

ORIGINAL ARTICLE

The Effect of Interprofessional Critical Care Training on Interprofessional Knowledge and Perception: A Post-Test Evaluation Study**Ehab Kamal¹, Aisha Mahmoud Elsharkawy², Mennatallah Ahmed Alnagdy³, Lobna A Elgamal⁴, Abla Abdalla⁴, Shaimaa Anis⁵, Nelly Hegazy⁶, Marwa Rashad Salem⁷**

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Background	Studies demonstrate that interprofessional education (IPE) enhances knowledge, skills, and attitudes across healthcare disciplines and improves patient-centered outcomes.
Objectives	The aim of this study was to evaluate the feasibility and acceptability of the IPE curriculum among healthcare professionals.
Methods	The study was operation research using a posttest-evaluation design of an institution-wide IPE curriculum that was conducted at purposefully selected hospitals affiliated with MOHP. The study included 62 participants of health care providers. Nearly half of the participants (46.8%) were clinical pharmacists, 32.3% were critical care physicians and 21% were high nurses.
Results	Clinical pharmacists demonstrate higher percentages in the pass score with statistically significant differences than high nurses and critical care physicians in module 1. The trainees showed positive perceptions of participants for IPE. The male participants and high nurses show higher mean total scores of IPE with no statistical significance difference. However, the participants of the curative sectors and institutions get higher mean total scores of IPE that are statistically significant than other workplaces.
Conclusions	The high knowledge score post-intervention and positive perceptions of participants for IPE in our study solidify the extra benefit for IPE programs to be used by healthcare professionals more widely. This study endeavored to document a successful model of IPE implementation that could be replicated in other contexts. This may open the door for decision-makers and medical educators in Egypt to recognize the pressing need to start interprofessional education for healthcare practitioners early in undergraduate programs to improve the quality of patient care.
Keywords	Critical Care, Hospitals, Interprofessional Education, Perception.

INTRODUCTION

Delivery of complex care in the intensive care unit (ICU) requires a collaborative, team-based approach^[1, 2]. This has become increasingly apparent during the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic. Interprofessional education (IPE) facilitates collaboration among healthcare professionals and prepares trainees to succeed in a team environment^[1, 3].

IPE, as defined by the World Health Organization (WHO) aims for the effective collaboration between two or more health professionals of different specialties, who learn about, from and work with each other resulting in improving health outcomes^[4]. Studies demonstrate that IPE enhances knowledge, skills and attitudes across healthcare disciplines and improves patient-centered outcomes^[5 - 7]. Despite calls for the inclusion of IPE in advanced critical care training, successfully implemented models are lacking^[8].

The Egyptian Ministry of Health and Population provides a wide range of training programs in different specialties, as a wide variety of resources are allocated toward the enhancement of critical care management, including physician fellowships (medical, surgical and anesthesia). The study goal is to foster a collaborative, team-based approach, especially in the context of delivering complex health care. Therefore, an institution-wide IPE curriculum, in the form of an Interprofessional Education Series (IES), tailored for critical care management across various specialties was developed to enhance knowledge, skills and attitudes across healthcare disciplines, which will ultimately improve patient-centered outcomes.

The aim of this study was to evaluate the feasibility and acceptability of the IPE curriculum among healthcare professionals.

METHODS

Study setting and design

The study was experimental research using a post-test-evaluation design that was conducted at purposefully selected hospitals affiliated with Marietta occupational health partners (MOHP) to implement the IPE curriculum. These hospitals were chosen based on either their high patient flow, their risky profile for patient care or their time-critical processes and/or complex interprofessional composition (e.g. operating areas, intensive care units and emergency outpatient departments).

The Ethical Review Committee in the Ministry of Health and Population, Cairo, Egypt revised and

approved the study protocol (Approval number: ERC-MOHP-2023-156). A written informed consent was waived as we were conducting health system research. Data confidentiality and informants' identities were maintained throughout the study.

Study population

The study included critical care physicians, clinical pharmacists and high nurses who were currently providing critical care services at the participating hospitals during the study period and were willing to participate.

Data collection tools

Two main tools were used for data collection:

1. A self-administered Google form including:

- a) Personal data (gender, specialty and place of work)
- b) Post test questions for three training modules (150 questions for module 1, 50 for module 2 and 57 for module 3).

