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Novel educational training of para medical professionals in cervical cancer screening

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A B S T R A C T

Background: Cervical cancer is a public health problem in India due to weak national screening policy compounded by lack of resources including scarcity of trained personnel to carry out community-based screening program. Para medical professionals (PMPs) are closely related to women in local communities. Hence, training PMPs by incorporating novel technology and reduced time duration to achieve adequate competence in screening is an area underutilized and needs to be explored.
Materials and methods: A pilot cross sectional analytical study was conducted at a tertiary referral cancer center using a shorter version of educational intervention of 2 weeks duration (EI2W) involving PMPs. Pre- and post-training assessment of knowledge, attitude, and practice (KAP) was done using questionnaires consisting of 5 domains viz. awareness of cervical cancer, awareness of cervical pre-cancer, practical screening methodology (practice oriented), data management and aspects of human papilloma virus (HPV). Wilcoxon signed-rank test was used for comparison and the degree of change was measured using analysis of covariance (ANCOVA). A p value of <0.05 was considered significant.
Results: 118 PMPs were included. There was a significant improvement in scores of all domains (except cervical pre-cancer domain), following introduction of EI2W. Knowledge scores, post EI2W was better in Auxiliary Nurse Midwives (ANMs) than other participants. Awareness regarding cervical cancer was higher with more years of experience. The KAP analysis showed excellent interrater reliability in the practice 0.726 (0.649–0.792) followed by knowledge domain 0.711 (0.626–0.783).
Conclusion: EI2W was effective in significantly improving the competence of PMPs, thus reducing human resource constraints in cervical cancer prevention and elimination.

1. Introduction

The GLOBOCAN 2020 data from India lists cervical cancer as the second most common cancer in women, contributing to 18.3 % of new cases and 9.1 % of cancer-related deaths (Sung et al., 2021; WHO Globocan, 2020). A recent review analyzing the worldwide age-specific cervical cancer screening coverage demonstrated that India had screened just 2 % of its women aged 35–45 years in the preceding 5 years (Bruni et al., 2022). This means the screening efforts must increase 35 times over the next 5 years to achieve the World Health Organization (WHO) target of 70 % screening coverage for the elimination of cervical cancer. Another review analyzing the WHO and UNICEF estimates of national HPV immunization coverage 2010–2019 demonstrated that only 3 % women had received 1 dose and only 1 % had completed the full schedule of HPV vaccination in South Asia including India. These estimates are in stark contrast to the WHO target of 90 % immunization coverage for the elimination of cervical cancer (Bruni et al., 2021). The main hurdles of cervical cancer screening are competing diseases for health budget allocation, lack of time and resources needed for training the trainers and poor public awareness of the disease and its consequences (Dsouza et al., 2020; Srivastava et al., 2018).

Para medical professionals (PMPs) at the community level are the first point of contact for the general population and integration of such professionals into cancer control programs help to overcome barriers such as trust, awareness, and acceptance of screening by the community. PMPs include other health care professionals like nursing personnel and beyond, who support medical work and need to be incorporated for health care capacity building. As PMPs are already working in other

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areas of community health care delivery such as maternal, reproductive, child, adolescent health, and the prevention of communicable and non-communicable diseases [as a part of the National Health Mission (NHM)], it becomes logical to integrate them into cervical cancer screening (Rath and Gandhi, 2014; Ministry of Health and Family Welfare, 2023a; Ministry of Health and Family Welfare, 2023b). This would also help in achieving the set targets for screening and coverage of the at-risk population.

The training period (also called educational intervention [EI]) for any screening program is traditionally done over a few weeks to months (Hariprasad et al., 2018; NICPR-ECHO, 2023). Reducing the training period with a comprehensive practical hands-on learning along with e-learning modules was necessary for rapid capacity building of PMPs to achieve the goal of reducing cervical cancer burden in India. Hence, we undertook a pilot study to measure the overall training effectiveness of educational intervention of 2 weeks duration (EI2W) to achieve competence in knowledge, awareness, and practice (KAP) of cervical screening. The effectiveness was measured with a questionnaire which was administered pre and post EI2W.

2. Methods

This pilot cross sectional analytical study was conducted at the Preventive oncology department of Tata Memorial Centre (TMC), Mumbai, India. Video modules were developed in collaboration with Indian Institute of Technology (IIT), Mumbai, India, with inputs from clinical investigators in the study. Time period of study was from 27/06/2016 to 21/07/2018. A total of 118 PMPs, which included Auxiliary Nurse Midwives (ANMs), General Nursing and Midwives (GNMs) and Lady Health Visitors (LHVs) were invited to undergo EI2W. A written informed consent was obtained from all participants prior to enrollment. The trial was approved by the Institutional Review Board (IRB).

