer was measured using a five-point Likert scale, where 5 indicated "strongly agree" and 1 indicated "strongly disagree". The practice question asked experience of receiving cervical cancer screening and its reason.

Study procedure

First, the researchers informed the principal collaborator (*i.e.*, PPMDoEYS) who notified school representatives of the detailed steps of the study process separately for intervention and control clusters to minimization contamination. As a gender consideration, we involved school directors, who are mostly male, to collaborate as facilitators to make it easier for the female teachers to participate in the health education and screening.

At the baseline measurement, all women in the target schools were asked to provide informed consent, and those who agreed to participate in this study were asked to complete either an online or paper-based KAP questionnaire. Then, women in the control group were invited to register for a free cervical cancer screening using an HPV-test at one of the three trained hospitals in the city. Invitations were made through announcement boards for teachers at each school and through existing communication systems (*e.g.*, letter, phone call, instant messaging group app) connecting the primary education office of PPMDoEYS, district education offices, and each school director. Eligible women who opted for a screening test registered online or by phone call and were notified by a research staff member of possible date, time, and location for the test.

Subsequently, women in the intervention group were given the intervention (*i.e.*, health education program) and one week later were invited to register and undergo cervical cancer screening in the same manner as the control group. Three months after completion of the health education program for the intervention group, all women in both groups were asked to complete the same questionnaire used in the baseline survey. The baseline and endline surveys were conducted in September 2022 and May 2023, respectively, with the period between the baseline survey and the endline survey being nine months.

Outcomes

Primary outcomes were cervical cancer screening test registration and uptake. Secondary outcomes were changes in knowledge and attitude about cervical cancer.

Statistical analysis

All data from the baseline survey, cervical cancer screening registration, attendance, and endline survey were linked and compiled in a Microsoft Excel spreadsheet. Data analysis was performed using STATA SE16 software (Stata Corporation, College Station, TX, USA). Baseline characteristics of the participants, primary outcomes, and secondary outcomes between the intervention group and control group, or baseline and end line data were compared using chi-square, Fisher's exact, McNemar's, Wilcoxon matched-pairs signed-rank, and Student *t*- tests, depending on the type and distribution of the data. Statistical significance was set at $p < 0.05$.

Ethical considerations

The study protocol was approved by the Cambodia National Ethics Committee for Health (183 NECHR) and the ethical committees of the National Center for Global Health and Medicine, Japan (NCGM-S-004516-00). Written informed consent was obtained from all participants.

Results

Participants

The flow diagram of participants is shown in (Figure 1). Eighty primary schools were randomly selected across 14 district education offices in Phnom Penh city,

of which 41 schools were allocated to the control group and 39 schools to the intervention group. Among 1,538 women in target schools, 988 (control group [*n* = 542] and intervention group [*n* = 446]) agreed to participate in the study and completed the baseline survey. After nine months, 815 women (control group [*n* = 460, 84.9%] and intervention group [*n* = 355, 79.6%]), completed the endline survey.

Baseline characteristics of participants

Among the 815 participants eligible for analysis, 782 were aged 30 years old and above. As shown in Table 1, of the total analyzed, 85.3% (*n* = 695) of participants were married, 68.5% (*n* = 558) had graduated from high school or higher, and 96.1% (*n* = 783) were full-time employees. Despite the random allocation, there were differences in age, history of pregnancy, and number of children, all of which were significantly lower in the intervention group. Mean participant age was 46.6 (± 7.8) years in the control group and 44.8 (± 7.8) years in the intervention group. The proportion of women ever being pregnant was 90.9% (*n* = 418) in the control group and 85.6% (*n* = 304) in the intervention group. The proportion of women having one or more children was 91.1% (*n* = 419) in the control group and 86.8% (*n* = 308) in the intervention group. Other baseline characteristics were comparable between the two groups.

Cervical cancer screening test registration and uptake

Table 2 presents the numbers and proportions of the 782 women aged 30 years old and above who registered for and underwent a screening test. Both registration (32.1% *vs.* 18.8%, $p < 0.001$) and uptake (24.1% *vs.* 12.7%, $p < 0.001$) were significantly higher in the intervention group compared to the control group.

