Original Research

IMPROVING KNOWLEDGE OF NON-COMMUNICABLE DISEASE PROGRAM MANAGERS IN TUBERCULOSIS-DIABETES MELLITUS CONTROL AND CARE

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ABSTRACT

Introduction: Indonesia ranks second in the number of TB cases worldwide, accounting for 10% of the total TB cases. In addition, Indonesia ranks fifth in the number of DM cases worldwide. However, the integration of TB and DM disease management programs to ensure safe and quality care in health facilities is generally insufficient. **Aims:** This study aims to improve the knowledge of NCD program managers regarding TB-DM and their role in TB control and care. **Methods:** This study used a quasi-experimental design (non-randomized and non-control group) involving all healthcare workers (HCWs) managing NCD programs in Yogyakarta City. The participants were selected from 18 community health centers, 5 hospitals, the Health Office of Yogyakarta City. Prior to and following the training sessions, the knowledge of the participants was assessed. **Results:** According to the results of the Kruskal-Wallis test, no significant differences in TB-DM knowledge were observed among participants based on age group, length of employment, occupation, and highest level of education. However, following the training sessions, the participants showed a significant improvement in TB-DM knowledge according to the results of the Wilcoxon signed-rank test p = 0.000, with an effect size (r) of 0.57 (95% CI [0.000, 0.113]). **Conclusion:** Training for NCD program managers has been shown to improve their knowledge about TB-DM and their potential roles. Therefore, it is crucial to conduct continuous capacity-building programs for HCWs. These programs should be supported by policies, systems, and necessary infrastructures to ensure effective implementation of integrated care for TB and other diseases.

Keywords: case finding, diabetes mellitus, knowledge, TB-DM, tuberculosis

INTRODUCTION

Chronic diseases, including non-communicable diseases (NCDs) and infections, are a significant global burden as they are the primary cause of illness and mortality (World Health Organization (WHO), 2018). The burden of NCDs is increasing, especially in low- and middle-income countries (Salam, 2016). One of the significant NCDs is diabetes mellitus (DM), with a high prevalence. In 2020, 537 million people suffered from DM (International Diabetes Federation, 2021). Sun et al.

(2022) found that in 2021, the prevalence of diabetes was higher in urban areas (12.1%) than in rural areas (8.3%), and in high-income countries (11.1%) than in low-income countries (5.5%). In addition, Indonesia ranks fifth in the number of DM cases worldwide with 19.5 million cases (International Diabetes Federation (IDF), 2021). IDF predicts that the number of individuals with DM in Indonesia will continue to increase every year.

Infectious diseases, such as tuberculosis (TB), are among the top 10 causes of death worldwide (WHO, 2020).

In 2019, 10 million people suffered from TB, resulting in approximately 1.2 million deaths excluding HIV (Chakaya *et al.*, 2021). In 2022, 30 countries with a significant TB burden accounted for 87% of global TB cases. Eight of these countries comprised two-thirds of the global TB cases. Indonesia ranked the second and contributed to 10% of the global TB cases (WHO, 2023). According to national reports, Indonesia has 1,017,290 TB cases (Ministry of Health, 2018), with an estimated annual mortality rate of 61,000 deaths (Ministry of Health, 2011).

The high incidence of TB cases in which DM is a significant contributing factor necessitates the implementation of an integrated TB-DM program as a national priority (WHO, 2022). Research has shown that the incidence of diabetes among TB patients ranges from approximately 5% to more than 50% (Zheng, Hu and Gao, 2017). In contrast, in underdeveloped Asian nations, the prevalence of TB among patients with DM was 1.8 to 9.5 times higher than in the general population. Moreover, the prevalence of DM is more significant than TB mortality, as it directly affects the likelihood of developing TB (WHO, 2023). DM is also associated with treatment failure, relapse, and mortality in TB cases (Golub et al., 2019). However, the COVID-19 pandemic has significantly decreased the number of reported TB cases (World Health Organization, 2023). Therefore, it is essential to implement a variety of strategies, including cross-program roles, to achieve the elimination of TB by 2030.

