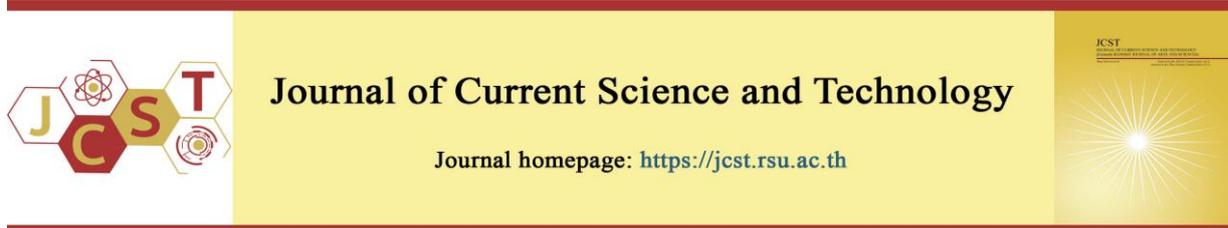


Cite this article: Pattarakiatjaroen, B., Chumworathayi, B., & Leeladapattarakul, S. (2026). Process indicators of 2018 WHO cervical cancer elimination in personnel of a medical school and their daughters. *Journal of Current Science and Technology*, 16(2), Article 182. <https://doi.org/10.59796/jcst.V16N2.2026.182>



## Process Indicators of 2018 WHO Cervical Cancer Elimination in Personnel of a Medical School and Their Daughters

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Received 12 November 2025; Revised 17 December 2025; Accepted 12 January 2026; Published online 25 March 2026

### Abstract

This study aimed to evaluate progress toward the WHO's 2018 cervical cancer elimination targets (90–70–90: % vaccinated, % screened, and % treated) among medical school personnel. This prospective descriptive-analytic study enrolled female medical school personnel aged 20–65 who participated in annual health examinations from March to December 2024. We collected Human Papillomavirus (HPV) vaccination uptake among participants' daughters aged 11–20, cervical cancer screening uptake, and further management data for participants who received abnormal results. Main outcomes were benchmarked against the WHO elimination targets. Among a total of 4,127 female medical school personnel aged 20–65, 3,034 came for the 2024 health check, but only 1,185 participated in cervical screening, and 669 gave their informed consent. Thirteen of them were further excluded because of a previous total hysterectomy, leaving only 656 for analysis. The HPV vaccination rate among the participants' daughters (n = 125) reached only 45.6%, which was significantly below the 90% target. Age-stratified cervical screening rates were 65.36% in women < 45 years (n = 393), and 75.09% in women ≥ 45 years (n = 263)—only those aged ≥ 45 years achieved the 70% target. Sixty-four participants (9.94%) tested positive for HPV. Further management compliance for the HPV-positive cases (n=64) was as high as 98.4%, exceeding the 90% target. Despite high treatment compliance, critical gaps persist in their daughters' vaccination and screening uptake among medical school personnel. Institution-specific interventions addressing accessibility and workflow optimization are essential to achieve the WHO targets. Such improvements would demonstrate that medical school personnel can serve as a model for community-wide cervical cancer elimination efforts.

**Keywords:** *cervical cancer elimination; cervical cancer prevention; cervical cancer screening; cervical cancer treatment; HPV vaccination; medical school personnel; WHO targets*

### 1. Introduction

Cervical cancer is well known as a preventable disease. It recently ranked as the fourth most common cancer among women in Thailand, behind breast, colon, and lung cancer, and accounted for 5,219 new cases in 2020, with an incidence rate of 10.3/100,000 women-years in 2019–2021 (Thanasitthichai et al., 2025). Although this rate has been decreasing for a few decades, cervical cancer in Thailand has not yet

been eliminated (Pasane et al., 2025). In 2017, the Royal Thai College of Obstetricians and Gynecologists (RTCOCG) had collaborated with the Thai Ministry of Public Health (TMOPH) to eradicate cervical cancer by signing an MOU and establishing working processes; however, no definition of how to achieve eradication was mentioned (Bureau of Information, Office of the Permanent Secretary of MOPH, 2017).