The reasons for those who registered but did not take the screening test were menstruation, pregnancy, illness, side effects of the COVID-19 vaccine, and not finding a place to undergo the screening.

Changes in knowledge and attitude on cervical cancer

Table 3 shows knowledge and attitude on cervical cancer at baseline and endline for the control and intervention groups. At baseline, there were no significant differences in knowledge and attitude between intervention and control groups, except for one question on attitude, "Screening helps prevent cervical cancer", which showed borderline significance ($p = 0.0504$).

The percentage of women who were aware of HPV being the cause of cervical cancer increased significantly in the intervention group (baseline 23.7%, endline 57.5%, $p < 0.001$) but not significantly so in the control group (baseline 24.4%, endline 29.1%, $p = 0.101$). Despite this improvement, 32.7% (*n* = 116) of the women in the intervention group still selected incorrect answers in the endline questionnaire, including poor genital hygiene 22.5% (*n* = 80), chemicals in food 5.1% (*n* = 18), and frequent abortions 5.1% (*n* = 18).

For the question on symptoms suggestive of cervical cancer, at baseline, one-third of the women selected "Do not know" (control 38.5%, intervention 33.0%) and "Itching of the vagina" (control 30.0%, intervention 33.8%). However, at the endline, the proportion of women who chose the correct answers significantly increased in the intervention group ("Bleeding from vagina after sexual contact" (baseline 13.0%, endline 28.5%, $p < 0.0001$), "Bleeding from vagina between menstrual cycle or after menopause" (baseline 15.5%, endline 27.6%, $p = 0.0001$), and "Discharge from vagina that smells bad" (baseline 21.7%, endline 31.8%, $p = 0.0014$).

Most women had good knowledge about the two prevention methods at baseline, although recognition was

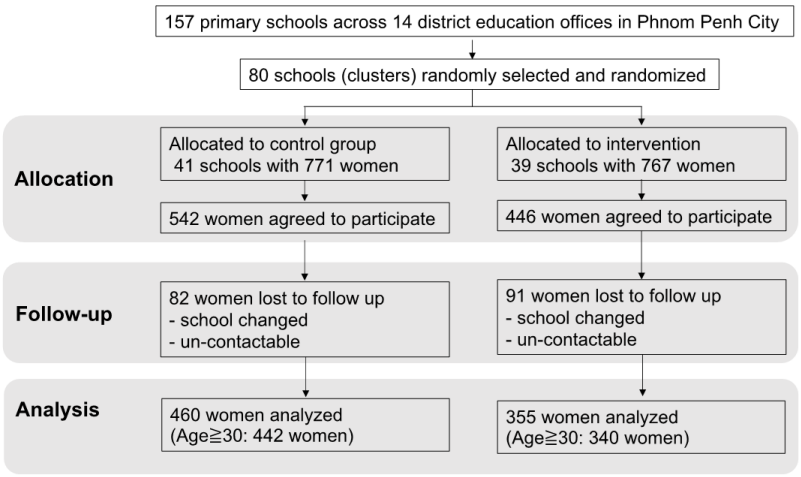

Figure 1. Flow diagram of participants.

