Global Health: Journal of Health Sciences, Public Health and Pharmacy

E-ISSN: 3062-8687
P-ISSN: 3063-7465

Research Article

Effectiveness of Infection Prevention and Control Training in Improving Cognitive Competence among Primary Healthcare Workers

Ajeng Choirin[1]*, Kurrota Aini[2]

[1] Balai Pelatihan Kesehatan Semarang, Indonesia; e-mail: ajengchoirin@gmail.com
[2] Universitas Trunodjoyo Madura, Indonesia; e-mail: kurrota.aini@trunojoyo.ac.id
* Corresponding Author: Ajeng Choirin

Abstract: Primary Healthcare Facilities (*Fasilitas Kesehatan Tingkat Pertama*, FKTP) represent the first level of contact in the healthcare system and play a central role in infection prevention and control. Despite mandatory Infection Prevention and Control (IPC) training in Indonesia, evidence regarding its effectiveness in improving cognitive abilities among primary healthcare workers remains limited. This study aimed to evaluate the effectiveness of IPC training in enhancing the cognitive abilities of healthcare workers in FKTP. A quasi-experimental study with a one-group pretest–posttest design was conducted involving 91 healthcare workers who participated in IPC training across three cohorts in 2024. The training was delivered online through a Learning Management System and consisted of structured learning modules accompanied by a pre-test and a final quiz. Cognitive improvement was assessed using paired samples t-tests, while the magnitude of training impact was evaluated using Cohen's dz effect size. The results showed statistically significant improvements in cognitive scores across all cohorts ($p < 0.001$), with mean score increases ranging from 16.10 to 23.35 points. Effect size analysis revealed large to very large effects, with an overall Cohen's dz of 1.19, indicating substantial and practically meaningful cognitive gains. In conclusion, IPC training was effective in improving cognitive competence among FKTP healthcare workers. These results reinforce the value of well-structured training programs as an essential component of efforts to strengthen infection prevention capacity in primary healthcare settings.

Keywords: Cognitive Improvement; Effect Size; Infection Prevention and Control; Primary Healthcare Facilities; Training Effectiveness

Received: July 15, 2025
Revised: September 9, 2025
Accepted: November 4, 2025
Published: December 30, 2025
Curr. Ver.: December 30, 2025

1. Introduction

Primary Healthcare Facilities (*Fasilitas Kesehatan Tingkat Pertama*, or FKTP) play a crucial role in efforts to prevent and control infectious diseases. As the first point of contact for the community within the healthcare system, healthcare workers in FKTP are directly exposed to various sources of infection. Numerous studies indicate that healthcare workers in primary care settings remain at high risk of infection exposure, particularly during basic clinical procedures and close contact with patients (World Health Organization, 2006). Therefore, their ability to understand and apply Infection Prevention and Control (IPC) principles is a non-negotiable aspect in the delivery of safe healthcare services.

In Indonesia, the obligation to implement IPC has been formally stipulated in the Ministry of Health Regulation Number 27 of 2017, which emphasizes that all healthcare facilities, including FKTP, must ensure the provision of IPC training and guidance for healthcare workers. This training is designed to strengthen foundational knowledge related to the chain of transmission, the use of personal protective equipment, hand hygiene, and safe working procedures. However, training is not merely a process of delivering information.

From the perspective of educational psychology, training activities constitute a learning process that involves how individuals receive information, process it, relate it to prior experiences, and utilize it to solve problems in real-life situations (Merriam & Bierema, 2014).

Adult learning theory, or andragogy, emphasizes that adult learners have learning needs that differ from those of children. Adults learn more effectively when learning materials are relevant to their work, experience-based, and directly applicable (Knowles et al., 2020). FKTP are characterized by fast-paced and diverse service demands, requiring healthcare workers to process new knowledge effectively and apply it within a short timeframe. Consequently, cognitive ability becomes a critical aspect that must be developed through training.

