

Empowerment-based ToT HIV intervention among Indonesian construction workers: a quasi-experimental study

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ABSTRACT

Preventing HIV/AIDS in high-risk workplaces remains a public health priority, particularly in the construction sector. However, empirical evidence on structured, sustainable, and empowerment-based Training-of-Trainers (ToT) interventions for HIV prevention in Indonesian construction workplaces remains limited. This study evaluated a ToT-based intervention designed to build internal peer-facilitator capacity among construction workers and to strengthen workplace HIV prevention through a feasible, scalable, and participatory model. A quasi-experimental single-group pre-test–post-test study was conducted among 30 construction workers attending a two-day facilitator training. HIV/AIDS knowledge was assessed before and immediately after training using a structured questionnaire. Paired-sample t-tests, Wilcoxon signed-rank test, Cohen's *d*, and thematic content analysis were applied. Results: Mean knowledge scores increased significantly from 60.00 (SD = 12.66) to 91.33 (SD = 7.65), with a mean difference of 31.33 (95% CI: 26.76-35.90; $p < 0.001$). These findings suggest that peer-facilitator training may be a promising workplace health promotion strategy to strengthen HIV prevention capacity in construction settings, although further controlled studies are needed. Qualitative findings highlighted increased confidence, perceived relevance, and stronger peer networking. The ToT-based intervention was associated with substantial short-term gains in HIV/AIDS knowledge among construction workers and may help strengthen internal workplace prevention capacity. Further controlled studies with longer follow-up are needed to confirm its effectiveness and sustainability.

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1. INTRODUCTION

HIV/AIDS remains a major global public health challenge, with an estimated 39.9 million people worldwide living with the virus [1], [2]. Beyond its clinical consequences, HIV/AIDS imposes substantial social and economic burdens, particularly in low- and middle-income countries where access to prevention and treatment services may be uneven. Recent burden analyses further indicate that HIV/AIDS remains closely linked to economic underdevelopment, under-resourced health systems, and limited therapeutic access in many low- and middle-income settings. In addition, household-level evidence suggests that the financial consequences of HIV care can be considerable. A recent study from Ghana estimated that the economic cost of managing HIV with common comorbidities reached approximately 45.24% of annual GDP

per capita, underscoring the potential of HIV-related illness to deepen household vulnerability [3]. In Indonesia, the prevalence of HIV is approximately 0.5%, with more than 550,000 adults aged 15–49 years living with HIV by the end of 2023 [2], [4]. Given that this age group constitutes the core of the productive workforce, workplace-based HIV prevention strategies are increasingly recognized as an essential component of national public health efforts.

Construction workers represent a particularly vulnerable occupational group. The workforce is predominantly male and highly mobile, often engaged in temporary or informal employment arrangements that limit healthcare access continuity [4], [5]. Evidence from construction and migrant road construction settings also suggests substantial levels of risky sexual behavior in this population. In Ethiopia, risky sexual behavior was reported in 44.9% of construction workers, while a study among migrant road construction workers in Cameroon documented high levels of multiple sequential partnerships, multiple concurrent partnerships, low consistent condom use, and low perceived HIV risk. These findings reinforce concerns that mobility, fragmented social networks, and limited access to health information may increase the vulnerability of construction-related occupations to HIV transmission [6], [7]. Taken together, these studies suggest that mobility, temporary employment, limited access to health information, and fragmented social networks may increase HIV-related vulnerability among construction workers. For example, in Tanzania, more than 50% of construction workers reported viewing multiple sexual partnerships as normative [5], [6]. Similarly, migrant workers in Malaysia face socioeconomic vulnerabilities and limited outreach services, creating barriers to HIV prevention and care [7]. In Indonesia, labor force data indicate that many workers remain active beyond the age of 50, and informal employment contributes to underreporting in official labor statistics [8].

Although Indonesia has established regulatory frameworks mandating workplace HIV education, non-discrimination policies, and access to voluntary counseling and testing, including the Decree of the Minister of Manpower and Transmigration number 68/Men/IV/2004, implementation remains inconsistent. Policy analyses suggest that despite regulatory requirements, construction companies frequently lack structured and sustainable HIV programs [9], [10]. This persistent policy–practice gap highlights the need for interventions that move beyond compliance and actively engage workers in prevention efforts.