Table 1. Baseline characteristics of the participants

Variable	Total *n* = 815 *n* (%)	Control *n* = 460 *n* (%)	Intervention *n* = 355 *n* (%)	*p* value
Age (years), mean ± SD	45.8 ± 7.9	46.6 ± 7.8	44.8 ± 7.8	0.002[a]
≤ 29	33 (4.1)	18 (3.9)	15 (4.2)	
30-39	117 (14.4)	51 (11.1)	66 (18.6)	
40-49	342 (42.0)	190 (41.3)	152 (42.8)	
50-59	323 (39.6)	201 (43.7)	122 (34.4)	
> 59	0	0	0	
Highest level of school attended				
Secondary school	257 (31.5)	133 (28.9)	124 (34.9)	0.064[b]
High school	432 (53.0)	246 (53.5)	186 (52.4)	
College or higher	126 (15.5)	81 (17.6)	45 (12.7)	
Others	0 (0)	0 (0)	0 (0)	
Employment status				
Employee (full-time)	783 (96.1)	443 (96.3)	340 (95.8)	0.914[b]
Employee (part-time)	9 (1.1)	5 (1.1)	4 (1.1)	
Others	23 (2.8)	12 (2.6)	11 (3.1)	
Marital status				
Married	695 (85.3)	389 (84.6)	306 (86.2)	0.330[b]
Single	50 (6.1)	26 (5.7)	24 (6.8)	
Divorced or widowed	70 (8.6)	45 (9.8)	25 (7.0)	
Ever pregnant				
Yes	722 (88.6)	418 (90.9)	304 (85.6)	0.020[b]
No	93 (11.4)	42 (9.1)	51 (14.4)	
Number of children				
0	88 (10.8)	41 (8.9)	47 (13.2)	0.033[b]
≧1	727 (89.2)	419 (91.1)	308 (86.8)	

[a]*t*-test; [b]Chi-square test.

Table 2. Cervical cancer screening registration and uptake (Women aged 30 years and above)

Variable	Total *n* = 782 *n* (%)	Control *n* = 442 *n* (%)	Intervention *n* = 340 *n* (%)	*p* values (Chi-square test)
Registration for a screening test	192 (24.6)	83 (18.8)	109 (32.1)	< 0.001
Screening test uptake	138 (17.7)	56 (12.7)	82 (24.1)	< 0.001

higher for HPV vaccination (control 60.9%, intervention 64.8%) than for screening (control 43.9%, intervention 41.4%). At endline, women who selected HPV vaccination significantly increased in both groups (control group [baseline 60.9%, endline 70.4%, $p = 0.0011$] and intervention group [baseline 64.8%, endline 75.5%, $p = 0.0012$]). However, the women who selected screening as a preventive method at endline increased significantly only in the intervention group (baseline 41.4%, endline 54.7%, $p = 0.0001$).

The proportion of women who thought that cervical cancer could be cured if found early increased significantly in the intervention group (baseline 87.3%, endline 94.9%, $p < 0.001$), whereas it did not in the control group (baseline 85.0%, endline 86.7%, $p = 0.732$).

Attitude scores were basically high at baseline in both groups. Of the four questions, the mean score for the question "Do you think you have a chance of getting cervical cancer?" increased significantly at endline in the intervention group (baseline 3.58 ± 1.11, endline 3.79 ± 0.90, $p = 0.0044$) but not in the control group (baseline 3.57 ± 1.10, endline 3.64 ± 0.90, $p = 0.5846$). The scores of women who answered positively to "Do you think cervical cancer is a serious disease?" and "Do you think screening helps to prevent cervical cancer?" were significantly increased in the control group only at endline. The score for "Do you think it is helpful for you to detect early cervical cancer?" was increased in both groups at endline.

Reasons for not attending cervical cancer screening

Table 4 shows the reasons for those who answered "No" to the question "Have you ever had a screening for cervical cancer?" at baseline and endline. The reasons given in the control and intervention groups also were compared at endline.

Most women in both groups cited being healthy as the reason at baseline. However, the proportion of women who cited this reason significantly decreased in the intervention group (baseline 36.8%, endline 26.2%, $p = 0.025$), whereas it did not in the control group (baseline