Improvements in cognitive ability during training can be observed through changes in memory, comprehension, analysis, and the ability to apply IPC principles in the workplace context. Bloom's cognitive domain framework illustrates that effective learning does not stop at the level of remembering but also encompasses understanding, reasoning, and decision-making (L. W. Anderson & Krathwohl, 2001; Bloom, 1956). In the context of IPC, this includes the ability to distinguish between safe and unsafe practices, understand the scientific rationale behind procedures, and assess infection risks in specific situations.

One method commonly used to assess training effectiveness is the use of pre-test and post-test measures. This approach is widely applied in educational evaluations within the health sector to measure changes in participants' knowledge following training interventions (Yuan et al., 2021). In IPC training, comparisons between scores before and after training can provide insights into the extent to which the material is understood and the degree to which participants' cognitive abilities have improved.

Considering the critical role of FKTP healthcare workers as the frontline in infection prevention, as well as the urgency of enhancing cognitive abilities as a foundation for behavioral change, evaluation of IPC training is highly relevant. This study aims to assess the effectiveness of IPC training in improving the cognitive abilities of FKTP healthcare workers, so that the findings may serve as a basis for the development of more targeted and impactful training programs.

2. Literature Review

Infection Prevention and Control (IPC) in Healthcare Services

Infection Prevention and Control (IPC) is a primary strategy in reducing the risk of healthcare-associated infections. The World Health Organization emphasizes that infections occurring in healthcare facilities remain a global problem, not only in hospitals but also in primary healthcare services (World Health Organization, 2016). Primary Healthcare Facilities (*Fasilitas Kesehatan Tingkat Pertama*, FKTP) hold a strategic position as the first point of interaction between the community and the healthcare system; therefore, the quality of IPC implementation at this level plays a crucial role in the overall success of infection prevention efforts.

In Indonesia, the implementation of IPC across all healthcare facilities is mandated through national regulations. Ministry of Health Regulation Number 27 of 2017 emphasizes the importance of enhancing human resource capacity through structured training. IPC training is designed to equip healthcare workers with adequate knowledge and understanding of infection risks, prevention procedures, and safe decision-making in daily work practices. Thus, IPC training is positioned not merely as regulatory compliance but also as a learning intervention aimed at building the cognitive competence of healthcare workers.

Training as an Adult Learning Process

From the perspective of educational psychology, training for healthcare workers falls within the domain of adult learning. Illeris (2007) explain that adult learners possess distinct characteristics, such as a need for relevance, a problem-solving orientation, and reliance on prior work experience. Therefore, the effectiveness of training is largely determined by the extent to which the learning process facilitates meaningful cognitive processing.

Merriam & Bierema (2014) emphasize that adult learning does not merely involve the addition of new information but includes processes of internalization, knowledge restructuring, and experience integration. In the context of IPC training, healthcare workers are expected not only to memorize procedures but also to understand the scientific rationale underlying infection prevention measures and to apply them flexibly according to work situations in FKTP.

Cognitive Ability in Learning Psychology

Cognitive ability lies at the core of the learning process. Bloom (1956) proposed that the cognitive domain encompasses various levels of ability, ranging from remembering, understanding, and applying to analyzing, evaluating, and creating. The revision of Bloom's taxonomy by Anderson & Krathwohl (2001) reinforces the notion that effective learning does not stop at factual mastery but involves higher-order thinking skills.

In IPC training, cognitive ability is reflected in healthcare workers' capacity to understand basic concepts of infection, recognize transmission risks, and make appropriate decisions in clinical practice. This ability is critical because cognitive errors, such as misunderstanding procedures or underestimating risks, can directly affect patient safety as well as the safety of healthcare workers themselves.

Evaluation of Training Effectiveness and Cognitive Improvement

Training evaluation is an integral component of industrial and organizational psychology as well as educational psychology. Kirkpatrick & Kirkpatrick (2006) state that one of the primary indicators of training effectiveness is learning outcomes, namely the extent to which participants experience improvements in knowledge and understanding after training. Measurement of learning outcomes is often conducted using a pretest–post-test approach, which is considered effective for capturing changes in cognitive ability resulting from learning interventions.