The participants were invited to a training program provided through IPE in three modules and were concerned with vital topics of critical care that mandate knowledge, skills and teamwork collaboration from different healthcare professions. A self-administered Google form includes personal data (gender, specialty and place of work) and posttest questions for the three training modules. The training program was implemented through scheduled sessions, including theoretical and practical training. The training program was assessed by 150 post-test questions after module 1, 50 post-test questions after module 2 and 57 post-test questions after module 3. (More details are available in the Annex. I)^[9].

Additionally, participants were invited to complete an interdisciplinary education perception tool, which is a self-administered questionnaire, previously validated, published in English and licensed for public use. The tool uses a Likert scale from 1 to 6 (strongly disagree, strongly agree). This scale consists of four subscales: competence and autonomy are represented in items 1, 3, 4, 5, 7, 9, 10 and 13; perceived need for cooperation is represented in items 6 and 8; perception for actual cooperation is demonstrated in items 2, 14, 15, 16 and 17 and lastly understanding others' value is shown in items 11, 12 and 18. (Annex II)^[10].

Annex I: Post-test Questions for Training Modules

Module 1: Fundamentals of Antibiotics in Critical Care (150 questions).

Sample questions:

1. What is the first-line antibiotic treatment for ventilator-associated pneumonia?
2. Describe the mechanism of action of carbapenem antibiotics.

3. In what situation would you consider using combination antibiotic therapy in sepsis?

Module 2: Advanced Life Support and Emergency Procedures (50 questions)

Sample questions:

1. What is the correct compression to ventilation ratio in adult CPR?

2. Describe the steps for inserting a central venous catheter.

3. What are the indications for emergency intubation in the ICU?

Module 3: Interprofessional Communication and Teamwork in the ICU (57 questions).

Sample questions:

1. What are the key components of an effective handover in the ICU?

2. Describe the roles of different team members during a rapid response call.

3. How can you apply the SBAR technique in communicating patient information?

Annex II: Interdisciplinary Education Perception Scale (IEPS).

Instructions: Please rate your level of agreement with each statement using the following scale:

- 1- Strongly Disagree,
- 2- Moderately Disagree,
- 3- Somewhat Disagree,
- 4- Somewhat Agree,
- 5- Moderately Agree,
- 6- Strongly Agree.

Competence and Autonomy Subscale:

1. Individuals in my profession are well-trained.
2. Individuals in my profession are able to work closely with individuals in other professions.
3. Individuals in my profession demonstrate a great deal of autonomy.

Perceived Need for Cooperation Subscale:

1. Individuals in my profession need to cooperate with other professions.
2. Individuals in my profession must depend upon the work of people in other professions.

Perception of Actual Cooperation Subscale:

1. Individuals in my profession are willing to share information and resources with other professionals.
2. Individuals in my profession have good relations with people in other professions.

Understanding Others' Value Subscale:

1. Individuals in my profession respect the work done by other professions.
2. Individuals in other professions respect the work done by my profession.

The interprofessional critical care training curriculum consisted of three modules, each focusing on vital topics in critical care that require knowledge, skills and teamwork collaboration from different healthcare professions. The modules were tentatively titled:

1. Module 1: Fundamentals of Antibiotics in Critical Care (150 post-test questions).

2. Module 2: Advanced Life Support and Emergency Procedures (50 post-test questions).

3. Module 3: Interprofessional Communication and Teamwork in the ICU (57 post-test questions).

Each module was designed to be completed over a 2-week period, for a total program duration of 6 weeks. The teaching process incorporated both theoretical and practical components:

- Theoretical training: Interactive lectures, case-based discussions and online learning modules

- Practical training: Simulation exercises, role-playing scenarios and supervised clinical practice in the ICU.

The training was conducted using a blended learning approach, with face-to-face sessions held twice a week and supplemented by online materials and discussions. Each face-to-face session lasted approximately 4 hours.

The study was likely conducted over a 3-month period, allowing for recruitment, implementation of the training program and post-intervention data collection. Given the paper's date (April 2024), we can hypothesize that the study might have been conducted from September to November 2023 Data Collection Timing.

Data collection occurred immediately after the completion of each training module and at the end of the entire training program.

Intervention

Participants underwent a training program provided through IPE in three modules, covering vital topics in critical care that require knowledge, skills and teamwork collaboration from different healthcare professions. The training program was implemented through scheduled sessions, including both theoretical and practical components.

