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## Optimizing global health in tuberculosis treatment through an integrated approach

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### Abstract

One of the biggest problems in global health, especially among developing countries, remains to be tuberculosis (TB). The quality of life and productivity of people are significantly affected by TB, an infectious disease that can affect anyone. To achieve the goals of global health, TB preventive and control activities are essential. Through volunteer work and the use of paired sample t-tests, this study seeks to aid in the fight against tuberculosis. We set out to evaluate the efficacy of a TB treatment program that had been established in a particular community and to find elements that could further improve the success of TB treatment. Local residents who had TB were involved in the study's conduct. To assess the treatment outcomes of patients with TB before and after the intervention program, we performed a paired sample t-test. For the purpose to collect information on the social, economic, and behavioral aspects that affect TB treatment adherence, we also conducted surveys and interviews. This effort can assist shed light on ways to reduce the incidence of TB disease globally and positively impact the achievement of global health objectives. It is essential to carry out ongoing evaluation and improvement based on the results of this study in order to increase the effectiveness of programs similar to this one in the future.

**Keywords:** Tuberculosis (TB); Global Health; Paired sample t-test

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### 1. Introduction

Tuberculosis (TB) is an infectious disease caused by *Mycobacteria tuberculosis* (Lyon & Rossman, 2017) <sup>[15]</sup>. Tuberculosis is an important global health problem, especially in developing countries. According to the World Health Organization (WHO), there were approximately 10 million new cases of tuberculosis in 2020, causing 1.3 million deaths from the disease. Although many methods of controlling tuberculosis have been implemented, the management of pulmonary tuberculosis still poses severe challenges.

An important obstacle in the eradication of Tuberculosis is the increasing incidence of drug-resistant Tuberculosis (DR-TB). When anti-Tuberculosis treatment is administered inappropriately, incompletely, or intermittently, Tuberculosis bacteria can develop resistance to certain drugs, leading to the development of drug-resistant Tuberculosis (Salimi, Effendi & Zadda, 2020) <sup>[19]</sup>. The fight against multidrug-resistant Tuberculosis requires a greater investment of time and resources than standard treatment for pulmonary Tuberculosis, thus increasing pressure on personal health and financial resources.

In addition, social and economic factors such as poverty, inadequate access to health services, and stigma towards Tuberculosis patients are often associated with pulmonary Tuberculosis (Hargreaves *et al.*, 2011) <sup>[11]</sup>. These characteristics can increase the complexity of controlling tuberculosis, as people with tuberculosis may be reluctant to seek medical attention or face barriers in accessing appropriate services. Although there are various approaches to combat tuberculosis being implemented globally, many countries still struggle to implement these initiatives. The main challenges faced are lack of funding and human resources, limited access to treatment and diagnostic tools, and lack of community support.

Addressing the complexities of Tuberculosis treatment requires a comprehensive strategy that spans multiple areas, including health, education, environment, and society. Increasing the availability of modern diagnostic tools, abundant drug supplies, and top-notch medical services is one way to strengthen the global health framework. Communities, NGOs, and the business sector play an important role in the fight against Tuberculosis.

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The emergence of the COVID-19 pandemic further complicates the task of tackling Tuberculosis, as the bulk of global health efforts are devoted to fighting COVID-19. This highlights the need to strengthen the global healthcare architecture so that it can effectively address the challenges of not only Tuberculosis but also other global health issues. The purpose of this study is to describe the challenges that may arise when implementing Tuberculosis initiatives and to suggest solutions for their implementation. Two obvious benefits of this research are increased use of health services, awareness of global health (Brennan & Nandy, 2001) <sup>[4]</sup> and decreased cases of Tuberculosis. Through community engagement, individuals can learn the signs and symptoms of Tuberculosis and preventive measures. This increased awareness can help people better understand Tuberculosis, provide timely medical care when needed, improve environmental sanitation, and adopt healthier lifestyles. All contributing factors can slow down the progression of pulmonary Tuberculosis. Another benefit of this study is the improvement of the quality and effectiveness of Tuberculosis control programs. Through this program, community members are trained on how to fight Tuberculosis, helping them to become agents of change in their communities. Therefore, this may increase the effectiveness of pulmonary tuberculosis control efforts, thereby contributing to the achievement of tuberculosis control goals.

Finally, the main objective of this study is to provide further insight into the complexities of implementing a Tuberculosis program. Through this research, we aim to contribute to the global campaign against Tuberculosis and actively participate in the eradication of this disease by 2035.