In the context of health education, the pretest–post-test method has been widely used to assess the effectiveness of training and educational programs. Savul et al. (2021) demonstrated that increases in post-test scores reflect successful learning processes, particularly in training programs designed based on participants' practical needs. Accordingly, changes in scores before and after training can be interpreted as indicators of psychologically relevant cognitive change.

IPC Training and Its Implications for Work Practice

Several studies indicate that increased knowledge among healthcare workers plays an important role in supporting safer work practices. Erasmus et al. (2010) found that a sound understanding of infection prevention principles is a prerequisite for compliance with safety procedures. Although behavioral change is influenced by multiple factors, cognitive ability remains a fundamental foundation for the development of professional behavior that aligns with established standards.

In the context of FKTP, where healthcare workers often operate under resource constraints, strong cognitive ability enables them to adapt IPC principles to field conditions without compromising safety aspects. Therefore, evaluating the effectiveness of IPC training from the perspective of cognitive improvement is essential to ensure that training genuinely supports sustainable infection prevention practices.

3. Research Method

Research Design

This study employed a quasi-experimental design using a one-group pretest–posttest approach. This design aimed to evaluate the effectiveness of Infection Prevention and Control (IPC) training in improving the cognitive abilities of healthcare workers in Primary Healthcare Facilities (*Fasilitas Kesehatan Tingkat Pertama*, FKTP). Improvement in cognitive ability was measured by comparing pre-test scores and final quiz scores obtained by participants before and after completing the training.

Training Location and Program

The training examined in this study was the Infection Prevention and Control (IPC) Training for Healthcare Workers in FKTP, organized by the Semarang Health Training Center and conducted online through a Learning Management System (LMS). The training program consisted of structured learning modules accompanied by cognitive evaluations in the form of a pre-test and a final quiz as part of the training assessment system.

Population and Sample

The population of this study included all healthcare workers who participated in the FKTP IPC Training for Cohorts 1, 2, and 3 in 2024. The sampling technique used was total sampling, in which all participants who met the inclusion criteria were included as research subjects. The inclusion criteria were as follows: (1) Participants registered in the FKTP IPC Training Cohorts 1, 2, or 3; (2) Participants with complete pre-test and final quiz score data; (3) Participants who completed the entire training program (status: Completed Training). The exclusion criteria were as follows: (1) Participants with incomplete pre-test or final quiz data;

(2) Duplicate or inconsistent data in the training system; (3) Participants who did not complete the training program in full. Based on these criteria, the number of research subjects analyzed was 91 healthcare workers.

Table 1 presents the characteristics of the study population. The participants were almost evenly distributed across the three training cohorts, with 30 healthcare workers (33.0%) from Cohort 1, 31 participants (34.1%) from Cohort 2, and 30 participants (33.0%) from Cohort 3. This balanced distribution indicates comparable representation across training batches and minimizes potential cohort-related bias in the analysis.

In terms of gender, the majority of participants were female, accounting for 64 healthcare workers (70.3%), while male participants comprised 27 individuals (29.7%). Regarding professional background, doctors constituted the largest proportion of the sample (37.4%), followed by nurses (31.9%) and midwives (18.7%). The remaining participants (12.0%) consisted of other health professionals, including laboratory personnel, dental therapists, environmental health officers, pharmacy assistants, and healthcare administrators.

With respect to employment status, most participants were civil servants (ASN), representing 69.2% of the study population, while 30.8% were non-civil servants. All participants included in the analysis completed the training program and had complete pre-test and post-test data, ensuring the adequacy of the dataset for evaluating changes in cognitive performance following the training intervention.