Training: EI2W consisted of video-based tutorials, lectures, and hands on training for 2 weeks. PMPs were given individual electronic tablets consisting of video modules for revision and retention of knowledge during the training period. The tutorials consisted of four modules: health education, practical methods of performing visual inspection of acetic acid (VIA), PAP smear and human papilloma virus (HPV) collection techniques. Steps to prepare Lugol's iodine and diluted acetic acid in primary health care center (PHC) and other practical tips to improve specimen collection were also included in the video. Translations of the video tutorials were available in 3 languages: English, Hindi, and Marathi.

Administration of questionnaire: A self-administration questionnaire format was chosen to evaluate the effectiveness of EI2W. The PMPs were encouraged to read the brief instructions at the top of the page and select the response that is most applicable. The questionnaires were administered pre and post EI. The questionnaire consisted of 50 questions in 3 categories: multiselect, true/false and knowledge score (**Appendix 1 in supplement**). These were further divided into 5 domains: a) awareness of cervical cancer b) awareness of cervical pre-cancer c) practical screening methodology (practice oriented) d) data management and e) HPV and cervical cancer including HPV vaccination.

Scoring: The questions were divided into 3 categories (**Table 1 in supplement**):

a) Multiselect: In this format, the user is allowed to answer none, one, or more than one choice. Scores provide the ability to add specific scoring and feedback values to the question choices. The score per choice scoring process was used in which a score is given for each choice selected. Each main question had multiple answers. The maximum mark for each main question was 1 and minimum was 0.
b) True/False: Three type of response (True, false, do not know) were converted and scored.
c) Knowledge score: In open label questions, the answers were converted and scored as follows [Best 1, Good 0.66, Poor 0.33, do not know 0 and wrong −1].

The average of score of all items were considered as domain score. For all domains, a higher score represents a higher (better) and lower score represents a lower (poorer) level of performance. The overall score for pre and post EI2W was calculated by taking average of all domain scores. Any difference between pre and post EI2W score (post-pre) was calculated. Quartile-based approach was used to categorize the overall score on a scale from a low to excellent level of performance.

Statistical analysis: The domains were standardized as continuous variables. The qualitative data were analyzed using descriptive statistics. Descriptive analysis was performed to identify the distribution of variables under study. Normal distribution of the values was tested using the Kolmogorov–Smirnov test, and homogeneity of variance was tested using Levene's test. Wilcoxon signed-rank test was used for comparison of pre and post EI2W levels of KAP. The change from pre to post EI2W KAP scores were analyzed using analysis of covariance (ANCOVA) with each socio-demographic variable (designation, marital status, years of experience, parity and undergone cervical cancer screening and past professional gynecological experience). Using the above model, adjusted mean change from baseline, along with 95 % confidence interval (CI) were reported. All tests were two sided and a p-value ≤ 0.05 was considered statistically significant. All statistical analysis was performed using SPSS version 25 (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp).

KAP analysis: KAP analysis was done to test the validity of the questionnaire. KAP analysis was defined as follows: knowledge about HPV and vaccination was classified as knowledge, cervical cancer and pre cancer awareness as awareness and practical knowledge related to screening methodology and data management as practice. The post-test performance scores of KAP were applied to each demographic variable to test if a baseline demographic variable impacted change in scores / learning and understanding.

3. Results

Socio Demographic characteristics: A total of 118 PMPs participated in this program. Participants' socio-demographic characteristics with level of knowledge pre training are presented in Table 1. Ninety-six (81.36 %) PMPs had previous experience in basic gynecologic procedures. None of the socio- demographic parameters were statistically significant with respect to the participant level of knowledge pre-training.

Pre and post-test analysis of performance status: Pre and post-test comparison analysis of performance status has been depicted in Table 2. The same has been depicted as a cluster chart in **figure 2 of supplement**. Descriptive analysis showed a significant improvement in post test scores in cervical cancer awareness, screening methodology, data management and knowledge about HPV vaccination domains. The gain of score was maximum in knowledge about HPV vaccination domain with multiselect questions showing mean pre-test scores (SD) of -0.04 ± 0.61 to post-test 0.82 ± 0.29, true/false questions pre-test score of -0.32 ± 0.51 to post-test 0.78 ± 0.28 and knowledge score questions pre-test score of -0.42 ± 0.51 to post-test 0.71 ± 0.23. There was no significant gain of post-test scores in cervical precancer awareness domain.