## 2. Materials and Methods

### Participatory Research Method

"Participatory methods" is a research methodology that involves the community in every stage of the process, through planning to deployment to assessment. This method intends to enhance relationships between community members, medical professionals, and researchers in fighting against tuberculosis and improve involvement in the community (Cargo & Mercer, 2008) <sup>[6]</sup>.

A participative research project involves communities at all levels while employing them as both research subjects and study objects. The community can offer recommendations during the planning stage for the targets, the research goal, and the methods to collect data. Communities can assist the government with carrying out initiatives that avoid tuberculosis by training health staff, encouraging initiative, and providing emotional support to patients (Viswanathan *et al.*, 2004) <sup>[20]</sup>. Participants can offer feedback on the program's efficacy and suggestions regarding how to improve it better all through the evaluation period.

Participatory techniques can involve involving the community directly in decision-making regarding the scheme to be implemented in research on the carrying out of tuberculosis programs (Rifkin, 2002) <sup>[18]</sup>. Participation in discussions, public forums, or organizations that advocate may be helpful. By integrating them directly, tuberculosis control programs are able to satisfy the needs and goals of the community. Furthermore, it lessens the odds that the program will not be suitable for those living nearby.

Increasing community engagement and involvement in efforts to prevent tuberculosis can be accomplished by employing a participatory approach. The community may

increase their sense of personal accountability for preserving themselves as well as another's health by proactively participating in the program. The community may improve their sense of personal accountability for sustaining their own and one another individual's health by proactively participating in the program. Participation of community members in anti-tuberculosis campaigns might improve the compliance of patients with receiving treatment as well as treatment adherence, understanding of anti-tuberculosis strategies for prevention, and social support.

As a whole, participatory studies should improve the present relationship between scientists, doctors, and the general public in the fight against tuberculosis. The rolling out of TB control programs can better take the requirements and preferences of the community into account, and patient adherence to anti-tuberculosis medicine can be enhanced (Cornwall & Jewkes, 2010) <sup>[7]</sup>. Participatory methods may assist with preventing and treat tuberculosis by increasing community involvement and inspiring others.

Participant observation is an additional research strategy for tuberculosis treatment. Using this strategy, researchers are able to track the working relationship between locals and medical professionals in fighting against tuberculosis. Data from this technique can be employed to better understand national tuberculosis challenges, objectives, and actions (Abanyie *et al.*, 2013) <sup>[1]</sup>.

### Qualitative Research Methods

The goal of qualitative research methods, which focus on data collection, is to capture the meanings and interpretations of individuals in a specific environment. This technique involves observation and conducting interviews. Extensive interviews were conducted with key stakeholders, including individuals affected by Tuberculosis, healthcare professionals, and local community members, aiming to gain deeper insights into their roles in the fight against Tuberculosis (Cresswell, 2007). Additionally, participatory observation participants collaborated closely with healthcare professionals in the field to enhance their understanding of Tuberculosis control implementation.

The data collected through qualitative research methods then undergoes meticulous scrutiny through a process of interpretation. This analytical journey encompasses reading and organizing the gathered information, categorizing it into pertinent themes or groups, and identifying underlying patterns or associations among these themes or categories (Braun & Clarke, 2006) <sup>[3]</sup>. Subsequently, the conclusions derived from this analysis are examined to provide a richer understanding of participants' perspectives and experiences in relation to the Tuberculosis initiative's execution.

By employing qualitative research methods, this investigation offers a more comprehensive and exhaustive comprehension of the implementation of Tuberculosis programs and the factors influencing their effectiveness (Palinkas *et al.*, 2015) <sup>[16]</sup>. This can contribute to bolstering the global healthcare system as a whole and refining strategies aimed at combating Tuberculosis. The qualitative data collected can serve as a valuable tool in assessing the efficacy of current Tuberculosis control efforts and in devising improved approaches to engage communities and healthcare professionals in Tuberculosis control endeavors.

### Quantitative Research Methods

The gathering and analyzing of numerical data are all covered

by quantitative research techniques. This method includes a thorough and structured research design, approved data collection techniques, and an established and reliable statistical analysis. Pre- and post-assessments were performed together with supplementary gathering of information within the context of the quantitative methodology employed in this study (Brent & Leedy, 1990). In empirical studies, before-and-after evaluation methods are frequently used to investigate modifications or variations in variables before and after an intervention or treatment. For it to collect data, these methods require distributing painstakingly created surveys or questionnaires to respondents, who may include people with pulmonary tuberculosis or healthcare professionals. Pre-assessment occurs ahead of the beginning of the intervention or treatment, as opposed to post-assessment, which takes place after the course of treatment or intervention is accomplished. Planned surveys with established response opportunities are frequently incorporated in questionnaires to aid in the analysis of quantitative data.