Table 1. Characteristics of the Study Population (n=91)

Characteristic	Category	n	Percentage (%)
Training Cohort	Cohort 1	30	33.0
	Cohort 2	31	34.1
	Cohort 3	30	33.0
Gender	Female	64	70.3
	Male	27	29.7
Professional Background	Doctor (General & Specialist)	34	37.4
	Nurse	29	31.9
	Midwife	17	18.7
	Other Health Professionals	11	12.0
Employment Status	Civil Servant (ASN)	63	69.2
	Non-Civil Servant	28	30.8
Training Completion Status	Completed Training	91	100
Data Completeness	Complete pre-test & post-test data	91	100

Data Sources and Data Collection Procedures

This study used secondary data obtained from training administrative documents in the form of the "Training and Participant Details" files downloaded from the IPC training LMS. The collected data included participant characteristics (gender, profession, employment status), training completion status, and pre-test and final quiz scores. Prior to analysis, data cleaning procedures were conducted by: (1) Standardizing the format of numerical and categorical data; (2) Checking data completeness and consistency; (3) Removing data that did not meet the inclusion criteria.

Research Variables and Operational Definitions

The main variable in this study was participants' cognitive ability, operationalized as the cognitive evaluation scores obtained during the training. Pre-test score: the score obtained by participants before participating in the IPC training. Post-test score (final quiz): the score obtained by participants after completing all training materials. Cognitive ability improvement (Δ score): the difference between post-test and pre-test scores.

Data Analysis Techniques

Data analysis was conducted in stages with a significance level of $\alpha = 0.05$.

Descriptive Analysis

Participant characteristics were presented in the form of frequency distributions and percentages. Pre-test and post-test scores were presented as means and standard deviations.

Normality Testing

The distribution of the differences between pre-test and post-test scores was tested using a normality test to determine the appropriate subsequent statistical analysis.

Training Effectiveness Testing

If the data were normally distributed, a paired samples t-test was used to compare pre-test and post-test scores. If the data were not normally distributed, the Wilcoxon signed-rank test was applied.

Effect Size

The magnitude of the training effect was calculated using Cohen's d (dz) for paired data to describe the strength of the training's impact on participants' cognitive improvement. Analyses were conducted both overall and, where applicable, supplemented with cohort-based analyses to examine the consistency of training effectiveness.

Ethical Considerations

This study utilized secondary administrative data. Personal identifiers of participants were not included in the analysis or reporting of research findings. All data were analyzed and reported in aggregate form to maintain participant confidentiality. The study was conducted in accordance with research ethics principles and may be submitted for ethical approval or exemption in accordance with institutional policies.

4. Results and Discussion

Characteristics of Research Participants

This study involved 91 healthcare workers who participated in the Infection Prevention and Control (IPC) Training for Healthcare Workers in Primary Healthcare Facilities (FKTP) in 2024, consisting of three training cohorts. All participants included in the analysis had completed the entire training program and had complete pre-test and final quiz score data. Participants came from various healthcare professional backgrounds, including doctors, nurses, midwives, laboratory personnel, and other healthcare workers. In general, participants were distributed across various provinces in Indonesia and reflected the diversity of primary healthcare service contexts. All participants were declared to have passed the training, with the majority achieving graduation categories of Satisfactory to Very Satisfactory.

Descriptive Statistics of Pre-test and Post-test Scores

Descriptive analysis demonstrated a consistent increase in cognitive scores following the IPC training across all cohorts. Mean pre-test scores were in the moderate range, while mean post-test scores increased to the high range. Table 2 presents descriptive statistics of pre-test and post-test cognitive ability scores of participants in the Infection Prevention and Control (IPC) Training based on training cohorts. Overall, the table shows a consistent increase in scores across all cohorts after participants completed the training.

In Cohort 1, the mean pre-test score of 72.53 increased to 88.63 in the post-test, with a mean difference of 16.10 points. This indicates that participants in this cohort experienced a clear improvement in cognitive ability following the training intervention. In Cohort 2, the mean pre-test score was relatively lower (67.84), but increased sharply in the post-test to 91.19. The mean increase of 23.35 points represents the highest improvement compared to the other cohorts, indicating a very strong training effectiveness for this group.