ANCOVA was then applied to see any statistically significant change in performance within individual demographic variables (Table 3). Our results showed a uniform gain in performance within each subcategory of demographic variable. We then performed multiple comparisons within age, years of prior experience, marital status, parity, personal history of cervical screening and past gynecological experience to see which subcategory within each demographic variable had greatest gain in performance when compared to others. The overall change in performance was better in ANMs than others. The adjusted mean (SE) of

Table 1
Scoring pattern in relationship with socio-demographic parameters.

VARIABLES N = 118	Overall knowledge score (pre-training)				p value
	Poor (n = 29)	Average (n = 30)	Good (n = 30)	Excellent (n = 29)	
Designation					
ANM (n = 43)	14 (32.60)	8 (18.60)	13 (30.20)	8 (18.60)	0.108
GNM (n = 56)	12 (21.40)	19 (33.90)	9 (16.10)	16 (28.60)	
LHV(n = 19)	3 (15.80)	3 (15.80)	8 (42.10)	5 (26.30)	
Age (years)					
< = 25 (n = 21)	4 (19.00)	6 (28.60)	5 (23.80)	6 (28.60)	0.409
26–35 (n = 45)	13 (28.90)	12 (26.70)	7 (15.60)	13 (28.90)	
36–45 (n = 21)	2 (9.50)	5 (23.80)	9 (42.90)	5 (23.80)	
>45 (n = 31)	10 (32.30)	7 (22.60)	9 (29.00)	5 (16.10)	
Marital Status					
Unmarried (n = 38)	10 (26.30)	12 (31.60)	7 (18.40)	9 (23.70)	0.572
Married/ widow (n = 80)	19 (23.80)	18 (22.50)	23 (28.70)	20 (25.00)	
Years of Experience					
<5 (n = 56)	13 (23.20)	17 (30.40)	12 (21.40)	14 (25.00)	0.860
06 to 10 (n = 21)	4 (19.00)	4 (19.00)	6 (28.60)	7 (33.30)	
11 to 15 (n = 7)	1 (14.30)	2 (28.60)	2 (28.60)	2 (28.60)	
>15 (n = 34)	11 (32.40)	7 (20.60)	10 (29.40)	6 (17.60)	
Parity*					
YES (n = 72)	15 (20.80)	17 (23.60)	22 (30.60)	18 (25.00)	0.285
NO (n = 8)	4 (50.00)	1 (12.50)	1 (12.50)	2 (25.00)	
Personal history of cervical cancer screening**					
YES (n = 50)	16 (32.00)	9 (18.00)	15 (30.00)	10 (20.00)	0.093
NO (n = 30)	3 (10.00)	9 (30.00)	8 (26.70)	10 (33.30)	
Past gynecological experience					
YES (n = 96)	26 (27.10)	22 (22.90)	26 (27.10)	22 (22.90)	0.293
NO (n = 22)	3 (13.60)	8 (36.40)	4 (18.20)	7 (31.80)	

* (n = 80).
** (only married participants were considered).

Table 2
Comparison of pre and post EI2W performance status of PMPs.

Domain	Questions	Descriptive statistic	Pre-Test	Post Test	p value
Cervical cancer awareness	Multiselect	Mean (SD)	0.58 ± 0.21	0.62 ± 0.22	**0.033**
		Median (IQR)	0.63 (0.00)	0.75 (0.13)	
	True/False	Mean (SD)	0.21 ± 0.31	0.80 ± 0.14	**<0.001**
		Median (IQR)	0.17 (0.50)	0.83 (0.17)	
Cervical precancer awareness	Multiselect	Mean (SD)	0.44 ± 0.26	0.45 ± 0.28	0.898
		Median (IQR)	0.53 (0.36)	0.28 (0.51)	
Screening methodology (Practice oriented)	Multiselect	Mean (SD)	0.43 ± 0.22	0.73 ± 0.14	**<0.001**
		Median (IQR)	0.48 (0.22)	0.74 (0.20)	
	True/False	Mean (SD)	−0.31 ± 0.36	0.62 ± 0.23	**<0.001**
		Median (IQR)	−0.33 (0.67)	0.67 (0.33)	
	Knowledge score	Mean (SD)	0.17 ± 0.41	0.73 ± 0.24	**<0.001**
		Median (IQR)	0.15 (0.47)	0.80 (0.25)	
Data Management	Multiselect	Mean (SD)	0.17 ± 0.66	0.39 ± 0.69	**0.006**
		Median (IQR)	0.50 (1.00)	0.75 (1.00)	
	True/False	Mean (SD)	−0.53 ± 0.52	−0.29 ± 0.51	**<0.001**
		Median (IQR)	−1.00 (1.00)	0.00 (1.00)	
Knowledge about HPV and vaccination	Multiselect	Mean (SD)	−0.04 ± 0.61	0.82 ± 0.29	**<0.001**
		Median (IQR)	0.04 (0.94)	1.00 (0.50)	
	True/False	Mean (SD)	−0.32 ± 0.51	0.78 ± 0.28	**<0.001**
		Median (IQR)	−0.67 (0.67)	1.00 (0.33)	
	Knowledge score	Mean (SD)	−0.42 ± 0.51	0.71 ± 0.23	**<0.001**
		Median (IQR)	−0.53 (1.00)	0.77 (0.17)	

