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Assistance in the Prevention of TBC Transmission with The Application of Appropriate Technology Using Cyclone Ventilator Modification (CVM) in the Houses of Pulmonary TB and ISPA Patients as Well as PHBS Activities in Wonokusumo District

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ABSTRACT In Wonokusumo Village, 2022 saw a significant health challenge, with 186 cases of tuberculosis (TB) and 155 cases of acute respiratory infections (ARI) reported by the Health Department. This community service initiative aimed to reduce TB and ARI cases through promotional and preventive measures utilizing a modified cyclone ventilator (CVM). The CVM enhances indoor lighting and maintains optimal air circulation at a velocity of 0.15 m/s, in accordance with healthy housing regulations. Many homes in Wonokusumo are overcrowded and lack proper ventilation, with natural ventilation less than 15% of floor area. The close proximity of houses restricts light and air flow, and inadequate space conditions (rooms smaller than 4m² housing more than two occupants) contribute to unhealthy living environments. Implementing a healthy housing structure is vital for ensuring clean indoor air, which can prevent disease transmission, including TB. Our community service involved educating residents about maintaining clean and healthy homes, focusing on the importance of proper ventilation, lighting, and humidity control to mitigate TB and ARI risks. We distributed CVMs to three TB and ARI patients' homes, significantly improving knowledge about TB and ARI, as demonstrated by pre- and post-test results: TB knowledge rose from 20% to 94%, ARI from 18% to 90%, handwashing from 16% to 92%, and sanitation awareness from 14% to 90%. We recommend that the local health center promote health initiatives to reduce household transmission risks for TB. Overall, this initiative fostered improved public health awareness and contributed to enhancing community well-being in Wonokusumo.

INDEX TERMS : Tuberculosis (TB), Acute Respiratory Infections (ARI), Cyclone Ventilator, PHBS.

I. INTRODUCTION

The Indonesian healthcare system has undergone significant transformations in recent years, responding to a growing population and complex health challenges. The Ministry of Health of the Republic of Indonesia emphasizes the need for a revamped health system to enhance service effectiveness and efficiency. This transformation aims to improve service quality, increase accessibility, and reduce health disparities across regions[1].

At the core of this health transformation are six pillars, which serve as strategic pathways for advancement: (1) Primary Service Transformation, (2) Referral Service Transformation, (3) Health Resilience System Transformation, (4) Health Financing Transformation, (5) Human Resource Transformation, and (6) Health Technology Transformation. A critical aspect of this initiative is the effort to break the transmission chains of infectious diseases, including tuberculosis (TB), diarrhea, dengue fever, and malaria[2] [21].

Tuberculosis remains a significant public health issue in Indonesia, with an estimated 824,000 cases. It ranks as one of the top ten causes of global mortality, placing Indonesia third in TB burden after India and China. The country aims to eliminate TB by 2030, targeting an incidence rate of 65

per 100,000 population and a mortality rate of 6 per 100,000. However, only 48% of TB cases are identified, treated, and reported, leaving many undetected[3] [22]..

In East Java, TB cases increased from 53,289 in 2021 to 81,753 in 2022, with 40,000 cases currently reported. The city of Surabaya accounts for a significant portion of these cases, with various districts reporting high incidences of TB and acute respiratory infections (ARI). In Wonokusumo, the high population density exacerbates health risks, as inadequate housing conditions contribute to the spread of these diseases[4] [6].

The living conditions in Wonokusumo, with a population of over 76,000, present challenges in maintaining healthy environments. Many homes lack adequate ventilation, light, and space, further promoting disease transmission. Low awareness regarding healthy living practices, particularly in hygiene and sanitation, amplifies these risks[7] [16..

Unhealthy housing conditions create a conducive environment for airborne pathogens, facilitating the transmission of diseases such as TB and ARI. With insufficient air circulation and cleanliness, homes can become breeding grounds for harmful microorganisms. This reality underscores the urgent need for effective interventions[5] [17].

To address these challenges, implementing appropriate technology for indoor air quality improvement is crucial. The modified cyclone ventilator (CVM) offers a viable solution by enhancing ventilation, increasing natural light, and maintaining humidity levels, which are essential for preventing disease transmission[8] [9].

Research indicates a strong correlation between housing sanitation and indoor air quality, particularly concerning TB transmission. Studies have demonstrated that technologies like the CVM can significantly improve indoor air conditions, reducing the risk of airborne diseases[10] [11].