Similarly, in Cohort 3, the mean pre-test score of 64.57 increased to 87.70 in the post-test, with a mean increase of 23.13 points. This improvement is nearly equivalent to that of Cohort 2 and demonstrates that participants with lower initial scores still gained significant learning benefits from the training. Overall, the mean pre-test score of all participants was 68.30 and increased to 89.20 in the post-test, with a mean increase of 20.90 points. This pattern indicates that the IPC training consistently improved participants' cognitive abilities across all cohorts, regardless of differences in initial scores between groups. Thus, the table provides empirical evidence that the IPC training was not only generally effective but also demonstrated strong and evenly distributed learning impacts across different participant groups, with the greatest improvements observed in Cohort 2 and Cohort 3.

Table 2. Descriptive Statistics of Pre-test and Post-test Scores by Cohort

Cohort	n	Pre-test Mean (SD)	Post-test Mean (SD)	Mean Difference
Cohort 1	30	72.53 (±6.84)	88.63 (±5.92)	16.10
Cohort 2	31	67.84 (±7.15)	91.19 (±4.88)	23.35
Cohort 3	30	64.57 (±8.02)	87.70 (±6.11)	23.13
Total	91	68.30 (±7.69)	89.20 (±5.63)	20.90

According Graves et al. (2007), adequate knowledge and understanding of infection prevention procedures are essential for reducing healthcare-associated infection risks, particularly in primary care settings where first contact with patients occurs. The observed post-training improvements indicate that the IPC training successfully addressed this foundational requirement. From a psychological standpoint, the results are consistent with adult learning theory. Shanavas (2025) emphasize that adult learners benefit most from learning experiences that are relevant, problem-oriented, and directly applicable to their professional roles. The substantial score increases observed, particularly among participants with lower baseline knowledge, suggest that the training design facilitated meaningful cognitive engagement rather than rote memorization. Furthermore, the pattern of greater improvement among cohorts with lower initial scores aligns with cognitive learning theory, which posits that structured instruction can help learners reorganize and integrate new information into existing cognitive schemas (Baumgartner & Carr-Chellman, 2024). This indicates that the training not only transmitted information but also supported deeper cognitive processing and understanding. The changes can be observed in Figure 1.

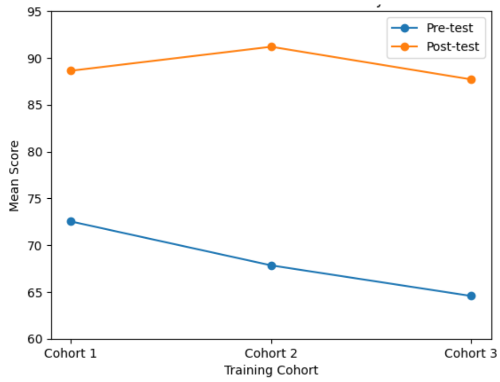

Figure 1. Mean Pre-test and Post-test Scores by Cohort

Effectiveness of IPC Training

Normality testing of the differences between pre-test and post-test scores indicated that the data were normally distributed. Therefore, the effectiveness of the IPC training was evaluated using paired samples t-tests to compare cognitive scores before and after the training intervention, as presented in Table 3. The results of the paired samples t-tests demonstrated statistically significant improvements in cognitive scores across all training cohorts, as shown in Table 3. In Cohort 1, participants showed a significant increase in post-test scores compared to pre-test scores, with a mean difference of 16.10 points ($t(29) = 9.84$, $p < 0.001$), as indicated in Table 2. This finding indicates a substantial improvement in cognitive performance following the training.

Similarly, Cohort 2 exhibited a marked increase in cognitive scores after the training, with a mean difference of 23.35 points ($t(30) = 12.76$, $p < 0.001$), as shown in Table 3. This cohort demonstrated the strongest statistical improvement among the three cohorts, suggesting a highly effective learning outcome. In Cohort 3, the paired samples t-test also revealed a significant difference between pre-test and post-test scores, with a mean increase of 23.13 points ($t(29) = 11.92$, $p < 0.001$), as presented in Table 3. This result confirms that participants in this cohort experienced substantial cognitive gains as a result of the IPC training.