SD: Standard Deviation; IQR: Inter Quartile Range.

ANM-LHV difference in scoring, pre and post training [0.061 (0.030)] was statistically significant (p = 0.0421). Other multiple comparisons did not yield any significant result.

Using the KAP analysis, in the knowledge domain (Table 4), 58.13 % of ANMs showed very good - excellent post-test performance compared to 53.57 % GNM and 21.05 % of LHV. Post-test performance was very good – excellent in 68.42 % of unmarried participants when compared to 41.25 % of married participants. These results were statistically significant. None of the other socio demographic characteristics had any significant influence in post-test performance in knowledge domain. In the awareness domain (**Table 2 in supplement**) 69.76 % of ANM showed very good – excellent post-test performance compared to 33.92 % of GNM and 57.9 % of LHV. Awareness about cervical cancer and pre cancer was maximum among PMPs who were older, thus with more years of experience with 64.52 % of PMPs >45 years and 67.65 % with >15 years of experience showing very good - excellent scores. Married participants showed 60 % very good – excellent post-test scores when compared to 31.57 % of unmarried participants. Participants with >15 years of past professional gynecological experience showed 67.65 % very good – excellent post-test scores compared to 35.71 % of participants with <5 years of experience. Personal history of cervical cancer screening and parity had no impact on post-test awareness scores. None of the demographic characteristics had any significant influence on practical knowledge related to screening methodology and data management (**Table 3 in supplement**).

Interrater reliability analysis: This was done using single domain wise analysis. The maximum interrater reliability in post-test answering of questionnaire was seen in screening methodology (practice oriented) domain, 0.733 (0.658–0.798) [73 % of responders were at concurrence with the questions correctly answered] followed by knowledge about HPV and vaccination domain, 0.711 (0.626–0.783) [71 % of responders were at concurrence with the questions correctly answered]. The interrater reliability in cervical cancer awareness and data management domains were 0.439 (0.272–0.580) and 0.419 (0.211–0.580) respectively. Lowest levels were observed in cervical precancer awareness domain −0.002 (-0.361 – 0.275). Using the KAP analysis, excellent interrater reliability in post-test answering of questionnaire was seen in

Table 3
Result of ANCOVA for overall change in performance with demographic variables.