Study design

Data entry and analysis were carried out using SPSS version 28.0 (IBM, SPSS, USA). Categorical variables were expressed as numbers and percentages, with comparisons made using Chi-square and Fischer exact tests. Quantitative variables were expressed using means and standard deviations, with comparisons made using independent t-tests and one-way ANOVA tests.

Knowledge scores were converted to percentages, with a pass score set at 50 %. Scores were interpreted as good (> 80 %), moderate (50 - 79 %) and poor (< 50 %).

For the IEPS, the total score ranges from 18 to 108. Higher total mean scores indicate an increased perception of interdisciplinary education. The Cronbach's alpha for our study was 0.98.

Sample Size

The study included 62 participants in total recommended from training sector of MOHP.

10 males and 52 females:

- Nearly half (46.8 %) were clinical pharmacists.
- 32.3 % were critical care physicians.
- 21 % were high nurses.
- Most (83.9 %) worked in curative sectors and institutions affiliated with the Ministry of Health and Population in Egypt.

A purposive sampling technique was used to select participants. The sample size was determined using the following formula:

$$n = [Z^2\alpha/2 * P(1-P)] / d^2.$$

Where:

n = sample size.

Z²α/2 = 1.96 (for 95 % confidence level)

P = expected proportion (we used 50 % as there was no previous data).

d = precision (margin of error, set at 0.05)

This calculation yielded a minimum sample size of 384. However, due to resource constraints and the specialized nature of the study, we were able to recruit 62 participants. While this smaller sample size limits generalizability, it still provides valuable insights into IPE in this context.

Statistical Analysis

Data entry and analysis were carried out using SPSS (Statistical Package for Social Science) version 28.0 (IBM, SPSS, USA). Categorical variables were expressed as numbers and percentages. For comparisons of categorical variables, the chi-square test was primarily used. However, when the expected frequencies in more than 20 % of the cells were less than 5, Fisher's exact test was employed instead. This approach ensures more accurate results for small sample sizes or sparse data. Quantitative variables were expressed using means and standard deviations. For comparing means of quantitative variables between two groups, the independent t-test was used. When comparing

means across more than two groups, one-way ANOVA was employed. Regarding knowledge questions, after reviewing the literature, the knowledge scores were converted to percentages, with the pass score set at 50 %. The scores were interpreted as good (> 80 %), moderate (50 - 79 %) and poor (< 50 %)^[11,12]. For the interdisciplinary education perception tool, the total score ranges from 18 to 108. The total mean scores of the scale and subscales were assessed. Higher total mean scores obtained from the subscales and the scale indicate an increase in perception of interdisciplinary education. The Cronbach's alpha for the original scale was 0.872, while in our study it is 0.98, indicating high internal consistency.

Statistical significance was set at *p* < 0.05 for all analyses^[10,13].

RESULTS

The study included 62 participants of health care providers.

Table 1 demonstrates the sociodemographic characteristics of participants (10 males and 52 females) Nearly half of the participants were clinical pharmacists, one-third were critical care physicians and the remaining were high nurses. More than three-quarters of the participants were working in the curative sectors and institutions affiliated with the Ministry of Health and Population in Egypt.

Table 1: Socio-demographic characteristics of the trainees (N = 62):

Variables		No	%
Gender	Male	10	16.1
	Female	52	83.9
Specialty	Clinical pharmacist	29	46.8
	Critical care physician	20	32.3
	High nurses	13	21
Place of work	Health care authority	5	8.1
	curative sectors and institutions	52	83.9
	Hospital and educational institutions	2	3.2
	Primary care	3	4.8

Data are presented as frequency.

Table 2 demonstrates the post-intervention knowledge scores for the three modules. Most trainees have got moderate scores in module 1. More than two-thirds of trainees got moderate scores in module 2 and one-third achieved good scores. In module 3, more than half of the trainees got moderate scores versus 41 % achieved good scores, as demonstrated in Figure 1.