Fortunately, in 2018, the World Health Organization (WHO) has launched the “General calls for all countries to take action to help end the suffering caused by cervical cancer” by defining cervical cancer elimination as an incidence rate of less than 4 per 100,000 women-years. This target was expected to be achieved by the next decade (WHO, 2018a). This resulted in a practical approach divided into three components: 1) Human Papillomavirus vaccination (HPV) to girls under 15 years of age by 90%, 2) cervical cancer screening of 70% using a high throughput method at least once at age 35 and twice at age 45, and 3) a 90% rate of receiving further management (either investigations, treatments, or follow-ups) after an abnormal screening test. These targets were expected to be reached by the year 2030 (WHO, 2019; WHO, 2018b).

To our knowledge, the targets of 90–70–90 could be considered as cervical cancer prevention process indicators. These goals must be reached persistently and continuously each year to help reduce cervical cancer incidence rates in the future. However, after the Thai national guideline had included the primary HPV testing as the preferred screening option since 2020 (Health Intervention and Technology Assessment Program (HITAP), 2020), and an HPV vaccine also became part of the national vaccine recommendation for the 11–20 years-old girls since 2023 (Department of Disease Control (DDC), 2024), there have still been no available reported data regarding the monitoring of these process indicators in Thailand.

The existing research gaps concern not only the measured outcomes of the process indicators but also the methodological approach to measuring them within the Thai context. The current Thai national guideline should also be followed, and the research protocol must be consistent with it, especially for the vaccination and screening. Therefore, the operative (simplified) definition of these 90–70–90 targets used in this research were 1) HPV vaccination to the personnel’s daughters aged 11–20 years by 90%, 2) cervical cancer screening of 70% by any means at least once before age 45 and at least twice at age 45 or older, and 3) a 90% rate of receiving further management (either investigations, treatments, or follow-ups) after an abnormal screening test. Reaching these targets means that most preinvasive cervical lesions would be detected and treated before invasive cervical cancer could develop, thereby averting premature death.

In any workplaces or organizations where women work, there must be a health check-up program. All women or their family members should be evaluated or educated to receive the best available health services for the prevention or treatment of diseases, whether occupational or non-occupational. A medical school should serve as the best role model by implementing this process and setting the standard for other organizations. Therefore, this study aimed not only to monitor and evaluate the cervical cancer prevention process indicators achieved by personnel in a medical school, but also to test whether a practical protocol could simultaneously monitor and achieve the three targets (90–70–90) in all workplaces. If these processes cannot be implemented in a medical school, they certainly cannot be implemented in other organizations. Where the expected results were not achieved, the authors analyzed and reported the identified barriers as secondary outcomes. These findings are intended to inform future research efforts aimed at resolving these challenges.

## 2. Objectives

The objectives of this study were to measure the gap between the real-life practices of cervical cancer elimination by Thailand's medical school personnel and the WHO's 2018 90–70–90 goals.

## 3. Materials and methods

This research was a prospective descriptive-analytic study conducted at Srinagarind Hospital, a tertiary-care hospital and medical school of Khon Kaen University, Thailand. The study protocol was approved by the Office of the Khon Kaen University Ethics Committee in Human Research on February 28, 2024 (HE671067). Afterwards, registration of this prospective protocol was done on March 20, 2024 (TCTR20240320007), followed by the recruitment of volunteers from March to December 2024.

The inclusion criteria were defined as female personnel aged 20–65 years working at Srinagarind Hospital who attended their annual health check-up program, including cervical cancer screening, in 2024. After providing informed consent, their data were extracted from their electronic medical records (EMR) in the Health Object (HO) software and from all electronic forms completed before attending the health check-up program from March 2024 to December 2024, as designed by the authors. These data were then entered into a computerized database for subsequent analysis. The exclusion criteria were as follows: unwilling to enter the study, having had a

previous total hysterectomy, or ultimately not having the HPV test.

The daughter's vaccination rate in this study referred to the cumulative vaccination rate among the volunteers' daughters aged 11–20 years, with an expected target of 90%. Only one dose (regardless of how many strains) was considered adequate. This was consistent with the latest WHO recommendation issued on December 20, 2022 (a one- or two-dose schedule for girls aged 9–14 years, a one- or two-dose schedule for girls and women aged 15–20 years, and two doses with a 6-month interval for women older than 21 years) (WHO, 2022).