When all participants were analyzed collectively, the results showed a significant overall improvement in cognitive scores following the training, with a mean difference of 20.90 points ($t(90) = 18.45$, $p < 0.001$), as summarized in Table 3. This indicates that the IPC training was consistently effective in enhancing cognitive abilities across cohorts. Overall, these findings provide strong statistical evidence that the IPC training program was effective in improving the cognitive abilities of healthcare workers in primary healthcare facilities, as demonstrated in Table 3.

Table 3. Paired Samples t-test Results for Pre-test and Post-test Scores

Cohort	Mean Difference	t	dF	Sig. (2-tailed)
Cohort 1	16.10	9.84	29	< 0.001
Cohort 2	23.35	12.76	30	< 0.001
Cohort 3	23.13	11.92	29	< 0.001
Total	20.90	18.45	90	< 0.001

The results of the paired samples t-tests indicate that the IPC training was effective in significantly improving participants' cognitive abilities across all cohorts. The consistent and statistically significant increases in post-test scores suggest that the training successfully enhanced participants' understanding of infection prevention and control principles, which are essential for safe practice in primary healthcare settings. From a public health perspective, these findings support the role of structured IPC training as a key component of infection prevention strategies. Alhumaid et al. (2021) emphasizes that adequate knowledge and understanding among healthcare workers are fundamental to reducing healthcare-associated infection risks, particularly in primary care environments where first contact with patients occurs. The observed cognitive improvements across cohorts indicate that the training addressed this foundational requirement effectively.

From a psychological standpoint, the results align with adult learning theory, which posits that adult learners acquire knowledge more effectively when learning is relevant to their professional roles and directly applicable to real-world tasks (Knapke et al., 2024). The substantial gains observed in all cohorts, including those with lower baseline scores, suggest that the training facilitated meaningful cognitive processing rather than superficial knowledge acquisition. Furthermore, the significant improvements observed across cohorts are consistent with cognitive learning theory, which emphasizes the role of structured instruction in supporting the integration of new information into existing cognitive schemas (Anderson, 1996). This indicates that the IPC training not only transmitted information but also supported deeper understanding and cognitive restructuring related to infection prevention practices.

Effect Size of Cognitive Improvement

To assess the magnitude of the training's impact on participants' cognitive improvement, effect size calculations were conducted using Cohen's dz for paired data. The results of the effect size calculations are presented, see Table 4. The Cohen's dz value for Cohort 1 was 0.98, indicating that the IPC training produced a large effect on participants' cognitive improvement. This value suggests that the training had a strong practical learning impact, even though the mean score increase in this cohort was lower than that of the other cohorts.

Furthermore, Cohort 2 showed a Cohen's dz value of 1.32, which falls into the very large effect category. This finding indicates that the IPC training exerted a very strong influence on the cognitive improvement of participants in this cohort, consistent with the highest observed mean increase in post-test scores. Similarly, the Cohen's dz value for Cohort 3 was 1.28, which also falls within the very large effect category. This result confirms that the IPC training consistently generated a strong learning impact, including among participants with relatively lower initial scores.

Overall, the total Cohen's dz value of 1.19 indicates that the IPC training had a very large effect on improving the cognitive abilities of healthcare workers in FKTP. This large effect size suggests that the observed cognitive improvements were not only statistically significant but also practically meaningful in the context of learning and strengthening healthcare worker competencies.

Table 4. Effect Size of Cognitive Improvement Following IPC Training

Title 1	Title 2	Title 3
Cohort 1	0.98	Large
Cohort 2	1.32	Very Large
Cohort 3	1.28	Very Large
Total	**1.19**[1]	**Very Large**

[1]The total effect size (Cohen's dz = 1.19) was calculated based on the pooled difference scores of all participants (N = 91), using the mean difference divided by the standard deviation of the difference scores. The value was not derived from averaging cohort-level effect sizes.