In Indonesia, empirical evidence also supports the need for workplace-based HIV prevention in the construction sector. A study among 150 construction laborers in Surabaya reported that 50% of workers had never received HIV/AIDS-related information and 48% had never used HIV/AIDS services, indicating persistent gaps in information exposure and service utilization among this occupational group [11]. In addition, Indonesian literature has identified construction workers as a vulnerable group because many are male, highly mobile, separated from their families, and employed in work environments where HIV prevention may not be systematically implemented [12]. These findings support the need for structured, workplace-based interventions that can improve HIV-related knowledge and strengthen internal prevention capacity within construction companies.

Training-of-Trainers (ToT) models offer a promising approach to strengthening workplace HIV prevention. Previous train-the-trainer and peer-education literature suggests that training selected local facilitators can extend the reach of health education, strengthen local capacity, and support the sustainability of health promotion programs when adequate organizational support and opportunities for replication are provided [13], [14]. In HIV prevention, train-the-trainer and peer-education approaches have been used to develop peer educators and disseminate prevention messages within communities and health systems [15], [16]. ToT strategies are grounded in participatory learning principles and empowerment theory and emphasize peer-led knowledge dissemination, shared responsibility, and internal capacity building. Empowerment-based interventions have been associated with improved health behaviors and reduced stigma, whereas ToT approaches have demonstrated effectiveness in resource-limited settings by facilitating sustainable knowledge transfer [17]–[19]. This rationale is further supported by HIV implementation research showing that structured training for lay HIV workers can increase prevention knowledge, reduce stigma, and promote prevention information diffusion through peer and community networks. In China, a PrEP diffusion training program for lay HIV workers increased knowledge scores by 65% from pre- to post-training, and 43% of participants reported integrating PrEP education into their routine work after one month. In addition, empowerment-focused HIV interventions have demonstrated significant improvements in empowerment outcomes, supporting the inclusion of empowerment principles in workplace HIV education [20], [21]. However, the rigorous evaluation of ToT-based HIV interventions within construction workplaces remains limited. In particular, there is limited evidence regarding knowledge retention, perceived empowerment, and potential gender differences in learning outcomes.

This study adapted a structured ToT-based facilitator training program to the Indonesian construction context. By empowering selected workers to serve as peer facilitators, the intervention sought to enhance internal HIV prevention capacity and promote sustained organizational engagement. The objectives of this study were to evaluate the effectiveness of a structured ToT-based facilitator training program in improving HIV-related knowledge and perceived readiness for workplace prevention among construction

workers in Indonesia, examine whether knowledge gains differ across gender and sociodemographic subgroups, and collect qualitative feedback to inform refinement of future workplace empowerment and ToT initiatives. We hypothesized that participants would demonstrate significantly higher post-training knowledge scores compared with baseline assessment. Despite existing workplace HIV policies and prior studies on HIV vulnerability among construction and mobile workers, evidence on structured and sustainable intervention models within construction workplaces remains limited. Most previous studies have focused on risk profiles, stigma, or general HIV education, whereas empirical evaluations of ToT approaches in occupational construction settings are still scarce [9], [22]-[25].

To address this gap, this study adapted and evaluated a structured two-day ToT HIV prevention program in an Indonesian construction company. The program was designed to build internal peer-facilitator capacity, improve HIV-related knowledge, and strengthen perceived readiness for workplace HIV prevention. The study also explored whether knowledge gains differed across sex and selected sociodemographic characteristics and collected qualitative feedback to inform future refinement of workplace-based ToT initiatives.

The novelty of this study lies in applying and empirically evaluating a workplace-based ToT model in the construction sector and in combining quantitative pre-test–post-test assessment with qualitative feedback to examine both learning outcomes and perceived readiness for workplace prevention. The following sections describe the study design, intervention procedures, knowledge assessment, quantitative and qualitative findings, and implications of the ToT model for workplace HIV prevention.

2. METHOD

2.1. Study design

This study employed a quasi-experimental single-group pre-test and post-test design to evaluate the short-term effectiveness of a structured ToT facilitator program for HIV/AIDS prevention among construction workers. A control group was excluded because of operational and ethical considerations, as withholding training from eligible workers was not feasible within the organizational context. Accordingly, the design was intended to assess short-term within-participant changes rather than to establish definitive causal effects. The design allowed for the assessment of changes in knowledge and perceived readiness before and immediately after the intervention.