Table 3. Difference in knowledge and attitude on cervical cancer over time

Variable	Control (n = 460)			Intervention (n = 355)		
	Baseline n (%)	End line n (%)	p values	Baseline n (%)	End line n (%)	p values
Knowledge: cause of cervical cancer (single-choice)			0.101			< 0.001[a]
Human papillomavirus *(correct)*	112 (24.4)	134 (29.1)		84 (23.7)	204 (57.5)	
Poor genital hygiene *(incorrect)*	174 (37.8)	108 (23.5)		132 (37.2)	80 (22.5)	
Chemicals in food *(incorrect)*	35 (7.6)	33 (7.2)		44 (12.4)	18 (5.1)	
Frequent abortion *(incorrect)*	46 (10.0)	34 (7.4)		30 (8.5)	18 (5.1)	
Other than above *(incorrect)*	0 (0)	3 (0.65)		2 (0.56)	0 (0)	
Do not know	93 (20.2)	148 (32.2)		63 (17.7)	35 (9.9)	
Knowledge: symptom of cervical cancer (multiple-choice)						
Bleeding from vagina after sexual contact *(correct)*	56 (12.2)	73 (15.9)	0.125[b]	46 (13.0)	101 (28.5)	< 0.0001[b]
Bleeding from vagina between menstrual cycle or after menopause *(correct)*	78 (17.0)	73 (15.9)	0.719[b]	55 (15.5)	98 (27.6)	0.0001[b]
Discharge from vagina that smells bad *(correct)*	79 (17.2)	100 (21.7)	0.085[b]	77 (21.7)	113 (31.8)	0.0014[b]
Itching of vagina *(incorrect)*	138 (30.0)	72 (15.7)	< 0.0001[b]	120 (33.8)	86 (24.2)	0.0020[b]
Do not know	177 (38.5)	205 (44.6)	0.045[b]	117 (33.0)	62 (17.5)	< 0.0001[b]
Knowledge: prevention methods (multiple-choice)						
Get HPV vaccination when you are young *(correct)*	280 (60.9)	324 (70.4)	0.0011[b]	230 (64.8)	268 (75.5)	0.0012[b]
Get HPV vaccination when you are 30 years old and above *(incorrect)*	78 (17.0)	74 (16.1)	0.7644[b]	52 (14.7)	50 (14.1)	0.9179[b]
Visit a health facility regularly and get screened when you are 30 years old and above *(correct)*	202 (43.9)	187 (40.7)	0.3185[b]	147 (41.4)	194 (54.7)	0.0001[b]
Visit a health facility when you feel very sick or a lot of bleeding from vagina *(incorrect)*	62 (13.5)	47 (10.2)	0.1374[b]	48 (13.5)	36 (10.1)	0.1753[b]
Eat healthy food *(incorrect)*	56 (12.2)	44 (9.6)	0.2067[b]	38 (10.7)	31 (8.7)	0.4270[b]
Keep genital hygiene *(incorrect)*	127 (27.6)	93 (20.2)	0.0054[b]	103 (29.0)	83 (23.4)	0.0978[b]
Do not know	63 (13.7)	49 (10.7)	0.1750[b]	38 (10.7)	13 (3.7)	0.0001[b]
Knowledge: benefit of early detection (single-choice)						
Cervical cancer be cured if found early (one)						
True	391 (85.0)	399 (86.7)	0.732[a]	310 (87.3)	337 (94.9)	< 0.001[a]
False	10 (2.2)	8 (1.7)		6 (1.7)	6 (1.7)	
Do not know	59 (12.8)	53 (11.5)		39 (11.0)	12 (3.4)	
Attitude (scale from 1 to 5) Meman ± SD						
Do you think you have a chance of getting cervical cancer?	3.57 ± 1.10	3.64 ± 0.90	0.5846[c]	3.58 ± 1.11	3.79 ± 0.90	0.0044[c]
Do you think cervical cancer is a serious disease?	4.30 ± 0.95	4.47 ± 0.76	0.0050[c]	4.32 ± 0.90	4.34 ± 0.79	0.8775[c]
Do you think it is helpful for you to detect cervical cancer early?	4.39 ± 0.86	4.55 ± 0.65	0.0059[c]	4.45 ± 0.81	4.65 ± 0.52	0.0005[c]
Do you think screening helps to prevent cervical cancer?	4.05 ± 0.97	4.23 ± 0.77	0.0092[c]	4.18 ± 0.92	4.30 ± 0.74	0.1588[c]

[a]Chi-square test; [b]McNemar's test; [c]Wilcoxon matched-pairs signed-rank test.