Table 2: Post-intervention evaluation knowledge scores for the three modules:

Module	Total	Minimum	Maximum	Mean	SD
Module 1 score	150	66.00	117.00	89.7903	11.9
Module 1 score %	100 %	44 %	78 %	59.86 %	7.97
Module 2 score	50	20	48	36.8	6.1
Module 2 score %	100 %	40 %	96.00 %	73.62 %	12.2
Module 3 score	57	27	57	43.2	7.8
Module 3 score %	100 %	47.37 %	100 %	75.91 %	13.7

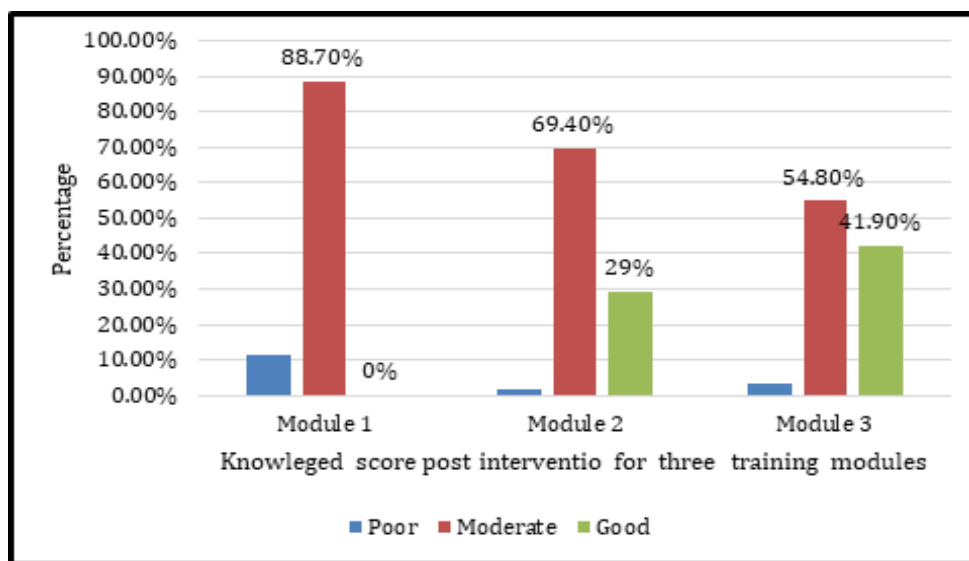


Figure 1: Knowledge scores post-intervention for the three training modules among trainees.

Table 3: Distribution of characteristics of the health care professionals and knowledge score post-intervention (N = 62):

Characteristics		Module1- Scores		Module 2 Scores		Module 3 Scores	
		Below 50 % N (%)	Above 50 % N (%)	Below 50 % N (%)	Above 50 % N (%)	Below 50 % N(%)	Above 50 % N (%)
Gender	1						
	Male (10)	1 (10 %)	90 (90 %)	1 (10 %)	90 (90 %)	1 (10 %)	90 (90 %)
	Female (52)	6 (11.5 %)	46 (88.5 %)	0 (0 %)	52 (100 %)	1 (1.9 %)	51 (98.1 %)
p**		0.8		0.053		0.25	
Specialty	Clinical pharmacists (29)	0 (0.0 %)	29 (100 %)	0 (0.0 %)	29 (95 %)	1 (3.4 %)	28 (96.6 %)
	Critical care physicians (20)	2 (10 %)	18 (90 %)	1 (5 %)	19 (95 %)	1 (5 %)	19 (95 %)
	High nurses (13)	5 (38.5 %)	8 (61.5 %)	0 (0.0 %)	13 (100 %)	0 (0.0 %)	13 (100 %)
	p**	0.001*		0.535		1	
Place of work	Health care authority (5)	1 (20 %)	4 (80 %)	0 (0 %)	5 (100 %)	0 (0 %)	5 (100 %)
	curative sectors and institutions (52)	6 (11.5 %)	46 (88.5 %)	1 (1.9 %)	51 (98.1 %)	2 (3.8 %)	5 (96.2 %)
	Hospital and educational institutions (2)	0 (0 %)	2 (100 %)	0 (0 %)	2 (100 %)	0 (0 %)	2 (100 %)
	Primary care (3)	0 (0 %)	3 (100 %)	0 (0 %)	3 (100 %)	0 (0 %)	3 (100 %)
p**		0.7		1		1	

Data are presented as frequency (%), P** indicates p-value from Fisher's Exact Test, used when >20% of cells have expected frequencies < 5.