2.2. Study setting and participants

This study was conducted within a construction company in Indonesia that implements workplace HIV prevention initiatives. Purposive sampling was used to recruit 30 participants. Participants were identified in collaboration with company representatives based on their involvement in workplace health promotion activities and their potential role as peer facilitators. Eligible workers were invited to participate, received an explanation of the study objectives and procedures, and provided written informed consent before data collection. The inclusion criteria were: current employment at the study site, willingness to participate in the full two-day training, and completion of both pre- and post-test assessments. Participants included both male and female workers. Sociodemographic data, including age, sex, job role, and project unit, were collected to characterize the sample and explore subgroup differences.

2.3. Sample size

The sample size of 30 participants was determined pragmatically based on the number of workers who were invited and voluntarily agreed to participate in the workplace-based facilitator training. This feasibility-based justification was considered appropriate because the study was conducted in a real occupational setting and aimed to assess short-term within-participant changes in HIV/AIDS knowledge rather than to provide definitive causal evidence. Resource- or feasibility-based sample size justification has been recognized as an acceptable approach when field constraints determine the attainable sample size [26]. In addition, a sensitivity power check indicated that 30 paired observations would be sufficient to detect a moderate within-participant effect. However, because no formal a priori power analysis was conducted, the findings should be interpreted as preliminary evidence of educational improvement.

2.4. Intervention

The intervention consisted of a structured two-day ToT-based facilitator training aligned with the HIV/AIDS prevention curriculum of the Indonesian Ministry of Manpower. The training included lectures, interactive discussions, case studies, group workshops, and scenario-based exercises. The training was delivered in sequential sessions consisting of introductory briefing, pre-test, interactive lectures, group-based case discussion, facilitator practice, action planning, and post-test evaluation.

Day 1 focused on foundational knowledge, including national HIV policies, modes of transmission, prevention strategies, workplace rights and responsibilities, and stigma reduction. Day 2 emphasized applied learning, including program planning, standard operating procedure development, case analysis, and simulation exercises for implementing workplace HIV programs. The training aimed to equip selected workers with both technical knowledge and facilitation skills to cascade information to their peers within their workplaces. Each session was facilitated using standardized training materials, guided discussion prompts, and practical exercises aligned with workplace HIV prevention objectives.

2.5. Measures and instruments

HIV-related knowledge was assessed immediately before and after the training using a structured 20-item multiple-choice questionnaire covering HIV transmission, prevention strategies, workplace policy and rights, and stigma reduction. Each correct answer was assigned five points, and total scores were converted to a 0–100 scale. The questionnaire was developed from the training content and reviewed by occupational health and HIV prevention experts for content relevance, clarity, and alignment with the training objectives. A preliminary psychometric assessment showed corrected item-total correlations of 0.91 and 0.72 for pre-test and post-test scores, respectively, indicating acceptable score validity, while Cronbach's alpha was 0.53, suggesting modest internal consistency. Open-ended questions were also used to collect qualitative feedback on the relevance, clarity, applicability, and areas for improvement of the training.

2.6. Data collection

The pre-test questionnaires were administered immediately before the start of the training program. Post-test questionnaires were administered at the end of the second training day. The participants completed the assessments anonymously using coded identifiers to enable paired analysis while maintaining confidentiality. Qualitative responses were collected using open-ended written questions at the end of the intervention.

2.7. Statistical analysis

Data were analyzed using IBM SPSS Statistics for Windows, version 26.0. Descriptive statistics were used to summarize the characteristics and knowledge scores of the participants. The normality of the score distributions was assessed using the Shapiro–Wilk test. Paired-sample t-tests were conducted to evaluate the mean differences between the pre-test and post-test scores. Although post-test scores deviated from normality, parametric testing was retained given the robustness of paired t-tests in samples approaching $n = 30$. A sensitivity analysis using the Wilcoxon signed-rank test was performed to confirm the consistency of the results. The effect size for paired data was calculated using Cohen's d_z by dividing the mean difference by the standard deviation of the paired difference scores [27]. Cohen's d based on the pooled standard deviation was also calculated for completeness, although Cohen's d_z was considered the more appropriate estimate for paired data. The 95% confidence intervals (95% CI) were calculated for mean differences. Statistical significance was set at $p < 0.05$ (two-tailed). Independent-sample t-tests were conducted as exploratory subgroup analyses to examine sex-based differences in post-training knowledge scores.

3. RESULTS AND DISCUSSION

3.1. Pre- and post-intervention knowledge scores

All 30 participants completed both the pre- and post-test assessments and were included in the analysis. The mean knowledge score increased from 60.00 (SD = 12.66) at pre-test to 91.33 (SD = 7.65) at post-test, with a mean difference of 31.33 points (95% CI: 26.76–35.90; $p < 0.001$). The paired analysis showed a Cohen's d_z of 2.56. Changes in knowledge scores following facilitator training as shown in Table 1.