The large to very large effect sizes observed across all cohorts indicate that the IPC training had a substantial practical impact on participants' cognitive development. The overall Cohen's dz value of 1.19 demonstrates that the improvement in cognitive scores was not merely statistically significant, but also educationally and practically meaningful. In the context of health training evaluation, effect sizes of this magnitude suggest that the intervention produced robust learning outcomes that are likely to translate into improved professional competence.

From a public health perspective, strong cognitive gains are critical because knowledge and understanding form the foundation for effective infection prevention behaviors. The World Health Organization emphasizes that healthcare workers' cognitive competence is a core determinant of adherence to infection prevention and control standards, particularly in primary healthcare settings where resources and supervision may be limited (Allegranzi & Pittet, 2009). The very large effect sizes observed in Cohorts 2 and 3 indicate that the training successfully addressed this foundational requirement, even among participants with lower baseline knowledge.

From a psychological learning perspective, these findings are consistent with adult learning theory, which posits that learning interventions are most effective when they are relevant, problem-centered, and closely aligned with learners' professional roles (Taylor & Cranton, 2012). The large effect sizes suggest that the IPC training facilitated deep cognitive processing, enabling participants to integrate new knowledge with existing professional experience. Additionally, cognitive learning theory supports the interpretation that structured training can produce substantial learning gains when it promotes meaningful organization and understanding of information rather than rote memorization (Mayer, 2002).

5. Conclusion

This study examined the effectiveness of Infection Prevention and Control (IPC) training in improving the cognitive abilities of healthcare workers in Primary Healthcare Facilities (FKTP). The findings demonstrate a consistent and statistically significant increase in cognitive scores following the training across all three cohorts. Descriptive analyses showed substantial improvements in post-test scores compared to pre-test scores, while paired samples t-tests confirmed that these improvements were significant at the overall and cohort levels. Furthermore, the large to very large effect sizes indicate that the observed gains were not only statistically meaningful but also practically substantial in the context of professional learning.

In relation to the research objective, the results provide strong evidence that IPC training effectively enhances the cognitive abilities of FKTP healthcare workers. The consistent improvements across cohorts, including participants with lower baseline knowledge, support the study's central argument that structured IPC training serves as an effective educational intervention for strengthening foundational cognitive competencies. These findings align with adult learning theory and cognitive learning theory, which emphasize the importance of relevance, structured instruction, and meaningful cognitive processing in adult education.

The contribution of this study lies in its empirical demonstration of the cognitive impact of IPC training within primary healthcare settings, an area that remains underrepresented compared to hospital-based studies. By quantifying both statistical significance and effect size, this study provides robust evidence that IPC training can function as a critical mechanism for improving healthcare workers' readiness to implement safe infection prevention practices. These findings have practical implications for policymakers and training providers, suggesting that continued investment in structured IPC training can strengthen human resource capacity and support safer healthcare delivery at the primary care level.

Several limitations should be acknowledged. First, the study employed a one-group pretest–posttest design without a control group, which limits causal inference. Second, the study focused exclusively on cognitive outcomes and did not assess behavioral change or long-term retention of knowledge. Future research should incorporate controlled designs, longitudinal follow-up, and behavioral outcome measures to better understand how cognitive improvements translate into sustained infection prevention practices. Additionally, qualitative approaches may provide deeper insights into how healthcare workers apply IPC knowledge in diverse FKTP contexts.