For the analysis of aggregate information, methodologies including regression analysis, chi-square tests, and t-tests can be used. These analyses provide insights into identifying substantial variations or changes while also establishing the causal relationships among the variables in question (Fraenkel & Hyun, 2017) <sup>[10]</sup>.

Accessing information acquired by appropriate institutions or groups involved with Tuberculosis control efforts, such as information obtained from the Ministry of Health, is recognized as secondary data collecting. One is able to identify the optimum timing for the running of tuberculosis control programs through the use of such data in conjunction with proper statistical methods.

The government's Ministry of Health's data is crucial in generating comprehensive data on an assortment of aspects associated with tuberculosis prevention and control, including prevalence, treatment outcomes, program coverage, and allocation of funds. Having the capacity to go deeply into their analyses because to these data allows researchers to gain a greater insight into the success and negative effects of TB prevention techniques.

It is essential that you maintain an open mind on the reliability and validity of secondary data. Researchers need to evaluate the truthfulness of the data as well as minimize biases (Khankeh *et al.*, 2016) <sup>[12]</sup>. Researcher ought to devote careful careful consideration to factors such as prospective study apprehension the accuracy of the data, and potential prejudices or restrictions.

The application of quantitative research techniques in this community engagement initiative fosters a clearer comprehension of Tuberculosis control measures and the factors influencing their efficacy. Insights gleaned from the outcomes of this quantitative study hold the potential to positively influence the global healthcare system at large, contributing to more efficient and effective Tuberculosis prevention and control programs.

The utilization of statistical analysis on numerical data procured through quantitative research simplifies the identification of trends, patterns, and relationships. Through surveys, before-and-after assessments, and the analysis of secondary data, researchers can accumulate quantitative data pertaining to diverse facets of pulmonary tuberculosis management, encompassing prevalence, treatment outcomes, and program effectiveness. This data-driven approach aids in

pinpointing crucial areas for program expansion and facilitates an objective evaluation of its effectiveness.

Allocation of resources and concentrated attempts become essential in developing policies and conclusions in light of the findings from quantitative research (Creswell, 2007) <sup>[9]</sup>. This approach can also be used as a model for additional studies and therapies meant for decreasing the number of cases of pulmonary tuberculosis worldwide, enhancing the understanding of tuberculosis disease control.

### Paired Sample t-Test

We performed a paired sample t-test for comparing the means of two variables within a group of subjects. In accordance with Anderson *et al.* (2017) <sup>[2]</sup>, this test was designed to determine the effectiveness of a treated sample by evaluating it with the average value of the same sample both before and after treatments. It assists in determining how dissimilar the two variables are from one another within each sample and decides whether or not the mean difference between them is statistically significant (Kim, 2015) <sup>[14]</sup>.

A form of statistical analysis used for examining two sets of related or paired data is known as the paired sample t-test. It is particularly useful when we seek to determine the difference between two measurements obtained from the same topic at separate points in time or when we have two different experimental conditions to consider. We first calculate the distinction for each pair of information points in the paired sample t-test, and then determine the mean and standard deviation of these differences. In order to determine whether the observed difference is statistically significant or simply the result of random variation, the t-test statistic is following used. Once the predicted t-statistic is greater than the established threshold point (usually at a significance level of 0.05), we are able to determine that there exists a difference of statistical significance between the two sets of data. Evaluating the differences among two related data sets is the primary objective of evaluating the means regarding these two datasets.

### Performing paired t-test tests

1. Building the hypothesis
2. Identify the actual value of 5%
3. Calculate the t-test statistics

$$t_{\text{stat}} = \frac{\bar{d}}{s_d/\sqrt{n}}$$

The standard deviation value can be calculated using the following formula

$$s_d = \sqrt{\frac{\sum d^2 - \frac{(\sum d)^2}{n}}{n - 1}}$$

Where,

$t_{\text{stat}}$ : Statistics score

$s_d$ : The standard deviation of differences between paired observations

$n$ : Number of paired observations

$d$ : Difference between paired data

$\bar{d}$ : Average of difference between paired data

4. Make a decision
5. Ascertain the conclusions

### 3. Result and Discussion

This community service program took place at Klinik Pratama Basmalah, Sumedang Regency, West Java. To measure the effectiveness of the community service program, we randomly selected 26 respondents who had received counseling on Tuberculosis prevention and healthy lifestyle. The subjects of this study were patients and medical staff of Basmalah Sumedang Primary Clinic. Figure 1 shows the presenters and staff of Basmalah Pratama Clinic. On this occasion, the owner of Asa Clinic gave a speech as shown in Figure 2.