The pre-test scores were normally distributed (Shapiro–Wilk $p = 0.644$), whereas the post-test scores deviated from normality ($p < 0.001$). Given the robustness of paired-sample t-tests in samples of approximately 30 participants and the absence of extreme outliers, parametric testing was retained. The Wilcoxon signed-rank test yielded consistent results ($p < 0.001$), supporting the robustness of the findings. The correlation between pre-test and post-test scores was positive but not statistically significant ($r = 0.356$, $p = 0.053$), indicating that baseline knowledge levels were not strongly predictive of post-training outcomes.

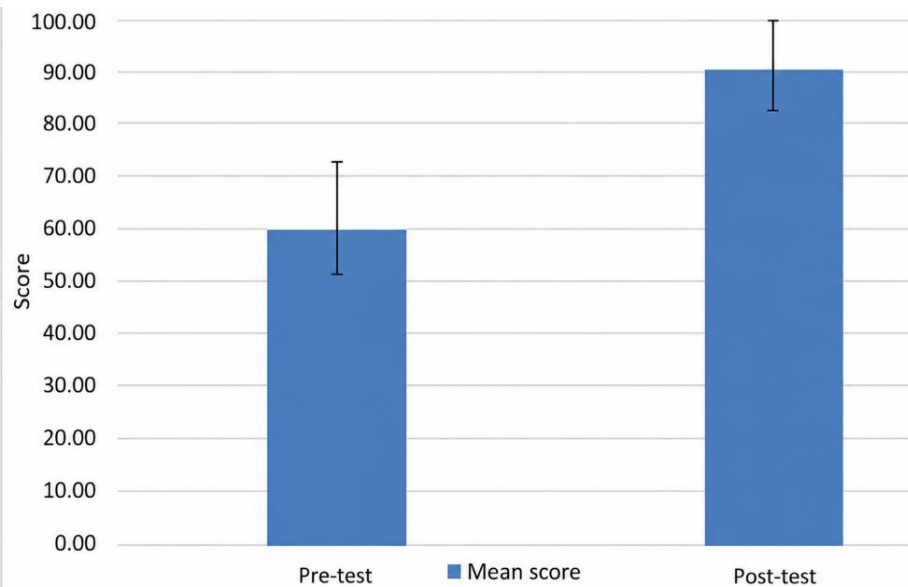
As an exploratory subgroup analysis, post-training knowledge scores differed significantly by sex ($p = 0.013$). Female participants had higher mean post-test scores ($M = 93.50$, $SD = 5.40$) than male participants ($M = 87.00$, $SD = 9.78$). This finding should be interpreted cautiously because the subgroup analysis was

exploratory and the sample size was limited. Figure 1 presents the corresponding visual change in mean scores, showing a marked increase from pre-test to post-test following the ToT-based intervention.

Table 1. Changes in knowledge scores following facilitator training (n = 30)

Measure	Mean	SD	Mean difference	95% CI	t (df)	P	Cohen's dz
Pre-test	60.00	12.66					
Post-test	91.33	7.65	31.33	26.76–35.90	-14.018 (29)	< 0.001	2.56

Notes: Values are presented as the mean and standard deviation (SD). The mean difference represents post-test minus pre-test scores. P-values were obtained using paired-sample t-tests. The effect size (Cohen's dz) was calculated using the standard deviation of the paired difference scores. CI = confidence interval.



Note: Bars represent mean scores; error bars indicate standard deviations

Figure 1. Mean HIV-related knowledge scores before and after the ToT intervention among construction workers

3.2. Qualitative feedback

The open-ended responses were analyzed using thematic content analysis. Three primary themes emerged: i) structured and practical learning design, ii) empowerment and confidence building, and iii) program enhancement recommendations. The participants frequently emphasized the clarity of the presentation, the relevance of the case studies, and the interactive format of the sessions. Participants indicated that the combination of theoretical explanation, case examples, and interactive discussion helped them understand the training content more clearly. Respondents also described increased confidence in promoting HIV prevention initiatives within their workplaces. Several participants reported feeling “more prepared” and “motivated to take action” following the training. Cross-departmental interaction was highlighted as a means of strengthening peer support networks. The participants recommended periodic refresher courses, the inclusion of experiential components such as voluntary counseling and testing simulations, and the extension of training duration to allow deeper discussion of implementation strategies.