Given the pressing health challenges in Wonokusumo, community engagement initiatives focusing on education about maintaining clean and healthy homes are essential. This program aims to utilize the CVM to enhance air quality while raising awareness of personal hygiene and healthy living practices among residents[23] [24] [25].

The proposed community service project aims to support TB and ARI patients by implementing the CVM technology, promoting public health, and fostering a healthier living environment in Wonokusumo, thus contributing to the overall goal of reducing TB transmission and improving community health outcomes.

II. METHODE AND IMPLEMENTATION

The planned community service activities in Wonokusumo Village, Surabaya City for the year 2024 are as follows:

A. TRAINING/EDUCATION (LECTURES AND DISCUSSIONS)

The training will focus on the appropriate technology of modified cyclone ventilators (CVM) and the benefits of this tool in creating good air circulation indoors, enhancing lighting in rooms (direct sunlight can directly kill the mycobacterium tuberculosis microorganisms), and maintaining room humidity with an airflow speed of 0.15 m/s. The CVM is also equipped with activated charcoal to absorb all substances, solids, gases, and microorganisms present in the room, conditioning it to be odor-free. Educational sessions will cover the dangers of Tuberculosis (TB) and Acute Respiratory Infections (ARI), healthy housing, and healthy living behaviors related to hand washing and personal hygiene, as well as the health impacts caused by environmentally based diseases. The CVM tool is intended to be implemented in more homes, thereby reducing the TB incidence through promotional and preventive activities. This material will be presented by speakers and students from the Academic Community of the Environmental Health Department at Poltekkes Kemenkes Surabaya, targeting the residents of Wonokusumo Village.

B. PROVISION OF PHYSICAL ASSISTANCE

Physical assistance will be provided in the form of three units of CVM to three households affected by TB/ARI as a model in Wonokusumo Village. The purpose of this model is to demonstrate improvements in healthy housing, including increased indoor lighting. The installation of the CVM in the homes of TB/ARI patients will be adjusted to the ceiling conditions of the respective houses.

The results of community service activities conducted in Wonokusumo Village, Surabaya City in 2024, titled "Assistance for Preventing TB Transmission through the Implementation of Modified Cyclone Ventilator Technology (CVM) in Homes of TB and ARI Patients, as well as PHBS Activities in Wonokusumo Village, Surabaya City in 2024" include:

C. IMPLEMENTATION OF APPROPRIATE TECHNOLOGY CVM

The community service activities led by the Environmental Health Department aimed to create good indoor air circulation in the homes of TB and ARI patients, ensuring that room humidity does not exceed 60%, which is an optimal condition for microorganism growth. The installation of CVM in the working area of the Wonokusumo Health Center was carried out in three patients' homes as follows:

FIGURE 1. Installation in Patient 1's home

FIGURE 1, 2 show that the living conditions in Wonokusumo Village are densely populated and the homes do not meet health standards, specifically due to insufficient ventilation (less than 15% of floor area for natural

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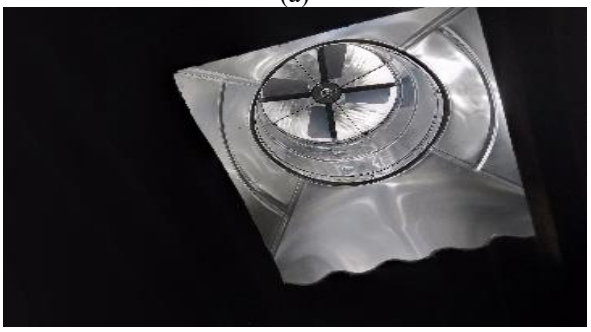
ventilation), lack of light, and obstruction of external air circulation by various items

The construction of these homes is semi-permanent using plywood, with rooms less than 4 m² and housing more than two people. Healthy housing construction can create a healthy indoor environment, protecting occupants from disease transmission, including temperature control, ventilation, lighting, and occupancy density. Lighting plays a crucial role in killing bacteria such as Streptococcus and Staphylococcus, which cause ARI, and Mycobacterium tuberculosis, which causes TB[1] [18].

(a)



(b)

FIGURE 2. (a) Installation in Patient 2's home and Installation in Patient 3's home

Unhealthy environmental conditions, such as air circulation of less than 0.15 m/s, humidity, and lack of lighting, can serve as breeding grounds for microorganisms like tuberculosis bacteria. Such conditions allow for airborne disease transmission, including influenza, pneumonia, measles, rubella, and TB. In Indonesia, TB transmission occurs rapidly due to the below-average economic conditions of the population, resulting in unhealthy housing facilities, inadequate ventilation and lighting, semi-permanent walls, and high occupancy density[2][3].