The cervical cancer screening rate was reported in two proportions; both were expected to meet the WHO target of 70%. Because primary HPV testing was used in the health check-up program at the study hospital for the first year, the attendance rate for cervical cancer screening in 2024 was assumed to be the cumulative rate of Pap smears within previous 10 years and HPV testing in the study year. We also retrieved data from the hospital's database on the cumulative cervical cancer screening rate, including both conventional Pap smears in the check-up program from 2014 to 2023 and HPV testing in 2024. These two proportions were then combined and compared with the WHO target of 70%, which applies to both the under-45 age group and the 45-and-older age group. The justification for this combination was that the cervical cancer screening is not needed annually under either WHO or Thai recommendations; either Pap smear or HPV testing once within the last 10 years is acceptable.

The further management rate after "abnormal screening results" referred to the percentage of participants receiving management after a positive primary HPV test, with an expected target of 90%. The secondary outcomes were barriers identified during the data collection processes. With a precision

of +5%, even a mean percentage that was only one percentage point below the targets would be interpreted as inadequate for achieving the process indicators.

We selected the expected cervical cancer screening uptake rate of 70.0% ( $p$ ) with an acceptable margin of error ( $d$ ) of 5% for sample size calculation, as this would be the most controllable number for recruitment. The estimated sample size was at least 323; however, we tried to recruit as many additional participants as possible. This research process may therefore benefit all participants and our institution's human resource management, with negligible inconvenience.

Descriptive statistics were used to describe demographic, daughters' data and baseline characteristics. Numerical data are expressed as means  $\pm$  standard deviations and percentages with 95% confidence intervals (CIs) where appropriate. Categorical variables are reported as counts and percentages. A  $p$ -value of  $< 0.05$  was considered statistically significant. All target rates were analyzed using the chi-squared test. All data analyses were performed using Stata™ Statistical Software, Version 17, 2021, (College Station, TX: StataCorp LLC).

#### 4. Results

Among a total of 4,127 female medical school personnel aged 20–65 working in 2024 at Srinagarind Hospital, 3,034 came for a health check, but only 1,185 participated in cervical screening, and only 669 provided informed consent between March and December 2024 (56.5% participation rate). Thirteen of them were further excluded because of a previous total hysterectomy, leaving 656 for demographic data and daughter's vaccination analyses. Twelve of them were further excluded because they did not ultimately receive HPV tests. Finally, 644 fully retrieved datasets were available for HPV test result analysis (Figure 1).

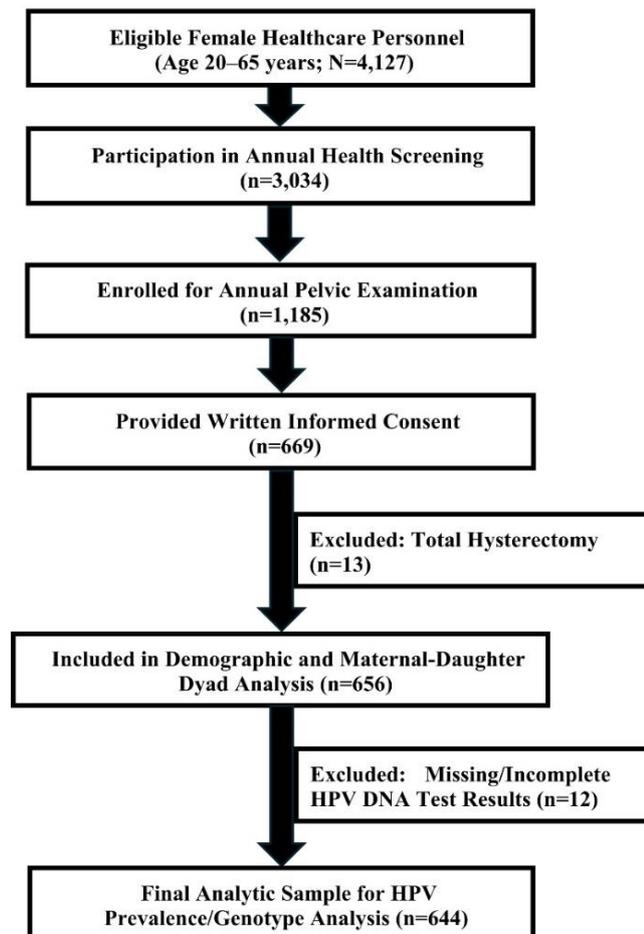


Figure 1 Participant flow diagram

#### 4.1 Primary Outcomes

Table 1 shows the participants' demographic data, status of having daughters aged 11–20 years, and the number of previous screenings according to age group. The participants' mean age was 41.75 years. Sixty percent of them were aged 20–44 years and had undergone 3–4 previous screenings, while the 45–65-year age group had undergone 4–5 previous screenings on average. Only 106 of the 656 participants had one or more daughters aged 11–20 years.