41.4%, endline 39.9%, p = 0.784). The second most common reason for not having been screened was feeling shy. The proportion of women who gave this reason increased significantly in the control group (baseline 20.0%, endline 28.3%, p = 0.025). It also increased in the intervention group although not significantly so (baseline 25.0%, endline 33.1%, p = 0.077).

When comparing the reasons at endline between the control group and intervention group, the proportion of women who answered "I am healthy" was significantly lower in the intervention group than in the control group (control 39.9%, intervention 26.2%, p = 0.003). However, the proportion of women who answered "I feel shy" remained unchanged (control 28.3%, intervention 33.1%, p = 0.284).

Discussion

This study evaluated the impact of a health education intervention on cervical cancer screening uptake among female primary school teachers in Phnom Penh, Cambodia. Results showed that our health education program, which included a lecture by a physician, peer group discussion, and question-and-answer session, nearly doubled cervical cancer screening test uptake. It also led to a notable improvement in knowledge regarding causes, symptoms, prevention, and benefits of early detection of cervical cancer.

To our knowledge, this is the first study to quantitatively examine the effect of health education on cervical cancer screening uptake among female primary school teachers in Cambodia. Prior to initiation of this study, we conducted a literature search using PubMed and Google scholar with the following keywords: health education, cervical cancer screening, uterine cervical neoplasms, early detection of cancer, and Cambodia. This search yielded 19 relevant studies, there is evidence that narrative interventions can influence HPV vaccination

Table 4. Reasons for those who answered "No" to the question "Have you ever had a screening for cervical cancer?" at Baseline and End line *(multiple-choice)*

Variable	Control			Intervention			Control *vs.* Intervention at endline *p* values
	Baseline *n* (%) *n* = 275	End line *n* (%) *n* = 258	*p* values	Baseline *n* (%) *n* = 220	End line *n* (%) *n* = 172	*p* values	
I am healthy	113 (41.1)	103 (39.9)	0.784	81 (36.8)	45 (26.2)	0.025	0.003
It may be painful	12 (4.4)	10 (3.9)	0.777	14 (6.4)	14 (8.1)	0.498	0.059
I feel shy	55 (20.0)	73 (28.3)	0.025	55 (25.0)	57 (33.1)	0.077	0.284
I do not know where to receive screening	51 (18.6)	52 (20.2)	0.638	42 (19.1)	32 (18.6)	0.903	0.691
I'm busy (No time to go to gynecologist)	31 (11.3)	28 (10.9)	0.877	33 (15.0)	25 (14.5)	0.898	0.255
It is expensive	42 (15.3)	36 (14.0)	0.667	49 (22.3)	28 (16.3)	0.138	0.507
Others	4 (1.5)	0 (0)	0.124F	3 (1.4)	2 (1.2)	1.000F	

[a]Chi-square test; F: Fisher's exact test.

behavior (*18*) and that culturally adapted health education impacts cervical cancer screening among Cambodian women in the United States (*19*). However, no studies have examined the effect of health education on cervical cancer screening uptake.

Our finding that health education programs increase cervical cancer screening uptake is consistent with existing research. A systematic review indicated that health education interventions contribute to boosting the screening uptake and intentions to screening (*11,20*). However, their effectiveness varied by study design and population, and which forms are most effective have not been reported (*21*).

Another systematic review with positive outcomes classified diversified health education interventions into three types, individual level, community level, and culturally sensitive (for immigrants), and showed how these types can increase screening uptake (*20*). Individual-level interventions refer to intensive behavioral intervention, minimal intervention focused on invitations, and one-to-one interactive educational programs. These interventions target changes at the individual level, such as modifying an individual's knowledge, attitudes, skills, and behaviors regarding health and affect behavior more directly. Community-level interventions include community-based radio broadcasts, structured lectures for practical sections, school health promotions, and education for lay health workers. The effectiveness of these interventions lies in their "cue to action", which raises awareness and knowledge. This has a significant effect in boosting screening uptake and in increasing knowledge about screening (*22*). Culturally sensitive interventions refer to culturally sensitive videos, educational pamphlets, invitations, reminders, culturally targeted interventions, and community gathering strategies that boost screening test uptake for cervical cancer. These are crucial for providing equitable, effective service for diverse immigrant communities and minorities by accounting for their unique cultural contexts, beliefs, barriers, and needs. Among these three types, our health education program is a community-level intervention aimed at increasing awareness and knowledge and provoking a "cue to action" for women to participate in screening. To further increase screening test uptake, it may be necessary to consider individual-level interventions that more directly influence behavior.