The integration of TB and DM programs remains ineffective despite the publication of the Collaborative Framework for Care and Control of Tuberculosis and Diabetes by the WHO in 2011 (WHO, 2011; Arini, Sugiyo and Permana, 2022). In 2019, the Indonesian government released the National Guidelines for Tuberculosis Treatment Medical Services, which requires strict adherence to similar guidelines as stated in the Decree of the Minister of Health of the Republic of Indonesia No. HK.01.07/MENKES/755/2019 concerning the National Guidelines for Tuberculosis Care Management (Ministry of Health, 2019). However, coordination between NCD and TB program managers is generally insufficient. Implementation at health facilities typically indicates that bidirectional screening and internal networking have not been implemented (Arini, Sugiyo and Permana, 2022). At the regency/city and provincial program levels, there is generally no policy to encourage the involvement of technical implementers (Prakoso et al., 2023). At the national level, there is still a need for full synchronization of health financing support in the implementation of TB screening for DM patients as mandated by the 2015 national guidelines (Arini, Sugiyo and Permana, 2022).

Inadequate TB-DM integrated care is often associated with a lack of awareness and knowledge among NCD healthcare workers (HCWs) about the susceptibility of DM patients to TB and vice versa, as well as the need for better diagnosis and management of TB-DM cases (Workneh, Bjune and Yimer, 2016). Limited knowledge among HCWs about TB-DM comorbidity can affect the effectiveness of the implementation of collaborative frameworks (Salifu and Hlongwana, 2021b). Communication and coordination issues often occur between HCWs at community health centers (CHCs), clinics, and hospitals, with limited feedback from referral health facilities (Arini, Sugiyo and Permana, 2022). In addition, there are gaps in integrated programs and joint coordination of TB and DM activities at the national and regional levels (Salifu and Hlongwana, 2021a).

According to the 2023 Health Profile of Yogyakarta City, the number of reported TB cases in Yogyakarta City increased from 879 in 2021 to 1,355 in 2022. In 2022, 13,676 patients with diabetes received healthcare services according to

standards, compared to 12,554 patients in 2021 (Health Office of Yogyakarta City, 2023). An increasing number of DM cases indicates a higher susceptibility to TB (Ayelign et al., 2019). Therefore, it is crucial that HCWs have adequate knowledge about the detection and diagnosis of TB in patients with DM, particularly in resource-limited settings (Ogbera et al., 2013). Strengthening healthcare providers in medical facilities for TB detection in DM patients will lead to a significant reduction in adverse health outcomes through early diagnosis and prompt treatment. As a result, this study aims to improve the knowledge about TB-DM among healthcare professionals responsible for managing NCD programs in health facilities and their contribution to the control and care of TB-DM.

METHODS
Design and Setting

This study used a quasi-experimental, non-randomized design with no control group and before-and-after analysis (Harris et al., 2006). This research was also a part of a larger research project aimed at improving medication supervision and TB treatment success rates in Yogyakarta City, an urban area and the capital of the Special Region of Yogyakarta Province. This study was conducted in collaboration with the Health Office of Yogyakarta City in June 2023. All community health centers (CHCs) and five hospitals in Yogyakarta City were involved in this study.

Participants

This study involved the entire population (total sampling) of all NCD program managers invited by the Health Office of Yogyakarta City. The target population consisted of health workers managing the NCD program in health service facilities in Yogyakarta City, including 18 CHC officers, five hospital officers, and two officers of the Health Office of Yogyakarta City.

A questionnaire was used to collect data on the characteristics of the participants. Identifiers were used instead of actual identities, which are known only to the authors. Questionnaires containing the identity of the participants are stored in a secure location to prevent unauthorized access.