3.3. Discussion

The present study addressed the limited availability of structured and sustainable workplace HIV prevention interventions in the construction sector by evaluating a ToT model designed to strengthen internal peer-facilitator capacity. The large within-participant effect size suggests that the ToT-based intervention was associated with a substantial short-term increase in HIV-related knowledge among construction workers. This finding indicates that structured facilitator training may be educationally meaningful and potentially useful for strengthening internal workplace HIV prevention capacity. Nevertheless, because this study used a single-group pre-test–post-test design without a control group, the findings should be interpreted as preliminary evidence of educational improvement rather than definitive causal evidence of intervention

effectiveness. This interpretation is particularly relevant because empirical evidence on HIV-focused ToT interventions in construction settings remains limited, especially in occupational contexts in low- and middle-income countries.

The improvement observed in this study is consistent with previous HIV training evaluations showing significant gains in knowledge after structured training programs, including train-the-trainer education among nurses in India and pre–post training among HIV treatment center staff in Pakistan [28], [29]. Evidence from workplace-based HIV interventions in Thailand and a systematic review of factory-worker interventions in low- and middle-income countries further supports the role of structured education and peer-related approaches in improving HIV knowledge and prevention-related outcomes [30], [31]. Together, these findings indicate that ToT-based workplace education may be a feasible approach for improving HIV-related knowledge while also strengthening internal prevention capacity in occupational settings.

The observed knowledge gain may be partly explained by the interactive and multimodal design of the intervention. Training components such as lectures, discussions, case-based learning, group workshops, and scenario-based exercises may have helped participants connect HIV prevention concepts with practical workplace situations. In addition, the ToT approach emphasized peer interaction and facilitator development. This is relevant because ToT is intended not only to transfer knowledge during a single training session, but also to build a cadre of internal agents who can disseminate prevention messages, sustain learning, and support organizational capacity for workplace HIV prevention [19, [32], [14].

The exploratory sex-based difference in post-training scores, with female participants achieving higher mean scores than male participants, should be interpreted cautiously. Because subgroup analysis was not the primary objective of this study and the sample size was relatively small, this finding should be considered hypothesis-generating rather than confirmatory. This interpretation is consistent with methodological guidance stating that exploratory subgroup findings should be interpreted cautiously because they may be influenced by chance variation and selection bias [33]. Gender-related differences in HIV knowledge have also been reported in previous literature, suggesting that gender may influence how HIV information is accessed, understood, and translated into prevention-related awareness [34]. However, the observed difference in this study should not be interpreted as an intrinsic difference in learning ability; rather, it may reflect variations in engagement, prior exposure to health information, communication dynamics, or other contextual factors that were not measured in this study. Future studies with larger and more balanced samples are needed to examine whether sex- or gender-responsive approaches may improve workplace HIV education outcomes.

The modest and non-significant correlation between pre-test and post-test scores suggests that baseline knowledge was not clearly associated with post-training performance. However, this finding should be interpreted with caution because individual factors such as educational background, prior HIV-related training, and health literacy were not assessed in detail. The structured and interactive design of the intervention may have helped participants with varying baseline knowledge levels engage with the training content. Future studies should further examine how individual learning characteristics influence knowledge improvement after workplace-based HIV training.

Qualitative feedback complements the quantitative results by highlighting participants' perceptions of clarity, relevance, and increased confidence to promote HIV prevention within their workplace. The recurring themes of empowerment and peer networking suggest that the intervention may have influenced not only cognitive outcomes but also perceived readiness to act. This is particularly important in occupational environments, where peer norms and informal leadership structures can strongly influence health-related attitudes and practices [17]. Taken together, these findings suggest that the intervention may have value not only as a one-time educational activity but also as a foundation for longer-term peer diffusion of HIV prevention messages within the workplace. This interpretation is strengthened by evidence from peer-based HIV interventions showing that such approaches can improve not only knowledge but also self-efficacy, stigma-related attitudes, and prevention-oriented communication. In Malawi, a peer-group intervention among hospital workers improved HIV-related knowledge, attitudes toward testing and condoms, and self-efficacy for prevention activities. Similarly, a meta-analysis of peer education interventions in developing countries found that peer-based programs were associated with significantly increased HIV knowledge (odds ratio [OR], 2.28; 95% confidence interval [CI], 1.88–2.75) and improved condom use outcomes [35], [36].