The study included 125 daughters aged 11–20 years born to the 106 participating mothers. Only 57 of the 125 had received HPV vaccination, yielding a daughters' vaccination rate of only 45.6% (95% CI: 36.87–54.33), which was significantly lower than

90% ( $p < 0.001$ ) (Table 2). Of these 57 vaccinated daughters, 32 (56.1%) had received their first dose before the age of 15 years.

There were 12 of the 656 participants who did not end up having their HPV test. Having one or more daughters was identified as a significant risk factor for not receiving the HPV test (OR = 0.18, 95% CI: 0.06–0.58,  $p = 0.004$ ) (Table 3). The reasons for not receiving the test were as follows: 2 participants lost contact at a young age (26 and 27 years), 2 participants lost contact despite having normal previous Pap smears, 2 participants had time constraints without previous Pap smears, 5 participants had time constraints despite having normal previous Pap smears, and 1 participant simply changed her mind because of a false sense of well-being.

**Table 1** Demographic and daughter data of the participants (N = 656)

Characteristic	Number	Percentage	Mean ± SD
1. Age			41.78 ± 10.07
2. Daughters			
No/Unknown	550	83.84	
≥ 1 Daughter	106	16.16	
3. BMI			24.07 ± 4.08
< 25	420	64.02	
≥ 25	236	35.98	
4. Live births			
No/Unknown	216	32.93	
≥ 1	440	67.07	
5. Marital status			
Virgin	66	10.06	
Having partner	590	89.94	
6. Prior STD			
No	611	93.14	
Yes	45	6.86	
7. Immunosuppressive status			
No/Unknown	574	87.50	
Yes	82	12.50	
8. Family history of cancer			
No/Unknown	506	77.13	
Yes	150	22.87	
9. Occupation			
Healthcare graduates	321	48.93	
Supporting staff/Unknown	335	51.07	
10. Education			
Under bachelor's degree/Unknown	216	32.93	
Bachelor's degree or above	440	67.07	
11. Smoking			
No/Unknown	650	99.09	
Yes	6	0.91	
12. Alcohol consumption			
Never/Unknown	404	61.59	
Yes	252	38.41	
13. Physical activity			
Sedentary	237	36.13	
Non-sedentary/Unknown	419	63.87	
14. Maternal HPV vaccination			
Yes	48	7.32	
No/Unknown	608	92.68	
15. Age groups and previous screenings			
20 – 34 years	197	30.03	2.57 ± 2.04
35 – 44 years	196	29.88	3.72 ± 2.04
45 – 65 years	263	40.09	4.28 ± 2.21

**Table 2** Number of mothers/daughters and percentages of vaccinated daughters and abnormal maternal cervical cancer screening

Total No. of mothers/ daughters	No. of vaccinated daughters)	% of vaccinated daughters	No. of abnormal maternal HPV tests	% of abnormal maternal HPV tests
Unknown: 19/0	N/A	N/A	1	5.26
Zero: 531/0	N/A	N/A	57	10.73
One: 88/88	39/88	43.32	6	6.82
Two: 17/34	18/34	52.94	0	0
Three: 1/3	0	0	0	0

**Table 3** Univariate analysis of daughter-having status as a predictor for receiving an HPV test

Daughter-having status	Receiving HPV test				OR	95% CI	p-value
	Yes (644)		No (12)				
	Number	Percentage	Number	Percentage			
Unknown/Zero (ref.)	544	98.91	6	1.09	1	–	–
≥ 1	100	94.34	6	5.66	0.18	0.06, 0.58	0.004*

\*p-value less than 0.05

The hospital’s database was accessed to determine the cumulative rate of cervical cancer screening among 5,484 female medical school personnel aged 20–65 years working at Srinagarind Hospital between 2014 and 2024. The data combined records of Pap smear tests (2014–2023) and primary HPV testing (2024), with the following results: Among participants under 45 years, 2,330 of the 3,565 (65.36%, 95% CI: 63.78–66.92) had undergone screening at least once (significantly less than 70%, with  $p < 0.001$ ). For those aged 45 years or older, 1,441 of the 1,919 (75.09%, 95% CI: 73.11–76.97) had undergone screening at least twice (significantly more than 70%, with  $p < 0.001$ ).