Table 1. Materials delivered to the participants

Topic	Speaker
National and regional policies regarding TB and DM	Head of Disease Prevention and Control Division, Health Office of Yogyakarta City
TB and DM situations in Yogyakarta	1. Head of Prevention and Control of NCD Section, Health Office of Yogyakarta City 2. Head of Prevention and Control of Infectious Diseases Section, Health Office of Yogyakarta
Integrated screening, diagnosis, and care of tuberculosis in individuals with diabetes, and vice versa, according to the Consensus on the Management of Tuberculosis and Diabetes Mellitus (TB-DM) in Indonesia	TB-DM integration expert

Intervention and Data Collection

Four speakers delivered the materials in three sessions, as detailed in

Table 1. After each session, the participants were given time for questions and answers. The training sessions focused on policies, the seriousness of TB-DM comorbidity, and

the critical role of DM program managers in detecting new TB cases or TB relapse in DM patients after TB treatment. The participants were also introduced to national and regional policies concerning TB-DM, the symptom-based TB screening tool, and follow-up and reporting of screening results. The importance of internal networking within healthcare facilities to improve TB-DM management was also highlighted. In addition, other roles, such as educating people on the benefits of early detection of DM or pre-diabetes conditions, can prevent susceptibility to TB later in life.

This study measured an educational intervention that was delivered once, with each session lasting approximately one hour. The speakers used PowerPoint for their presentations and the participants received supplementary materials in the form of soft files. These materials included the 2015 Consensus on the Management of Tuberculosis and Diabetes Mellitus (TB-DM) in Indonesia, a symptom-based TB screening instrument, and a Manual Adaptation of TB-DM Care and Control.

The study collected data through self-administered, paper-based pre-tests and post-tests. The questionnaire comprised ten true-or-false questions, as shown in Table 2. The questionnaire was validated for face and construct validity by experts in TB-DM and the TB program manager at the Health Office of Yogyakarta City. The Cronbach's alpha for the questionnaire was 0.749, indicating that the questionnaire was reliable. Based on the validity test results, question items 1 to 5 had corrected item-total correlation values lower than the R table (0.423). Despite this, the experts agreed that these items should not be deleted and should be retained due to their importance. These lower correlation values may also be due to the natural condition of the limited knowledge of the participants about the matters in question (Arini et al., 2021).

Table 2. Pre-test and post-test questionnaire

No.	Question	True	False
1.	Based on research, most TB patients in Indonesia initially seek treatment at community health centers.	☐	☐
2.	DM patients suffering from TB often show atypical symptoms.	☐	☐
3.	According to the WHO criteria, the diagnosis of pre-diabetes can be made if the fasting blood sugar level is between 100 and 125 mg/dl.	☐	☐
4.	A standard dose of anti-tuberculosis treatment can ensure an adequate level of TB drugs in the blood of patients with TB-DM.	☐	☐
5.	DM is an attributable factor that contributes to TB with a smaller increase in risk than undernutrition.	☐	☐
6.	The initial chest X-ray examination for DM patients according to the 2015 TB-DM management consensus in Indonesia is to establish a diagnosis of TB.	☐	☐
7.	If a patient with TB-DM does not have controlled blood sugar, TB treatment may be extended for up to nine months.	☐	☐
8.	TB treatment carries the risk of causing hepatotoxic side effects, which can reduce the effectiveness of oral hyperglycemic medications.	☐	☐
9.	The goal of DM care management for individuals with TB is to attain a post-prandial blood sugar level of less than 180 mg/dl.	☐	☐

No.	Question	True	False
10.	The implementation of public-private partnership in Indonesia emphasizes the involvement of the private sector at the regency/city level.	☐	☐

Data Analysis

The questionnaire was scored by assigning a value of 1 to correct answers and 0 to incorrect answers. No points were deducted for incorrect answers. The final score was determined by the total number of correct answers. The pre-test and post-test scores as well as the demographic characteristics of the participants, including sex, age, educational background, occupation, institution, and length of employment, were analyzed descriptively using SPSS to obtain frequencies, percentages, and means (age and length of employment).

The research findings were also analyzed using SPSS. The Shapiro-Wilk test was performed to assess the normality of the distribution of pre-test and post-test scores for sample sizes less than 100. Meanwhile, the Wilcoxon signed-rank test using the effect size (r) was performed to determine the significance of the difference between two paired or matched samples (Maher, Markey and Ebert-May, 2013). The test involved dividing the Z statistics by the square root of the sample size. Finally, the Kruskal-Wallis test was performed to compare the knowledge of the participants based on age, length of employment, educational level, and occupation.