Variable	Adj Mean (SE)	95 % CI	p value[#]	Multiple Comparisons	Adj Mean (SE)	95 % CI	p value[@]
Designation							
ANM	0.56 (0.02)	0.53–0.59	**<0.0001**	ANM - GNM	0.020 (0.022)	−0.02–0.06	0.3561
GNM	0.54 (0.01)	0.51–0.57	**<0.0001**	ANM - LHV	0.061 (0.030)	0.002–0.12	**0.0421**
LHV	0.50 (0.02)	0.45–0.55	**<0.0001**	GNM - LHV	0.041 (0.029)	−0.02–0.10	0.1581
Age (years)							
Below 25	0.55 (0.02)	0.50–0.60	**<0.0001**	below 25 - 26 to 35	0.010 (0.029)	−0.05–0.07	0.7329
26 to 35	0.54 (0.02)	0.51–0.58	**<0.0001**	below 25 - 36 to 45	0.018 (0.034)	−0.05–0.09	0.5912
36 to 45	0.53 (0.02)	0.49–0.58	**<0.0001**	below 25 - above 45	0.012 (0.031)	−0.05–0.07	0.6969
Above 45	0.54 (0.02)	0.50–0.58	**<0.0001**	26 to 35–36 to 45	0.008 (0.029)	−0.05–0.07	0.7783
				26 to 35 - above 45	0.002 (0.026)	−0.05–0.05	0.9338
				36 to 45 - above 45	−0.006 (0.031)	−0.07–0.06	0.8448
Experience (years)							
Below 5	0.54 (0.01)	0.51–0.57	**<0.0001**	Below 5 - 6 to 10	0.004 (0.028)	−0.05–0.06	0.8777
06 to 10	0.54 (0.02)	0.49–0.58	**<0.0001**	below 5 - 11 to 15	−0.013 (0.044)	−0.10–0.07	0.7711
11 to 15	0.55 (0.04)	0.47–0.64	**<0.0001**	below 5 - above 15	−0.005 (0.024)	−0.05–0.04	0.8281
Above 15	0.55 (0.02)	0.51–0.58	**<0.0001**	6 to 10 - 11 to 15	−0.017 (0.048)	−0.11–0.08	0.7200
				6 to 10 - above 15	−0.010 (0.031)	−0.07–0.05	0.7565
				11 to 15 - above 15	0.008 (0.046)	−0.08–0.10	0.8673
Marital Status							
Unmarried	0.56 (0.02)	0.52–0.59	**<0.0001**	Unmarried - Married/widow	0.022 (0.022)	−0.02–0.06	0.3190
Married/widow	0.54 (0.01)	0.51–0.56	**<0.0001**				
Parity[*]							
No	0.55 (0.02)	0.51–0.58	**<0.0001**	No - Yes	0.007 (0.021)	−0.03–0.05	0.7322
Yes	0.54 (0.01)	0.51–0.57	**<0.0001**				
Undergone cervical cancer screening[*]							
No	0.54 (0.01)	0.51–0.57	**<0.0001**	No - Yes	−0.006 (0.020)	−0.05–0.03	0.7576
Yes	0.55 (0.02)	0.52–0.58	**<0.0001**				
Past gynecological experience							
No	0.54 (0.02)	0.49–0.58	**<0.0001**	No - Yes	−0.009 (0.026)	−0.06–0.04	0.7247
Yes	0.54 (0.01)	0.52–0.57	**<0.0001**				

[*] n = 80, CI: Confidence Interval; Adj: adjusted.
[#] We conducted a pre- versus post-comparison using least square means from an ANCOVA model. We also checked the assumptions of normality and homogeneity of variance by investigating the residuals from the ANCOVA model.
[@] The adjusted p-value from the ANCOVA model takes into account variation within patients and time points (pre and post), as well as between-group comparisons.

the practice domain (screening methodology – practice oriented and data management) 0.726 (0.649–0.792) [72.6 % of responders were at concurrence with the questions correctly answered] followed by knowledge domain (knowledge about HPV and vaccination) 0.711 (0.626–0.783) [71 % of responders were at concurrence with the questions correctly answered]. In the awareness domain (cervical cancer and pre cancer awareness) the interrater reliability was 0.478 (0.326–0.607) [47.8 % i.e., almost half of the responders were at concurrence with the questions correctly answered] (Table 5).

4. Discussion

Traditional training method was based on physical attendance in clinics to learn practical methods. Personal electronic tablets with video tutorials were not given for revision and retention of knowledge. India's national health programs like the NHM – rural and urban have a step ladder pyramid organizational distribution of workforce to make sure that healthcare services which the government has to offer reaches every citizen at their doorstep (Ministry of Health and Family Welfare, 2023a). The National Cancer Control Program (NCCP) of India was launched in 1975 and later integrated with the National Program on prevention and control of diabetes, cardiovascular disease, and stroke in 2010. The objectives were mainly primary prevention of cancer by health education, secondary prevention by widespread screening and early detection, tertiary prevention by strengthening of treatment facilities and integration of palliative care (Rath and Gandhi, 2014). The District Cancer Control Program (DCCP) offers to serve as an interface between the national program and the community. The organizational blueprint of the DCCP demands the existing grassroot level health care workers to perform population-based cancer prevention and screening (Rath and Gandhi, 2014; Srivastava et al., 2018).