Among the 644 women screened with primary HPV testing, positive results were reported in 64 cases (9.94%) as Type 16, 18, or Others (Non16/18). There were 14 cases of Type 16, 3 cases of Type 16 + Others, 2 cases of Type 18, 1 case of Type 18 + Others, and 44 cases of Type Others. Thus, the remaining 580 cases had negative results. Of the 64 HPV-positive cases, 63 received further diagnostic and treatment procedures. Consequently, follow-up compliance for HPV-positive cases was as high as 98.4% (95% CI: 95.33–100), significantly exceeding the 90% treatment target ( $p = 0.025$ ). The reason for non-compliance in one case was loss of contact after the participant moved to another location.

#### 4.2 Secondary Outcomes

The barriers to achieving the 90–70–90 targets, even in a medical school, were also identified during the data collection process. The authors found the following obstacles.

##### 4.2.1 Availability and Pricing of the HPV Vaccines

The authors contacted the providers of HPV vaccination (tetravalent vaccine) who collaborated with Srinagarind Hospital in 2024. The quota for girls aged 11–20 years under the national policy was sufficient only for Khon Kaen University (KKU), but not for the whole Khon Kaen province. If a personnel member’s daughter did not study at KKU or the KKU demonstration schools, she might not have had access

to the HPV vaccine. The requirement for mothers to pay out of pocket for their daughters' vaccination represented a significant financial barrier. This situation was compounded by the anticipated availability of the preferred nonavalent vaccine through free or subsidized programs, leading to vaccine hesitancy. Consequently, mothers faced a dilemma: incurring immediate private costs or waiting for potential free availability, a decision that underscores the financial burden placed on families with daughters.

##### 4.2.2 Data Collection Process

1) The participation rate for the cervical cancer screening program was notably lower than the overall health check-up registration rate, with 1,185 participants out of 3,034 eligible personnel (Figure 1). Potential factors contributing to this disparity include: 1.1) the belief that annual screening is unnecessary; 1.2) reluctance to be examined by known colleagues; and 1.3) unwillingness to disclose premarital sexual activity.

2) The time scheduled for the health check-up service for medical school personnel was the same as the normal working hours for clinical services for other patients in the hospital. The hospital’s database showed that 206 of the 305 clinical staff did not attend the health check-up program. In contrast, only 32 of the 150 pre-clinical staff did not attend.

#### 5. Discussion

The aim of this prospective descriptive-analytic study was to evaluate the status of Thailand’s population toward the elimination of cervical cancer regarding the WHO’s 2018 90–70–90 monitoring process indicators. Data were collected from Srinagarind Hospital personnel undergoing their annual health check, representing a highly relevant and accessible sample population for this study (Figure 1 and Table 1). The study assessed the vaccination rate among daughters aged 11–20 years by using recalled data provided by the participants (Table 2). The reported cervical cancer screening coverage rates were derived by summing

conventional Pap smears from previous years and the current year's primary HPV testing from the hospital's database. The subsequent diagnostic and management compliance rate following abnormal screening results was calculated as a percentage, and its 95% CI was then tested against a fixed proportion. Finally, the three achieved rates were compared with the WHO's 90–70–90 process indicators (Bureau of Information, Office of the Permanent Secretary of MOPH, 2017; WHO, 2019).

## 5.1 Primary Outcomes

### 5.1.1 Daughters' Vaccination Rate

Among the 656 volunteers aged between 20 and 65 years, there were 106 mothers with 125 daughters aged 11–20 years. Only 57 of the 125 were vaccinated, yielding a percentage of 45.6%, which was significantly less than 90% (Table 2). Previous studies (Spencer et al., 2013; Bloom et al., 2024; Crippin et al., 2024) indicated a positive association between mothers' cervical cancer screening utilization and their child's HPV vaccination, independent of the child's gender. Likewise, although not statistically significant, this study showed a trend toward lower abnormal HPV test results among mothers (Table 2), which may reflect health-conscious behaviors in this subgroup. Recent studies have shown that the incidence of squamous cell carcinoma increased with parity (Muñoz et al., 2002; Tekalegn et al., 2022). However, the absence of data on parity, specifically concerning sons and daughters outside the 11- to 20-year age range, precluded the identification of this association in the current study.