Table 3 Distribution of characteristics of the health care professionals and knowledge score post-intervention. There is no statistically significant difference among gender or the place of work in the pass score in the 3 modules. However, specialty shows that clinical pharmacists demonstrate higher percentages in the pass score with statistically significant differences than high nurses and critical care physicians in module 1 which is concerned with the fundamentals of antibiotics. However, all high nurses passed modules 2 and 3 with no statistically significant difference between critical care physicians and clinical pharmacists.

Table 4 The results show that participants generally had positive perceptions of interprofessional education, with a total mean score of 76.39 out of a possible 108. The subscale scores indicate:

- Moderate to high perceived competence and autonomy (mean 27.5 out of 48)
- High perceived need for cooperation (mean 8.6 out of 12).
- Moderate perception of actual cooperation (mean 20.8 out of 30).
- Moderate to high understanding of others' value (mean 11.5 out of 18).

These scores suggest that participants value interprofessional education and see its benefits, though there may be room for improvement in some areas, particularly in actual cooperation.

Table 4: The Distribution of mean scores of IEPS subscales and Total:

Scales and subscales	Mean ± SD
competence and autonomy subscale	27.5 ± 9.6
perceived need for cooperation subscale	8.6 ± 2.9
actual cooperation subscale	20.8 ± 7.6
understanding others' value subscale	11.5 ± 4.1
Total score	76.39 ± 24.78

Data are presented as Mean ± SD, SD: stander deviation.

Table 5 demonstrates the distribution of characteristics of the health care professionals and IEPS score. The male participants and high nurses show higher mean total scores of IPE with no statistical significance difference. However, the participants of the curative sectors and institutions get higher mean total scores of IPE that are statistically significant than other workplaces.

Table 5: Distribution of characteristics of the health care professionals and IEPS scores (N = 62):

Characteristics	IPE Mean± SD	
Gender	Male (10)	80.7 ± 13.7
	Female (52)	70.7 ± 26.7
t = 1.1 P = 0.1		
Specialty	Clinical pharmacists (29)	71.66 ± 24.4
	Critical care physicians (20)	68.75 ± 25.7
	High- Nurses (13)	79.62 ± 24.4
F = 0.7 P = 0.4		
Place of work	Health care authority (5)	49.80 ± 19.7
	curative sectors and institutions (52)	77.13 ± 22.6
	Hospital and educational institutions (2)	29 ± 2.8
	Primary care (3)	56.67 ± 28.3
F = 5.4 P = 0.002*		

t: t-statistic from Independent Samples t-test, used to compare means between two groups (e.g., male vs female). F: F-statistic from One-Way ANOVA test, used to compare means among three or more groups (e.g., different specialties or workplaces).

DISCUSSION

The current evaluation study revealed high knowledge scores post-intervention and positive perceptions of participants for interprofessional training. While these findings are encouraging, it's important to note that without pre-intervention measurements, we cannot definitively attribute the high knowledge scores solely to the training. The participants may have had varying levels of knowledge prior to the intervention, which could have influenced the post-test results. Despite this limitation, the positive outcomes align with other studies in the field. For example, Tofil *et al.*^[14] found that interprofessional simulation training improved knowledge and teamwork in nursing and medical students during internal medicine clerkship. A more recent study conducted by Krielen, *et al.*^[15] reported that interprofessional simulation training was associated with an increase in knowledge scores across all subdomains for both nursing and medical students.

An interesting finding came from comparing knowledge scores according to trainees' specialty; clinical pharmacists scored higher than high-nurses and other specialties. The

professional backgrounds of clinical pharmacists expose them to rigorous training in pharmacology and clinical practice. Additionally, the role expectations, duties and responsibilities of the clinical pharmacists involve direct interaction with both the healthcare team and patients and they often work at a higher level of the hierarchy, which helps more exposure to interprofessional collaboration, thus performing better in IPE evaluations, which have already been noted in other studies. This could be one explanation for this outcome^[16-19].

The participants achieved a high total mean score of IEP of 76.39 ± 24.78 . Additionally, the mean scores of the four sub-scales of IEP: competence and autonomy, perceived need for cooperation, perception for actual cooperation and understanding others' value were good and above average. These findings are very promising as they indicate the positive attitude of healthcare professionals towards the IPE and their perception of the importance of understanding roles and responsibilities, collaborating, effectively communicating and working with each other to achieve better health outcomes. These findings were by other studies assessing the perception and readiness of medical and health-related professions toward the IPE In Saudia Arabia and Turkey and demonstrating high scores for the total mean scores of 77.7 ± 16.8 and 69 ± 6.62 , respectively^[13, 20].