From a public health perspective, the observed improvement in HIV-related knowledge suggests that peer-facilitator training may serve as a practical strategy for strengthening workplace HIV prevention capacity. At the policy level, the findings support the integration of peer-facilitator training into workplace HIV prevention programs, particularly in project-based industries where workers are mobile and workplace health promotion may be difficult to sustain. This interpretation is consistent with international workplace HIV/AIDS guidance, which emphasizes workplace-based prevention education, non-discrimination, confidentiality, care and support, and the integration of HIV prevention into workplace health programs [37].

Rather than relying solely on external facilitators, construction companies may benefit from developing internal peer educators who can deliver repeated, context-specific prevention messages and reinforce non-discrimination principles in daily work settings. Therefore, integrating ToT-based HIV education into broader occupational health promotion activities may strengthen both feasibility and sustainability.

Although the ToT-based intervention showed promising short-term educational gains, training alone may not be sufficient to produce sustained prevention outcomes unless it is embedded within broader organizational support. Previous workplace HIV intervention research suggests that HIV prevention programs are more likely to be effective when education is accompanied by workplace policies, access to prevention resources, behavioral campaigns, management commitment, and referral pathways to HIV-related services [31], [38]. Evidence from Thailand, for example, showed that workplace HIV programs were more effective when training was integrated with policy and service components [31]. Therefore, the ToT model should be viewed not only as a short-term educational activity but also as one component of a broader workplace HIV prevention system.

This study contributes to workplace health promotion literature by demonstrating the feasibility of applying a structured ToT model in the construction sector, a workforce that is often mobile, project-based, and underserved by sustained health education programs. The findings suggest that facilitator-centered training may help construction companies develop internal peer educators who can support repeated HIV prevention messages, stigma reduction, and linkage to workplace or community-based HIV services. In this sense, the study extends previous evidence on workplace HIV education by showing how a ToT approach can be operationalized in a construction workplace context.

The potential sustainability of the ToT model depends on whether trained facilitators are supported after the initial training. Conceptual and evaluative literature on ToT emphasizes that cascade effects require not only high-quality initial training but also opportunities for facilitators to apply their skills, organizational support, refresher training, and resources to sustain local training networks over time [14], [19]. Accordingly, future implementation should consider integrating ToT-based HIV education into routine occupational health and safety programs, periodic refresher sessions, peer counseling referral, stigma reduction activities, and linkage to voluntary counseling and testing services [22].

Several limitations should be considered when interpreting these findings. First, the single-group pre-test–post-test design without a comparison group limits causal inference; therefore, the observed improvement cannot be attributed exclusively to the intervention. Second, participants were recruited purposively and nominated by management, which may have introduced selection bias and limited the representativeness of the sample. Third, knowledge was assessed immediately after the intervention using the same instrument, so testing effects, short-term recall, and the absence of longer-term knowledge retention assessment should be considered. Fourth, the study focused mainly on immediate knowledge gain and perceived readiness, rather than behavioral change, stigma reduction, uptake of HIV-related services, or actual implementation of workplace prevention activities. Fifth, the modest reliability coefficient of the knowledge assessment suggests that future studies should refine the instrument by adding more items, testing dimensionality, and conducting more comprehensive psychometric validation. Finally, the relatively small sample size and focus on one occupational context limit the generalizability of the findings. Future studies using controlled designs, larger samples, validated instruments, and longitudinal follow-up are needed to confirm the effectiveness, sustainability, and real-world impact of ToT-based HIV prevention interventions in workplace settings.

4. CONCLUSION

The present study addressed the limited availability of feasible and sustainable workplace HIV prevention models in the construction sector by implementing a structured ToT intervention. The program substantially improved HIV-related knowledge among construction workers and strengthened perceived readiness to support workplace prevention efforts. These findings indicate that a workplace-based ToT approach is a feasible and potentially scalable strategy for strengthening internal HIV prevention capacity in high-risk occupational settings. Future studies with controlled designs and longer follow-up are needed to assess knowledge retention, behavioral outcomes, and the sustainability of peer-facilitated workplace prevention activities.

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C : Conceptualization

M : Methodology

So : Software

Va : Validation

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O : Writing - Original Draft

E : Writing - Review & Editing

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P : Project administration

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CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interest to declare.

INFORMED CONSENT

Written informed consent was obtained from all participants before enrollment.

ETHICAL APPROVAL





The study protocol was approved by the Medical and Health Research Ethics Committee, Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada, Indonesia, approval number KE/FK/077/EC/2023.

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