Surprisingly, having daughter(s) was identified as a significant risk factor for not receiving the HPV test (Table 3; OR = 0.18), suggesting that mothers with daughters in this age group may face greater time constraints. Finally, the implication of the above-mentioned studies (Spencer et al., 2013; Bloom et al., 2024; Crippin et al., 2024) and this study was that, in the general population, there is a high likelihood that the girls' vaccination rate would be lower than 45.6%, because even among medical school personnel's daughters, this rate was very low, at only half of the 90% set by WHO. An innovative strategy to encourage girls' vaccination should be developed as soon as possible. Mathematical models have shown that sufficient nonavalent vaccination coverage alone, without screening, could be enough to efficiently eliminate cervical cancer (Simms et al., 2019; Brisson & Drolet, 2019; Brisson et al., 2020).

### 5.1.2 Screening Coverage Rate

The ratio of medical school personnel who underwent cervical cancer screening to annual health check visits in 2024 was 1,185/3,034, or 39.06%, which was significantly lower than 70%. This did not surprise us, as they may have been aware that annual cervical cancer screening is not necessary. The WHO goal was defined as screening once at age 35 and twice at age 45, with a target of 70% at both ages. Therefore, we simplified this by analyzing the subgroup aged <45 years as requiring one screening and the subgroup aged ≥45 years as requiring two screenings through any method (Pap smears or primary HPV testing).

Fortunately, Srinagarind hospital had recorded the cumulative cervical screening rate from 2014 to 2024 for all female personnel aged 20–65 years. Those below 45 years had a rate of at least one screening of 65.36%, and those aged 45 years or older had a rate of at least two screenings of 75.09%. Only those aged 45 years or older significantly achieved the WHO target of 70%, whereas those aged below 45 years did not. However, if we strictly apply the WHO definition of at least once at age 35 and twice at age 45 with a 70% target, these rates might be lower than those reported in this study. Personnel aged less than 35 years should have had one screening, and those aged 35–45 years should already have had cervical cancer screening twice. These findings also urge our institute to improve strategies for increasing cervical cancer screening uptake among female personnel.

### 5.1.3 Further Management Compliance

Among the 656 participants who provided informed consent, 644 had completed the primary HPV cervical cancer screening test. In the end, there were 64 cases (9.94%) with abnormal screening results. Among these 64 cases with abnormal results, 63 of them came for further management. Consequently, the rate of receiving further management after abnormal screening results was 98.4%, making it the only significantly successful indicator in this study. The data supported the conclusion that an appropriate population sample had been selected.

### 5.1.4 Comparison with Other Countries

Research in this area is limited, as the WHO 90–70–90 targets were only introduced in 2018. A PubMed search conducted on November 16, 2025, using the term 'WHO 90–70–90' yielded 33 articles; however, subsequent screening determined that only five were relevant to the current context. Notably,

only one of the five studies addressed health personnel (from Malawi), and it was published recently (Mwalwanda et al., 2024). The others were from middle-income countries (MICs) (WHO/UNICEF, 2019), Japan (Haruyama et al., 2021), Ethiopia (Hussein et al., 2024), and Zambia (Lubeya et al., 2024). The operative definitions used differed from paper to paper; however, Thailand was comparable to MICs in terms of vaccination and performed better than the others in terms of screening and treatment (Table 4).

### 5.2 Secondary Outcomes

Known barriers to screening were 1) lack of knowledge and awareness, 2) cultural, traditional, religious, and gender norms, and 3) poorly resourced or disorganized health systems and high costs (Petersen et al., 2022). The authors think that the main barriers for medical school personnel, especially those identified in this study, were those mentioned in item 3 above. Therefore, the barriers to achieving the WHO 90–70–90 targets might be addressed through the following strategies:

- 1) The government should distribute a sufficient number of nonavalent vaccines, as only one dose per recipient aged 11–20 years would be sufficient.
- 2) If the vaccine supply is insufficient, negotiations with pharmaceutical companies should be conducted to obtain a lower price.
- 3) The medical school should conduct an annual review to confirm that personnel have undergone cervical cancer screening within the preceding five years; those who have not should be recalled for the procedure.
- 4) Ensure that personnel can choose a care provider with whom they feel comfortable and ensure that data about their visits are kept confidential.