Efforts to reduce TB/ARI rates include air sanitation, which aims to ensure that the air around us is free from pollutants that can affect health, particularly protecting against airborne infectious diseases. According to Minister of Health Regulation No. 1077 of 2011, efforts for indoor air sanitation include physical, chemical, and biological substances. Among the air pollutants defined in air pollution definitions, biological substances, particularly harmful bacteria-laden air, are highlighted. Research by Imam Thohari et al. in 2015 demonstrated a relationship between home sanitation and the microbiological quality of air in homes of TB patients in the Pegirian Health Center area in Surabaya. Research by Khambali et al. in 2017 showed that the application of modified cyclone ventilators for air sanitation proved effective in creating comfortable indoor air for occupants. Findings by Evi Nurdiana et al. in 2018 concluded that the physical condition of homes affects the transmission of TB among family members[4][5].

The primary issue with indoor air pollution is that pollutant concentrations are often higher indoors than outdoors. The United States Environmental Protection Agency (US EPA) states that long-term exposure to unhealthy indoor air can lead to severe and difficult-to-treat lung diseases, heart diseases, and cancers. Furthermore, according to indoor pollutants can cause health disturbances, both long-term and short-term, with sources of indoor air pollution stemming from household activities, kitchens, cigarette smoke, building materials, etc. Healthy air is essential for improving quality of life, but the current conditions have become detrimental, as residential areas become increasingly cramped, highlighting the need for air sanitation. The application of modified cyclone ventilator technology for indoor air sanitation is a fitting solution, especially in densely populated urban areas like Surabaya. This tool aids in creating good air circulation indoors, increasing lighting (direct sunlight will kill mycobacterium tuberculosis), and maintaining humidity with an airflow speed of 0.15 m/s, thereby controlling temperature and humidity. The device is also equipped with activated charcoal to absorb substances, solids, gases, and microorganisms present in the room, conditioning it to be odor-free. This device is the product of the Leading Basic Research of Higher Education (PDUPT) project titled "Application of Modified Cyclone Ventilator Technology to Improve Indoor Air Quality for TB and ARI Patients" [6].

D. EDUCATIONAL ACTIVITIES

The community service activities conducted by the lecturers and students of the Health Department, titled "Assistance for Preventing TB Transmission through the Implementation of Modified Cyclone Ventilator Technology (CVM) in Homes of TB and ARI Patients, as well as PHBS Activities in Wonokusumo Village, Surabaya City in 2024," included educational sessions as follows:

Based on the data in TABLE 1, it can be observed that prior to the educational sessions regarding TB, 10 respondents (20%) understood the subject, while 40 respondents (80%) did not. For ARI, 9 respondents (18%) understood, while 41 (82%) did not. For handwashing, 8 respondents (16%) understood, while 42 (84%) did not. Regarding sanitation, 7 respondents (14%) understood, while 43 (86%) did not. Post-test results showed that after the sessions, 47 respondents (94%) understood TB, while 3 (6%) did not. For ARI, 45 respondents (90%) understood, while 5 (10%) did not. For handwashing, 46 respondents (92%) understood, while 4 (8%) did not. For sanitation, 45 respondents (90%) understood, while 5 (10%) did not. During the Q&A session, respondents were very enthusiastic, evidenced by their active

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TABLE 1.
Level of Community Knowledge about Pulmonary Tuberculosis, Acute Respiratory Infections, Clean and Healthy Behavior, and Healthy Settlements

No	Variable	Understand		Not Understand		Total	
		n	%	n	%	n	%
Pre Test							
1	TB Paru	10	20	40	80	50	100
2	ISPA	9	18	41	82	50	100
3	CTPS	8	16	42	84	50	100
4	Sanitasi Permukiman	7	14	43	86	50	100
Post Test							
1	TB Paru	47	94	3	6	50	100
2	ISPA	45	90	5	10	50	100
3	CTPS	46	92	4	8	50	100
4	Sanitasi Permukiman	45	90	5	10	50	100

participation in answering questionnaires, which showed an increase in knowledge regarding TB, ARI, handwashing, and sanitation.