Ethics

As part of a larger research project, this study received approval from the Research Ethics Committee of the Faculty of Medicine and Health Sciences at University of Muhammadiyah Yogyakarta with a certificate number 161/EC-KEPK FKIK UMY/III/2023. Informed consent was obtained from all participants prior to data collection.

Table 3. Characteristics of the participants

Variable	Category	Frequency	(%)
Sex	Male	8	32
	Female	17	68
Age (years)	25-35	17	68
	36-45	3	12
	46-52	5	20
Educational background	Diploma	16	64
	Profession	4	16
	Bachelor's degree	5	20
Occupation	Doctor	6	24
	Nurse	17	68
	Others	2	8
Institution	District Health Office	2	8
	Community Health Center	18	72
	Hospital	5	20
Length of employment (years)	1-5	17	68
	6-10	3	12
	>10	1	4
	No information	4	16

RESULTS

This study involved 25 HCWs who managed NCD programs in CHCs, hospitals, and health offices. The characteristics of the participants are shown in Table 3. The most prevalent age group of the participants was 25-35 years (n = 17), accounting for 68% of the total sample size. The average age of the participants was 35.32 years, with a minimum of 25 years old and a maximum of 52 years old. The majority of the participants (n = 16; 64%) had completed their education at the diploma level. Seventeen participants (68%) worked as nurses. The majority of the participants (n = 17; 68%) reported a length of employment between one to five years, with a mean length of employment of 4.31 years (a minimum of one year and a maximum of 29 years). In addition, 72% of the respondents were from CHCs, which primarily run region-based NCD programs in Indonesia.

A non-parametric analysis was performed using the Wilcoxon signed-rank test since the data did not conform to a normal distribution ($p < 0.05$), as presented in Table 4. The results of the Wilcoxon signed-rank test showed a significant difference in the knowledge of the participants before and after receiving the materials ($p = 0.000$), as presented in Table 5. The average pre-test and post-test data analysis showed a significant increase from 55.20 to 77.60 (Figure 1). The effect size was medium ($r = 0.7$) based on Cohen's (1988) criteria (Wilcox, 2023).

This study also analyzed the comparison of knowledge based on pre-test and post-test scores among all participants, as shown in Table 6. In terms of knowledge about TB-DM comorbidity control and care, the results of the Kruskal-Wallis test showed no significant differences among the participants in terms of age group, length of employment, occupation, or highest level of education with a p-value of more than 0.05. Based on these findings, it appears that the demographics of the participants did not affect their knowledge about TB-DM comorbidity control and care.

Table 4. Data distribution using the Shapiro-Wilk normality test

	Statistics	**Degree of freedom**	**p**
Pre-Test	0.942	25	0.167
Post-test	0.862	25	0.003

Table 5. Knowledge comparison using the Wilcoxon signed-rank test

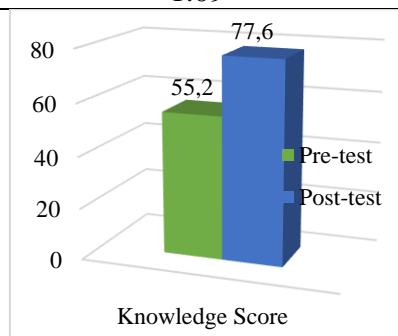|	**Mean**	**Standard deviation**	**p**	**z**	**r (effect size)**
Pre-test	5.52	1.23	0.000	-4.037	0.57
Post-test	7.76	1.09		(95% CI [0.000, 0.113])	

Figure 1. Mean of TB-DM Knowledge Scores (Pre- and Post-Test)

Table 6. Knowledge comparison among participants using the Kruskal-Wallis test

Category	Pre-Test (p-value)	Post-Test (p-value)
Age	0.110	0.693
Length of employment	0.158	0.274
Level of education	0.922	0.706
Occupation	0.302	0.197