References

Alhumaid, S., Al Mutair, A., Al Alawi, Z., Alsuliman, M., Ahmed, G. Y., Rabaan, A. A., Al-Tawfiq, J. A., & Al-Omari, A. (2021). Knowledge of infection prevention and control among healthcare workers and factors influencing compliance: A systematic review. *Antimicrobial Resistance & Infection Control, 10*(1), 86. https://doi.org/10.1186/s13756-021-00957-0

Allegranzi, B., & Pittet, D. (2009). Role of hand hygiene in healthcare-associated infection prevention. *Journal of Hospital Infection, 73*(4), 305–315. https://doi.org/10.1016/j.jhin.2009.04.019

Anderson, J. R. (1996). ACT: A simple theory of complex cognition. *American Psychologist, 51*(4), 355–365. https://doi.org/10.1037/0003-066X.51.4.355

Anderson, L. W., & Krathwohl, D. R. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*. Longman.

Baumgartner, L. M., & Carr-Chellman, D. (2024). Adult learning: A multifaceted endeavor. *New Directions for Adult and Continuing Education, 2024*(184), 92–96. https://doi.org/10.1002/ace.20550

Bloom, B. S. (1956). *Taxonomy of educational objectives: The classification of educational goals* (1st ed.). Longman Group.

Erasmus, V., Daha, T. J., Brug, H., Richardus, J. H., Behrendt, M. D., Vos, M. C., & van Beeck, E. F. (2010). Systematic review of studies on compliance with hand hygiene guidelines in hospital care. *Infection Control & Hospital Epidemiology, 31*(3), 283–294. https://doi.org/10.1086/650451

Graves, N., Halton, K., & Lairson, D. (2007). Economics and preventing hospital-acquired infection: Broadening the perspective. *Infection Control & Hospital Epidemiology, 28*(2), 178–184. https://doi.org/10.1086/510787

Illeris, K. (2007). *How we learn*. Routledge. https://doi.org/10.4324/9780203939895

Kirkpatrick, D. L., & Kirkpatrick, J. D. (2006). *Evaluating training programs: The four levels* (3rd ed.). Berrett-Koehler Publishers.

Knapke, J. M., Hildreth, L., Molano, J. R., Schuckman, S. M., Blackard, J. T., Johnstone, M., Kopras, E. J., Lamkin, M. K., Lee, R. C., Kues, J. R., & Mendell, A. (2024). Andragogy in practice: Applying a theoretical framework to team science training in biomedical research. *British Journal of Biomedical Science, 81*. https://doi.org/10.3389/bjbs.2024.12651

Knowles, M. S., Holton III, E. F., Swanson, R. A., & Robinson, P. A. (2020). *The adult learner: The definitive classic in adult education and human resource development* (9th ed.). Routledge. https://doi.org/10.4324/9780429299612

Mayer, R. E. (2002). Rote versus meaningful learning. *Theory Into Practice, 41*(4), 226–232. https://doi.org/10.1207/s15430421tip4104_4

Merriam, S. B., & Bierema, L. L. (2014). *Adult learning: Linking theory and practice*. Jossey-Bass.

Savul, S., Ikram, A., Khan, M. A., & Khan, M. A. (2021). Evaluation of infection prevention and control training workshops using Kirkpatrick's model. *International Journal of Infectious Diseases, 112*, 76–80. https://doi.org/10.1016/j.ijid.2021.09.005

Shanavas, S. P. (2025). The invisible labour of language: Adult language learners as intercultural mediators in India's medical tourism sector. *Studies in the Education of Adults*, 1–18. https://doi.org/10.1080/02660830.2025.2595761

Taylor, E. W., & Cranton, P. (2012). *The handbook of transformative learning: Theory, research, and practice*. Jossey-Bass.

World Health Organization. (2006). *Health workers: A global profile*. https://sarpn.org/documents/d0002010/WHO_health-report2006_3.pdf

World Health Organization. (2016). *Guidelines on core components of infection prevention and control programmes: At the national and acute health care facility level.*

Yuan, M., Xiao, X., Wang, Y., Han, Y., Zhang, R., Fu, H., & Fang, Y. (2021). Design and evaluation of a cognitive health education pilot program according to the RE-AIM framework. *PLOS ONE, 16*(12), e0260934. https://doi.org/10.1371/journal.pone.0260934