FIGURE 4. Photo of the Educational Activity

FIGURE 5. Symbolic souvenir packages

The activities aimed to conduct outreach on the topic of healthy settlements. The target audience for this outreach consisted of 50 community members in the Working Area of the Wonokusumo Health Center. The outreach on healthy settlements was delivered to these 50 participants. The community members showed great enthusiasm, as evidenced by their active participation in discussions regarding the topic of healthy settlements. During the discussions, participants who asked questions received souvenirs, such as handwashing supplies (soap and toothbrushes), to encourage active engagement. The community service team provided a total of 4 souvenirs. More information about the community service activities can be accessed at the following link : https://l1nk.dev/xPzvw

IV. DISCUSSION

Wonokusumo Village** is very densely populated, and the housing conditions do not meet health standards. There is a lack of ventilation, with less than 15% of the floor area allocated for natural ventilation. Light cannot enter the homes because they are tightly packed together, and external air circulation is obstructed by numerous items. The houses are constructed from non-permanent materials like plywood, with room sizes less than 4 m², often housing more than two people. Healthy housing construction can create a healthy indoor environment, protecting occupants from disease transmission, including controlling room temperature, ventilation, lighting, and occupancy density[7][19].

Lighting plays a crucial role in killing bacteria such as Streptococcus and Staphylococcus, which cause ARI, and Mycobacterium tuberculosis, which causes TB. Unhealthy environmental conditions, such as air circulation of less than 0.15 m/s, humidity, and lack of lighting, can become breeding grounds for microorganisms like tuberculosis bacteria. Such room conditions facilitate airborne disease transmission, including influenza, pneumonia, measles, rubella, and pulmonary TB. In Indonesia, the transmission of pulmonary TB spreads rapidly due to below-average economic conditions, resulting in unhealthy housing facilities with inadequate ventilation and lighting, semi-permanent walls, and high occupancy density[8] [20].

Efforts to reduce the incidence of TB/ARI include the following: Air sanitation is an effort to ensure that the air surrounding us is free from pollutants that can adversely affect health, particularly in protecting against airborne infectious diseases. According to Minister of Health Regulation No. 1077 of 2011, indoor air sanitation efforts include physical, chemical, and biological substances. Among the air pollutants defined, one is biological substances, with airborne bacteria being the most dangerous[9][16].

Research conducted by Imam Thohari et al. in 2015 demonstrated a correlation between home sanitation and the microbiological quality of air in the homes of TB patients in the Pegirian Health Center area in Surabaya. According to research conducted by Khambali et al. in 2017, the application of modified cyclone ventilators for air sanitation proved that this tool could create comfortable indoor air for its occupants. Findings from research by Evi Nurdiana et al. in 2018 concluded that the physical condition of homes influences the transmission of pulmonary TB among family members[10].

The primary issue with indoor air pollution is that pollutant concentrations are generally higher indoors than outdoors (Department of Health Minnesota in Saragih, Winda, 2011). An association known as the United States Environmental Protection Agency (US EPA) states that long-term exposure to unhealthy indoor air can result in severe lung diseases, heart diseases, and cancers that are difficult to treat and potentially fatal. According , the presence of pollutants in indoor air can cause health issues both in the long and short term, with sources of indoor air pollution arising from household activities such as kitchens, cigarette smoke, building materials, and more[21].

Healthy air is crucial for improving quality of life, but the current situation has become the opposite, with residential areas becoming increasingly cramped, highlighting the need for air sanitation. The application of modified cyclone ventilator technology for indoor air sanitation is a highly appropriate solution given the conditions in urban Surabaya where houses are closely packed together. This tool is beneficial for creating good air circulation indoors, enhancing lighting (direct sunlight can kill Mycobacterium tuberculosis), and maintaining indoor humidity with an airflow speed of 0.15 m/s, helping to regulate temperature and humidity. Additionally, the device is equipped with activated charcoal to absorb all substances, solids, gases, and microorganisms present in the room, conditioning it to be odor-free. This tool is the product of the Leading Basic Research of Higher Education (PDUPT) project titled “Application of Modified Cyclone Ventilator Technology to Improve Indoor Air Quality for TB and ARI Patients” [4].

V. CONSLUSION

Conclusions based on the results of the Community Service activities of Environmental Health Department Lecturers with the title "Assistance in Preventing TB Transmission by Implementing Appropriate Technology for Modified Cyclone Ventilators (CVM) in the Homes of Pulmonary TB and ISPA Sufferers and PHBS Activities in Wonokusumo Village, Surabaya City in 2024", which are as follows :

1. Increasing public knowledge about healthy home conditions based on statutory regulations.
2. Increase public knowledge about the importance of PHBS, TB prevention and ARI to keep the house clean and not become a breeding place for the mycobacterium tuberculosis microorganism
3. Empowering the community to be more active in maintaining a healthy home environment by having a Modified Cyclone Ventilator (CVM) device in the homes of pulmonary TB sufferers.
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