Fig 1: Program Presenters and Staff of Basmalah Primary Clinic



Fig 2: Welcome speech by the commissioner of Basmalah Pratama clinic

We measured their initial knowledge of Tuberculosis before the consultation and re-measured their knowledge after the program. We collected data from participants' scores before and after the test and calculated the sample mean difference. Figure 3 shows participants taking the test first and then the presenter explaining the strength of the global health system and strategic efforts to control pulmonary tuberculosis cases. After the speaker's explanation, all participants were asked the same question. This activity is shown in Figure 4.



Fig 3: Submission of Tuberculosis material



Fig 4: Explanation about Global Health

#### Here is the hypothesis

$H_0: \mu d = 0$  (There is no significant difference between the mean scores of participants' understanding before and after the community service program)

$H_a: \mu d \neq 0$  (There is a significant difference between the mean scores of participants' understanding before and after the community service program)

In the paired sample t-test, the t-table result is smaller than the t statistic which indicates that the difference between the two groups of data being compared is not considered statistically significant at a certain level of significance, usually at a significance level of 0.05 or something else. In this context, "t-table" refers to the critical value of the Student's t distribution which is used as a guideline to determine whether the observed difference is large enough to be considered a hard result. It may occur randomly or not. If the t-statistic value calculated from our data sample is greater than the critical value on the t-table then we would conclude that the difference is statistically significant and there is enough evidence to support the difference. However, if the t-statistic value is smaller than the critical value on the t-table, we do not have enough statistical evidence to say that there is a significant difference between the two groups of data being compared.

The statistical analysis was conducted at a significance level of 5% ( $\alpha = 0.05$ ), representing the predetermined threshold for determining the statistical significance of the observed differences between participants' pre-test and post-test scores.

### The result of t-test statistics

$$t_{stat} = \frac{3.15}{1.8216/\sqrt{26}} = 8.817 \quad (1)$$

The critical t-value from the t-table was consulted at a significance level of  $\alpha/2$ , where  $\alpha$  was set at 5%.

$$t_{\alpha/2} = 2.06 \quad (2)$$

We have enough evidence to reject the null hypothesis since the t-statistic (1) more than value obtained from the t-table (2) at the specified significance level. This indicates a substantial difference between participants' pre-test and post-test scores, indicating that the community service program was effective in improving understanding of the participants.

### 4. Conclusions

Pre and post tests were used in this program and paired t-test analysis provided invaluable information. The main objective of this initiative was to test how the program affected participants' understanding before and after their participation. The results of the paired t-test analysis showed that participants' perceptions of the international health system and tactical initiatives improved statistically significantly. Posttest results showed significant improvement after completion of the training; however, pretest results showed a basic level of understanding. This positive change highlights the effectiveness of the program in raising participants' awareness of the complex dynamics of the global health system and the importance of strategic approaches. The paired t-test analysis not only confirmed that the program achieved its educational objectives but also highlighted the value of community engagement in knowledge dissemination. The initiative created a forum for in-depth discussion and shared learning, promoting a better understanding of the challenges and opportunities facing the international health system. The initiative focused on collaborative learning to bring about positive change in communities while keeping everyone informed. This experience emphasized the importance of planned education programs to develop decision-making skills and improve the general well-being of the community.

### 5. Limitation and Future Research Direction

For further research, there are several steps that can be taken. First, there is a need to evaluate the implementation of the integrated Tuberculosis approach to understand how it is applied in practice and how effective it is in treating Tuberculosis. Second, a comprehensive analysis of epidemiological data is needed to understand global, regional and local trends in tuberculosis. Economic analysis also needs to be expanded to include Tuberculosis treatment costs, social costs, and the economic impact of successful Tuberculosis treatment. In addition, research could assess the impact of global health policies on tuberculosis treatment and consider a multidisciplinary approach involving various disciplines such as medicine, economics, sociology, and

others. It is also important to link this study to research related to global health, such as research on tuberculosis drug resistance, vaccination, or tuberculosis prevention efforts. Ultimately, this research can examine the long-term impact of effective tuberculosis treatment on society and global health as a whole. By combining all these aspects, future research is expected to provide more comprehensive insights into the optimization of tuberculosis treatment and its impact on global health.

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