Gender demonstrated no statistically significant differences in the total mean score of IPE; male participants got higher scores. This finding was aligned with similar studies that displayed no influence of gender on the perception of IPE^[13, 21, 22]. However, other studies exhibited higher results for females. The contradiction in gender effect may be attributed to the variety of background academic institutions and curriculum diversity. The barrier of gender stereotypes and the power of relations could impede interprofessional cooperation among different professions, which should be addressed in educational programs^[23, 24].

Although specialty did not affect the IPE significantly, high nurses demonstrated higher scores than critical care physicians and clinical pharmacists. This contrasted with similar studies illustrated that medical students and professionals exhibited higher scores in domains of IPE than high nurses and pharmacists, which can be referred to as the distinct training and teaching methods^[25, 26].

Furthermore, the participants of the curative sectors and institutions associated with the MOHP achieved higher mean total scores of IPE, which were statistically significant than other healthcare settings included in the study. This result can be interpreted in the light of divergent specialties and exposure to positive clinical experiences that enormously impact the perception of IPE. Additionally, different studies explained that the intense training in inpatient wards of critically ill patients mandates collaboration and effective communication between

healthcare professionals from multiple disciplines, which helps foster a positive perception toward IPE^[27, 28].

IPE has been increasingly recognized as an opportunity to enhance healthcare quality^[29, 30]. Measuring the professionally oriented perceptions and related affective domains for medical and health-related professionals in interprofessional education programs is fundamental and is considered the building block to follow the recommendation of WHO to implement the IPE as an integral part of the curriculum of undergraduate and postgraduate medical and other health-related professionals^[4, 31].

This study makes several important contributions to the existing literature on interprofessional education (IPE) in critical care settings. Firstly, it provides valuable insights into the implementation and effectiveness of IPE in the Egyptian healthcare context, an area that has been understudied to date. The high knowledge scores post-intervention and positive perceptions of IPE among participants suggest that such programs can be successfully implemented and well-received in Egypt's healthcare system. Secondly, our findings reveal interesting patterns in how different healthcare professionals respond to IPE, with clinical pharmacists demonstrating particularly strong performance. This highlights the potential for leveraging the unique strengths of different professions in designing future IPE initiatives. Lastly, our study is one of the few to examine IPE across various healthcare settings within a single country, revealing that professionals in curative care sectors may be especially receptive to IPE. These insights can guide policymakers and educators in tailoring IPE programs to different healthcare contexts.

Study limitations the current study findings should be interpreted considering the following limitations: First, the selection bias of the study participants in certain specialties from purposefully selected hospitals affiliated with the MOHP limits the generalization of the Training Program to other healthcare professionals. Second, this study used a posttest design with one measurement after interprofessional team training. To conclude the long-term effects and sustainability of this interprofessional team training, it would have been necessary to conduct repetitive training and collect further data. However, to the best of our knowledge, this is the first study to assess the situation in this new area of inquiry in Egypt.

Third, the lack of pre-intervention knowledge assessments limits our ability to directly attribute the high post-intervention knowledge scores to the training program. Future studies should include pre- and post-intervention measurements to more accurately assess the impact of the IPE intervention on participants' knowledge.

CONCLUSION

The high knowledge scores post-intervention and positive perceptions of participants for IPE in our study

suggest potential benefits for wider application of IPE programs among healthcare professionals. However, it's crucial to interpret these results cautiously due to the lack of pre-intervention measurements. This study documents a promising model of IPE implementation that could be replicated in other settings, with the addition of pre-intervention assessments to more accurately measure the impact of the training.

This can pave the way to arouse the attention of decision-makers and medical educators in Egypt toward the potential benefits of initiating Interprofessional education among healthcare providers for better quality patient care, starting earlier in the undergraduate program. Future studies should include pre-intervention assessments to more accurately measure the direct impact of IPE interventions.

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ETHICAL APPROVAL

The study protocol was revised and approved by the Ethical Review Committee in the Ministry of Health and Population (Approval number: ERC-MOHP-2023-156). A waiver of written informed consent was granted as this was considered health system research. Data confidentiality and participants' identities were maintained throughout the study.

CONFLICTS OF INTEREST

There are no conflicts of interest.

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