DISCUSSION

This study was conducted primarily to improve the outcomes of the TB program. As a preliminary step towards integrating two programs, this study sought to improve the knowledge about TB among health professionals who managed NCDs. The findings indicated a statistically significant increase in the knowledge of HCWs. Cross-program involvement is essential due to the reciprocal influence of TB and DM on each other's susceptibility and the risk of treatment failure in terms of pathophysiology (Ugarte-Gil et al., 2019). Integrating healthcare, especially TB-DM bidirectional screening, is crucial for improving patient satisfaction, perceived quality of care, and access to healthcare (Baxter et al., 2018). Diabetic patients should be screened to determine if they are infected with TB and seek immediate treatment (Ministry of Health, 2020a).

This study consideres the knowledge of healthcare workers essential for the collaborative care of diabetes and TB comorbidity. The challenges in integrating the care and control of TB-DM include prioritizing TB-HIV comorbidity over TB-DM, inadequate knowledge of TB and DM comorbidity, and limited understanding of the integrative framework due to insufficient training (Salifu and Hlongwana, 2021b). Several studies confirm the importance of improving the knowledge of health workers to establish collaborative TB-DM care and control (Ogbera et al., 2013; Workneh, Bjune and Yimer, 2016; Salifu and Hlongwana, 2020). In addition healthcare facilities, availability of medications, and data infrastructure, effective screening, diagnosis, and treatment of TB and diabetes comorbidity require significant investment in human resources (Koya et al., 2022).

Furthermore, the results of this study showed a significant increase in the knowledge of the participants prior to and following the training sessions. Improving the knowledge of implementers is the initial step towards achieving better community health outcomes. This finding is supported by previous research, which suggested that educational initiatives targeting HCWs can significantly improve their knowledge and healthcare outcomes (Elgazzar et al., 2023). A study on the implementation of TB-DM screening in a Pakistani program setting also provides valuable insights. The study highlights the importance of training HCWs to refer individuals with diabetes for regular TB screening. HCWs should also be trained to make reference for other diabetes-related complications (Basir et al., 2019). Similarly, Buregyeya et al. (2016) found that the lack of training on TB management is associated with insufficient knowledge and unfavorable attitudes of health professionals towards TB. A systematic review with meta-analysis confirms that education and training for HCWs and volunteers can improve TB case detection (Amare et al., 2023).

Consistent with this study, research findings from various settings have shown that lectures and discussions could significantly improve the knowledge of the participants. The program educates clinical staff to better manage and prevent TB in individuals with DM and provides a comprehensive guideline for developing similar programs in the community setting (Salcedo, 2015). Furthermore, there are significant differences in healthcare skills

between health professionals who have received health education and those who have not. These differences may affect the engagement of health workers in fulfilling their role as health education counselors (Kabasakal and Kublay, 2017). However, previous studies have found that understanding of and expertise in TB are complex, leading to insufficient knowledge of HCWs in some areas (Main *et al.*, 2022). Therefore, the expansion of TB education and engagement programs for healthcare workers is needed.

Most of the participants in this study had a high level of education, with the majority having completed a diploma. Additionally, pre-and post-test results showed no significant difference among the education level category. This may be due to TB-DM being a specialized topic that is not widely disseminated beyond TB program managers. In contrast to this study, several studies have shown a direct relationship between the education level of an individual and the impact of the educational content they are exposed to. Similarly, Noé et al. (2017) found that a higher level of education is associated with a higher level of knowledge. Moreover, a study conducted by Shrestha et al. (2017) showed that the knowledge level regarding tuberculosis infection control (TBIC) of health workers is significantly influenced by their educational status and the training they receive.

The results of this study showed no significant difference in knowledge among HCWs with different occupation. This finding may be attributed to TB education or training that is specific to HCWs who manage TB programs, regardless of their occupation. Meanwhile, Wondimu et al. (2021) found that the knowledge of an individual about TBIC is strongly associated with their current career, job setting, and training background. A study in conducted Gabon found a strong correlation between occupation and knowledge regarding TB (Vigenschow et al., 2021). Similarly, a study conducted in Ethiopia

showed a significant correlation between the current occupation of HCWs and their adherence to TBIC (Tadesse et al., 2020).