5) The annual health check-up service for medical school personnel should be scheduled outside of routine working hours and should require advance notice.

### 5.3 Strengths

This research is the first to investigate monitoring process indicators related to the WHO's 2018 cervical cancer elimination targets in Thailand. The authors began data collection in the first year of implementing primary HPV testing among medical school personnel and HPV vaccination monitoring among their daughters as an innovative approach. This study provides the first view of real-life monitoring process indicators in a medical school, a setting with the greatest readiness to achieve the targeted outcomes. The sample size was large and sufficient for all three targets.

### 5.4 Limitations

We concede that after the first year of implementing both primary HPV testing for cervical cancer screening among personnel and HPV vaccination monitoring for their daughters, even a tertiary care center and medical school still could not achieve all three of the WHO's 2018 monitoring process indicators. However, recall bias might have affected the HPV vaccination rate. Screening coverage rates, if calculated strictly according to the WHO target, might be lower than those derived from the method used in this study. Our operative definitions, including the age group of 11–20 years for vaccination and <45 and ≥45 years for screening, and the combination of Pap smears with HPV tests, may have introduced measurement bias; however, these were consistent with the Thai national guideline. Although cervical cancer incidence among personnel was not formally quantified, we note that, to our knowledge, no cases have been recorded in this population for several years.

**Table 4** Comparing Thailand's achievements to selected countries

Countries, year (N)	% vaccination	% screening	% treatment	p-values
Thailand, 2025 (125/1,919/64)	45.6	75.1	98.4	Reference
MICs, 2018 (NA/NA/NA)	8-98	NA	NA	NA/NA/NA
Japan, 2021 (NA/NA/85,426)	0.3	43	75	NA/NA/<0.0001
Malawi, 2023 (NA/70/NA)	NA	35.7	NA	NA/<0.0001/NA
Ethiopia, 2024 (NA/NA/NA)	61.2	71.1	79.8	NA/NA/NA
Zambia, 2024 (3,511/5,290/NA)	4.4	30.8	NA	<0.0001/<0.0001/NA

MICs = middle-income countries, NA = not applicable

## 6. Conclusion

Despite high treatment compliance, critical gaps persist in daughters' vaccination and screening uptake among medical school personnel. Institution-specific interventions addressing accessibility and workflow optimization are essential to reach the WHO targets. Such improvements would demonstrate that medical school personnel can serve as a model for community-wide cervical cancer elimination efforts. Furthermore, continuing cost-free primary HPV testing and affordable HPV vaccination for the daughters of medical school personnel in the targeted age group should be required in future assessments of these monitoring process indicators.

## 7. Acknowledgements

We would like to thank (a) Ms. Piyanan Suparattanakool, biostatistician at the Clinical Epidemiology Unit, Faculty of Medicine, Khon Kaen University, for her support with the statistical analysis of this study; (b) all supporting staff and participants at Srinagarind Hospital, the medical school involved in this study; and (c) Mr. Dirk Krapf for his professional English editing of this manuscript. This study was financially supported by the authors.

## 8. Abbreviations

Abbreviation	Full Term
BMI	Body Mass Index
CI	Confidence Interval
DDC	Department of Disease Control
EMR	Electronic Medical Record
HITAP	Health Intervention and Technology Assessment Program
HO	Health Object (software system)
HPV	Human Papillomavirus
IARC	International Agency for Research on Cancer
KKU	Khon Kaen University
MICs	Middle-Income Countries
MOPH	Ministry of Public Health
MOU	Memorandum of Understanding
OR	Odds Ratio
RTCOG	Royal Thai College of Obstetricians and Gynecologists
TCTR	Thai Clinical Trials Registry
TMOPH	Thai Ministry of Public Health
WHO	World Health Organization

## 9. CRediT Statement

**Benya Pattarakiatjaroen:** Investigation, Data Curation, Formal Analysis, Visualization, Writing – Original Draft.

**Saisamon Leeladapattarakul:** Resources, Validation, Data Curation, Software, Statistical Analysis, Project Administration.

**Bandit Chumworathayi:** Conceptualization, Methodology, Supervision, Funding Acquisition, Writing – Review & Editing, Project Administration.

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