1. ANM is a multipurpose female health worker based at a sub health center level consisting of 5–6 villages. She usually possesses a basic nursing diploma and is trained in maternity and childcare, immunization, and primary curative care of villagers. They are the front-line health workers of National Rural Health Mission (NRHM).
2. LHV is a multipurpose female health worker with a nursing degree slightly advanced than ANM and are based at a primary health center (PHC) covering a population of 20,000–30000. They are entrusted with supervision of 6 sub-centers and report directly to the medical officer. They have a role similar to ANM and are additionally involved in supervision and training.
3. GNM nurses possess a GNM degree and are stationed as staff nurses in district hospitals and community health centers.

This pilot cross sectional analytical study depicts that the PMPs possessed a higher level of knowledge in the cervical cancer awareness

Table 4
Association of knowledge with demographic characteristics.

VARIABLE (n (%))	Knowledge (N = 118)					p value[#]
	Poor (20.83)	Average (28.13)	Very Good (27.08)	Excellent (23.96)	Total (100.00)	
Designation						
ANM	8 (18.60)	10 (23.26)	8 (18.60)	17 (39.53)	43 (100.00)	**0.006**
GNM	10 (17.86)	16 (28.57)	19 (33.93)	11 (19.64)	56 (100.00)	
LHV	9 (47.37)	6 (31.58)	4 (21.05)	0 (0.00)	19 (100.00)	
Age (years)						
< = 25	4 (19.05)	4 (19.05)	8 (38.10)	5 (23.81)	21 (100.00)	0.836
26–35	9 (20.00)	12 (26.67)	13 (28.89)	11 (24.44)	45 (100.00)	
36–45	6 (28.57)	8 (38.10)	3 (14.29)	4 (19.05)	21 (100.00)	
>45	8 (25.81)	8 (25.81)	7 (22.58)	8 (25.81)	31 (100.00)	
Marital Status						
Unmarried	5 (13.16)	7 (18.42)	17 (44.74)	9 (23.68)	38 (100.00)	**0.011**
Married/widow	22 (27.50)	25 (31.25)	14 (17.50)	19 (23.75)	80 (100.00)	
Experience (years)						
Below 5	8 (14.29)	17 (30.36)	18 (32.14)	13 (23.21)	56 (100.00)	0.410
06 to 10	6 (28.57)	3 (14.29)	7 (33.33)	5 (23.81)	21 (100.00)	
11 to 15	2 (28.57)	3 (42.86)	1 (14.29)	1 (14.29)	7 (100.00)	
Above 15	11 (32.35)	9 (26.47)	5 (14.71)	9 (26.47)	34 (100.00)	
Parity*						
YES	21 (29.17)	21 (29.17)	14 (19.44)	16 (22.22)	72 (100.00)	0.262
NO	1 (12.50)	4 (50.00)	0 (0.00)	3 (37.50)	8 (100.00)	
Undergone cervical cancer screening*						
YES	11 (22.00)	14 (28.00)	9 (18.00)	16 (32.00)	50 (100.00)	0.124
NO	11 (36.67)	11 (36.67)	5 (16.67)	3 (10.00)	30 (100.00)	
Past gynecological experience						
YES	20 (20.83)	27 (28.13)	26 (27.08)	23 (23.96)	96 (100.00)	0.735
NO	7 (31.82)	5 (22.73)	5 (22.73)	5 (22.73)	22 (100.00)	

Knowledge about HPV and vaccination = Knowledge in KAP Analysis. Post-test performance scores in the knowledge and vaccination domain was applied to each demographic variable to test if a baseline variable impacted change in scores.

[*] n = 80 (only married participants were considered).

[#] p-value for the proportion of participants with differences in their level of knowledge based on demographic characteristics.

Table 5
Domain wise interrater reliability.

Domain	Number of items	Intraclass Correlations (ICC) (95 % CI)
Cervical cancer awareness	8	0.439 (0.272–0.580)
Cervical precancer awareness	3	−0.002 (−0.361–0.275)
Screening methodology (Practice oriented)	25	0.733 (0.658–0.798)
Data management	3	0.419 (0.211–0.580)
Knowledge about HPV and vaccination	11	0.711 (0.626–0.783)
Knowledge	11	0.711 (0.626–0.783)
Awareness	11	0.478 (0.326–0.607)
Practice	26	0.726 (0.649–0.792)

CI: Confidence Interval.
Intraclass Correlations (ICCs) were used to assess the reliability of a questionnaire during its validation process. ICCs measure the consistency of responses from different participants when answering the same questions.

domain compared to cervical precancer and prevention. They possessed the lowest level of pretest awareness in the knowledge about HPV and vaccination domain. This also showed the maximum jump in post test scores. There was a uniform gain in post EI2W scores irrespective of socio demographic characteristics with ANMs showing maximum pre and post EI2W scores. The results of the ANCOVA depict that our novel training and testing method was uniformly successful among the heterogenous participant population. In the KAP analysis, the knowledge and practice domains showed excellent interrater reliability with average interrater reliability in the awareness domain.