In our study, feeling healthy and embarrassment were the most common major reasons for not undergoing screening. Although screening uptake was increased in the intervention group, 67.9% of women did not register and 75.9% did not undergo screening. In other previous studies, embarrassment was also identified as a common reason for not undergoing cervical cancer screening, as were feeling healthy, fear of unfavorable test results, lack of time, and feelings of discomfort with the gynecologic examination (*23-25*). After health education, feeling healthy was significantly decreased in the intervention group, but the number of women who felt "embarrassed" remained the same. Self-sampling has been tried around the world as one solution to address embarrassment, and in Cambodia, self-sampling has been proven to produce the same results as physician-sampling (*26*). In the present study, self-sampling was also an option for screening, but it was given to women at the hospital. It might be efficacious to consider allowing women to self-sample at the health education site or at home without going to the hospital.

This study also showed that the health education program helped women gain more knowledge on the cause, symptoms, preventative measures, and benefit of early detection. Their attitude changed with the realization that anyone has a chance of getting cervical cancer, and it has enabled them to think about the disease as their own problem. According to the seven stages of the Precautionary Adoption Process Model, the stage at which a person becomes able to view cervical cancer as their own problem is considered stage 1 or 2 of moving "from unawareness to awareness" (*27*). This recognition is an important initial step that precedes subsequent stages of deciding how to seek screening. For another question, "Do you think screening helps to prevent cervical cancer?", the score was already high at baseline, and therefore, even if the score increased at endline, it

may not have been statistically significant. This may indicate a characteristic of schoolteachers, a highly conscientious group in society.

Although our health education program improved screening uptake among female primary school teachers, the overall rate was still just over 20%. A future challenge will be to increase this percentage. To improve cancer screening, it is important to provide health education as well as systematic screening invitations to the target population according to the WHO Report on Cancer 2020. When encouraging women to undergo cervical cancer screenings in the future, we should consider the ways of delivering information individually, such as a personal invitation letter with detailed information, followed by a phone reminder, in which information is delivered individually. In this study, the screening invitation was provided through announcement boards for teachers at each school and by other existing communication systems, but it was not necessarily a way for all eligible women to receive individual invitations. A review of individual invitations and reminders (call-recall system) showed an improvement in uptake (*10*). However, sending invitation letters is applicable in settings with well-organized postal systems (*10,28*), but is challenging in countries where postal codes do not work well. One way to overcome this issue is to incorporate health education and screenings into workplace health checkups. A systematic review of interventions to increase breast and cervical cancer screening uptake in Asian women reported that the combination of workplace-based group education programs with mobile screening services and attending screenings was effective in the promotion of breast and cervical cancer screening uptake (*29*).

Strength and limitations

The strength of this study was that we quantitatively examined the effect of health education on cervical cancer screening uptake in Cambodia. The present results may provide suggestions for future interventions in Cambodia. However, several limitations must be noted. First, we only targeted female primary school teachers living in the capital city, higher level of education and socioeconomic status, and thus, the study findings may not be replicable for the general female population in Cambodia. Second, female primary school teachers are a highly educated group, and their situation might be different from that of marginalized populations. Third, the process of the baseline questionnaire, screening registration, and endline questionnaire may have been complicated for the participants.

Conclusions

This study showed that providing a combination of health education programs and invitation for screening could increase cervical cancer screening test uptake by two-fold. To further increase screening test uptake, individual-level educational interventions that more directly influence behavior and systematic invitations to screening may be needed. In addition, while expanding health education, further development of screening capacity through increasing the number of facilities and human resources is necessary.

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