Furthermore, this study found that most participants were between 25 to 35 years and had less than five years of work experience. This study found no significant differences between age and length of employment in knowledge about TB-DM. Similarly, Nabihah et al. (2018) found no significant correlation between age and knowledge about TB. However, Baral and Koirala (2022) found that HCWs aged 40 years or older possess more knowledge than their younger counterparts due to their seniority and longer tenure in the field, which results in greater experience and expertise. Noé et al. (2017) also found that individuals, who have worked directly with the patients for one to five years, experience more than double the increase in knowledge. Nevertheless, it is important to note that age does not have a significant impact on the level of knowledge.

DM program managers can make a significant contribution to the elimination of TB. This study emphasizes the importance of educating individuals on preventing and detecting TB and DM, managing patients, handling data, and reporting according national guidelines. In addition to TB-DM bidirectional screening, as suggested by research in Malawi, HCWs can carry out joint coordination in TB-DM services, including monitoring patient management (Nyirenda et al., 2023). A study in Semarang, Indonesia found that health workers who had received training could carry out TB screening in DM patients (Sulistiyani et al., 2019). Therefore, providing TB-related training to HCWs is essential for NCD program managers.

Although the results showed a significant increase in knowledge after the educational intervention, knowledge alone cannot solve all problems related to disease control programs. Previous research has identified several factors that complicate the implementation of integrated TB-DM

care, including barriers within the healthcare system, inadequate bidirectional screening practices, and the need for multisectoral involvement (Arini, Sugiyo and Permana, 2022). A heavy workload in clinics, multiple responsibilities of HCWs, and unsafe working environments also hinder the integration of TB-DM care (Salifu and Hlongwana, 2021b). In addition, an essential component in supporting early detection and prevention of TB transmission is a support system from family, colleagues, and the community through health information seeking (Novita et al., 2022). Several factors may influence patients to visit health facilities, including education, employment status, health insurance, and perception of the disease (Puspitasari, Roesdiyanto and Rizka, 2023). As a consequence, the government is persistently working towards achieving TB eradication by 2030 through various approaches (Ministry of Health, 2020b).

More comprehensive efforts are needed so that knowledge improvement goes hand in hand with the improvement of program implementation and quality. Policymakers should consider supporting factors and breaking barriers to implementing integrated programs such as TB-DM (Prakoso et al., 2023). Ayatulloh et al. (2021) suggested that thorough efforts, such as knowledge management in health service facilities, can improve information and knowledge dissemination processes, decision-making skills, and the quality of healthcare services. Quaife et al. (2021) found that high-quality care in the health system depends on knowledgeable and motivated HCWs. Furthermore, in developing countries, health policy, infrastructure, and community empowerment are needed to ensure successful cross-program integration, as suggested by the Chronic Care Model (CCM) (Ariffin et al., 2017). Therefore, to achieve desirable healthcare outcomes, community activation, health systems, self-management support, and clinical information systems should run simultaneously (Lall et al., 2018; Kong et al., 2019).

This study has both strengths and limitations that must be taken into consideration. One strength is the involvement of the health office in this study, which contributed to achieving learning success. However, this study is limited to a single measurement of knowledge, which only allows for the assessment of changes in the knowledge or behavior of HCWs at a later time. This study examined general knowledge about TB-DM, but did not evaluate healthcare workers' abilities in screening, coordination, reporting, referrals, and other integrated service activities. Evaluating the practicality and accuracy of integrating TB and DM in primary and referral health facilities is essential for future research.

CONCLUSION

This study found a significant improvement in knowledge among NCD program managers regarding TB-DM after the training sessions. Considering that increasing knowledge is essential to raise awareness and capacity in cross-program implementation, continuous improvement in knowledge about the integration of TB-DM and other comorbid diseases is necessary. In addition, successful implementation of integrated care and control of TB-DM requires policy support, necessary infrastructure, and appropriate screening tools.

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