Table 6 depicts a list of studies which conducted cross sectional surveys about awareness of cervical cancer and screening among PMPs in low- and middle-income countries (Fotedar et al., 2017; Gharoro and Ikeanyi, 2006; Jain et al., 2016; Khanna et al., 2019; McCarey et al., 2011; Shekhar et al., 2013; Singh et al., 2012; Urasa and Darj, 2011). All used self-administered questionnaires with 1–2 types of questions. In concordance with our study, we found that although most of the PMPs were aware about cervical cancer, only a few of them were aware about its risk factors and pre invasive lesions. Just half of the surveyed PMPs were aware about all the screening methodologies currently available to prevent cervical cancer. Although there was impressive awareness about PAP smear to detect cervical cancer, <15 % of the PMPs had themselves undergone screening. The factors cited most were misconceptions and fear related to the process of getting a PAP smear. Knowledge about HPV and vaccination was overall poor in concordance with our pretest scores in this domain.

Teaching an existing health professional all aspects of preventive health management is a particularly good economic strategy and helps build trust and bonding with the community and improves productive work force. It has been demonstrated previously that a well-trained PMP can perform effective screening and in turn reduce the incidence and mortality from cervical cancer (Sankaranarayanan et al., 2007). A feasibility study in Tamil Nadu, India tested the role of a trained village health nurse (VHN) in performing effective screening. They found that

Table 6
Cross sectional awareness surveys with self-administered questionnaires in low- and middle-income countries.

AUTHOR/ YEAR	Fotedar/ 2017	Jain/ 2016	Shekar/ 2013	Singh / 2012	Urasa M/ 2011	Khanna/ 2019	Gharoro/ 2006	McCarey/ 2011
COUNTRY	India	India	India	India	Tanzania	India	Nigeria	Cameroon
N	122	157	262	133	137	290	195	850
STUDY GROUP	HCW	nurses	nurses	nurses	nurses	ASHA	HCW	doctors, nurses, medical students
COMPLIANCE	85.9 %	100 %	100 %	93.5 %	100 %	100 %	100 %	46.8 %
Male: Female	45:77	0:157	0:262	0:133	0:137	0:290	0:195	136:265
AGE (mean, years)	48.6	35	32.1	27.8	44.2	36	39	38 (median)
NO. OF QUESTIONS	12	NA	NA	NA	NA	NA	14	46
TYPE OF QUESTIONS	Close ended	Closed, open ended				Open ended, Likert scale	Open ended, Likert scale	Multiple choice
WORK EXPERIENCE (years)	26 (av.)	NA	NA	NA	21 (mean)	>10yrs	NA	NA
KNOWLEDGE SCORE (%)								
Incidence of CA Cervix	75	86.2	76.9	63.2	-	95.5	65.2	86
Risk Factors	44.3	65	36	74.4	46	50	-	58
Screening (all)	-	-	34	54.1	60.6	46.3	64.7	90
Vaccines	14.8	-	25.5	18	22.6	-	-	44
HPV	11.5	-	23.4	54	48.9	33.6	-	60
Treatment	-	-	71.7	76	-	-	-	75
Awareness about PAP Smear	91	86.2	81	73.7	-	-	64.7	84
Personally screened	-	3.4	7.1	11.3	15.4	10	14.1	-

the VHN was successful in screening many at-risk women and could also accurately identify an abnormal cervix and collect an adequate PAP smear (Gajalakshmi et al., 1996). A cluster randomized controlled trial conducted in the urban slums of Mumbai showed a decrease in mortality from cervical cancer when screening was performed by trained primary health workers (Shastri et al., 2014).

To improve the existing knowledge of the already recruited professionals in the system is especially important, it is almost like back integration methodology. The project ECHO ICMR-NICPR, Cancer Screening Training Program for Nurses (CSTP-N) offers training in cervical, oral and breast cancer screening through a 10-week virtual and 3-day hands on training course (NICPR-ECHO, 2023). It has proven to be an innovative and cost-effective method with a large outreach by leveraging technology to compensate for the sparse resources (Hariprasad et al., 2018; O'Donovan et al., 2019). Most of our existing PMP workforce are women with already existing professional responsibilities within community healthcare along with personal domestic commitments. Taking time out for training was a matter of concern. Hence, a reduced duration of training was proposed.

Efficacy of novel EI can be measured qualitatively and quantitatively. Administration of questionnaire pre and post EI enables us to make a measurement of the level of improvement or otherwise in individual domains and hence the efficacy of the educational tool. The questionnaire is different in such that it allows qualitative assessment of the participants knowledge level to give a quantitative score. This can be standardized and is easily reproducible. Typically, questionnaires are either open or closed ended and contain similar types of questions. The cervical cancer screening scale is different in which it consists of 5 domains covering all aspects of cervical cancer screening and prevention. It is composed of different format of questions. This makes the questionnaire interesting to answer and breaks the monotony. The participant thinks while answering every question which is akin to intelligent quotient (IQ) testing. Few questions are self-explanatory, and an observant participant might be able to answer correctly and self-teach. The scales are designed for PMPs self-administration but can also be administered by interview format.

Although the awareness about cervical cancer was good, it was low for precancer. Cervical cancer being a public health problem is well known but it being preventable due to the long pre cancer phase in mostly unknown. The participants might have found it difficult to understand the training methodologies used or interpret the questions related to this domain (only multiselect type of questions were used). There might be a need to refine the questionnaire and add more user-friendly questions along with incorporation of natural history of cervical cancer topic in the training program.

Although the participants predominantly work in community rather than in offices and the data acquisition and storage skills are different, they showed an acceptable pre-test knowledge of computers and data management which further improved post-test. This depicts an impressive outreach of user-friendly technology among all age groups. This might signify that the training method and testing questionnaire was uniformly valid for a heterogenous cohort of participants in the knowledge and practice domains. The concept of cancer prevention by a vaccine is interesting and percolates easily. With the Government of India (GOI) all set to introduce the HPV vaccine into the national immunization schedule, educating the PMPs about HPV vaccination is an important step towards India's cervical cancer elimination strategy (PIB Delhi, 2022).

5. Implications for practice and future research

Post study closure, 503 participants have taken the online tutorial on the National Cancer Grid (NCG) website with uniform gain in post-test scores. The NCG is a GOI initiative to create a nationwide network of cancer centers, research institutes, patient groups, and charitable institutions with the objective of developing uniform standards of patient care through specialized training and education in oncology. Currently, there are 270 hospitals in the NCG network. Usage statistics show maximum log ins during the COVID-19 pandemic lockdown in India. The short duration testing and training method has the potential to be a cost effective and efficient training strategy with a large outreach. The video tutorials can be accessed online at https://ncgeducation.in (**Figure 2 in supplement**).

6. Conclusion

The new training program with reduced duration of training is effective in significantly improving the competence of PMPs to undertake cervical screening in communities. The questionnaire survey was found to be effective as it tested knowledge, awareness, and practice by multiple methods to measure response accuracy hence validating the EI2W training. Further studies to look at population-based effectiveness of the new training module will hopefully have a positive impact on cervical cancer prevention and elimination in keeping with the WHO

global strategy.

CRediT authorship contribution statement

Sneha Raj: Data curation, Formal analysis, Methodology, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. **Abhay K. Kattepur:** Writing – review & editing, Data curation, Formal analysis, Methodology, Resources, Software, Validation, Visualization, Writing – original draft. **T.S. Shylasree:** Formal analysis, Writing – review & editing, Conceptualization, Data curation, Investigation, Methodology, Project administration, Resources, Supervision, Visualization, Writing – original draft. **Gauravi A Mishra:** Formal analysis, Data curation, Conceptualization, Writing – review & editing, Investigation, Methodology, Project administration, Resources, Supervision, Visualization, Writing – original draft. **Akshay Patil:** Formal analysis, Writing – review & editing, Investigation, Methodology, Project administration, Resources, Software, Validation, Visualization, Writing – original draft. **Sharmila Pimple:** Formal analysis, Data curation, Writing – review & editing, Conceptualization, Investigation, Methodology, Project administration, Validation, Visualization. **Santosh Noronha:** Formal analysis, Data curation, Writing – review & editing, Methodology, Project administration, Resources, Validation, Visualization, Writing – original draft. **C.S. Pramesh:** Methodology, Formal analysis, Writing – review & editing, Conceptualization, Investigation, Project administration, Validation, Visualization, Writing – original draft.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.gore.2023.101241.

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