

# Levels of Multidrug-Resistant Tuberculosis Treatment Success among ASEAN Countries

Mark Ian C. Andres, Brendalyn R. Basilan, Camille Yvonne D. Cubar and Ricky Villeta

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## **Abstract**

*Health expenditure of a country is intended to finance medicines and other medical services and assistance for those people affected with diseases especially those communicable ones. The global issue of tuberculosis has been a well-known communicable disease which could result in another type of such disease, if untreated. This study is conducted to assess the treatment success of multidrug-resistant tuberculosis (MDR-TB) cases, which had been a burden for countries in terms of financial aspects. Through the use of multivariate cluster and principal component analyses, ASEAN countries were grouped and ranked from very highly successful to least successful in the level of treatment success which would provide comprehensive findings as to what ASEAN country successfully provides financial to their diagnosed patients. Further, it was found out that the level of success of MDR-TB treatments among ASEAN countries varies inversely with the number of patients undergoing the treatment while directly proportional to the amount of investments in health expenditures. Hence, MDR-TB treatment success depends on the level of amount of investments for health the ASEAN country has and the number of patients undergoing the treatment. Thus, the success of the treatment can be achieved at high economic price.*

*Keywords: Multidrug-resistant tuberculosis (MDR-TB), multivariate cluster analysis, principal component analysis, health expenditure, adult literacy rate*

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## **1.0 Introduction**

World Health Organization (WHO) declared that tuberculosis (TB) is next to HIV/AIDS as one of the world's deadliest communicable diseases. Some studies show that tuberculosis resistant to first-line anti-TB drugs such as isoniazid and rifampicin become *multidrug-resistant tuberculosis (MDR-TB)* (Goble et al., 1993; Espinal 2003; Ormerod 2005; Sharma et al., 2006; Migliori et al., 2007; Velayati et al., 2009; Albanna et al., 2011,). This disease has a longer span of medication compared to an ordinary TB condition that takes 24-29 months consisting of daily injection and a range of 10-13

different drugs intake (Chavez et al., 1997; Whittier 2007; Enemark 2012; Engel 2012;). Most of the recorded cases of MDR-TB were due to an infection, inadequate drugs and improper routine intake of drugs that leads to the severity of TB condition (Caminero 2005; CTD 2007; Monedero 2009; Wang et al., 2014). Now, different health programmes were implemented by the government and other private organizations concerning with the public health that aims to carry out the expenses of those diagnosed patients for the betterment of the country. There had been data presented by WHO and United Nations Development Programme

(UNDP) concerning the number of diagnosed in MDR-TB and patients undergoing the treatment which made the researchers become interested and used such factors to measure the levels of MDR-TB treatment success among ASEAN countries.

It is known that MDR-TB has a very strict compliance with multiform drug regimens and lengthy multidisciplinary care which in financial aspects, the entire completion of medication is at higher expense and has the possibility to be poorly tolerated (Kent 1993; White et al., 2000; Ormerod 2005; Masjedi et al., 2008). Due to these facts, the government or certain organization funding of MDR-TB tuberculosis programmes is hesitant of investing abundantly for this disease since it needs to meet the growing number of patients (Espinal 2003; Mukherjee et al., 2004; Brigden et al., 2014). The lesser attention given to sustain the needs of patients, the higher risks occur in the spread of such disease in different countries (Brigden et al., 2014). Thus, globalization and population mobility will contribute to the increase or decrease of MDR-TB cases in a country as to a greater sense, both political will and money is very important (Fisher 2002; Ormerod 2005). Thus, countries all over the world are encouraged to attain a TB-free environment, which the main highlight is to lessen the cases of MDR-TB and implementations of control programmes such as DOTS (Directly Observed Treatment, Short-Course). This program is highly tolerated for the succeeding generations to halt the transmission of the disease and resources should be attained to provide the most appropriate services (Quelapio et al., 2007).

There are some studies conducted about MDR-TB cases that emphasize the outcome of the treatment success of patients, moreover, fails to consider some factors such as literacy rate,

health expenditure and the number of diagnosed patients undergoing the treatment which will suffice the data gathered. Thus, the researchers aim to determine the country's current status of MDR-TB cases and rank ASEAN countries based on the extent of the given factors that account the relation of each country to compel their response towards the level of treatment success of this disease.

## 2.0 Conceptual Framework

Multidrug-resistant tuberculosis develops from the ordinary tuberculosis condition that were neglected and poorly treated. Hence, it is an alarming global issue especially to the developing ASEAN countries. The primary factor, (a) number of patients undergoing treatment on such disease, is recorded in the World Health Organization (2012). Through the data presented, the researchers selected the ASEAN countries as field of interest in relation to the other succeeding factors. These include (b) health expenditure and (c) literacy rate. The three factors identified would be analyzed using multivariate cluster and principal component analysis which would lead us to group ASEAN countries and determine its level of success in multidrug-resistant tuberculosis treatment.

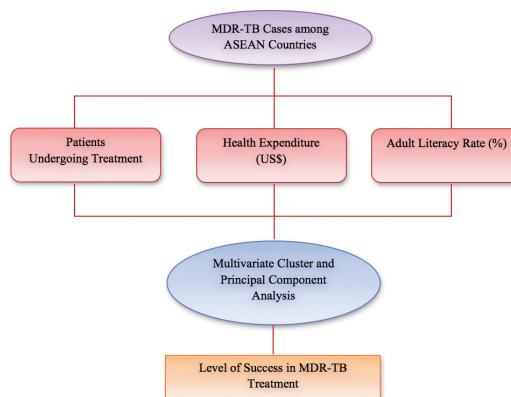


Figure 1. Schema of the Conceptual Framework of the Study

**3.0 Research Design and Methods**

Exploratory data analysis or data mining using multivariate cluster and principal components analyses were the methods used by the researchers to convert raw data into significant information to cluster and determine the level of success in MDR-TB treatment among ASEAN countries.

Multivariate cluster analysis uses the following variables to cluster the ASEAN countries. Then, principal component analysis utilizes the corresponding loads obtained from its factors and its known corresponding index in order to determine the level of treatment success.

Moreover, this study uses variables that indicate the factors that attributes to the level of success in MDR-TB treatment of ASEAN countries. The corresponding data were generated from World Health Organization Global Tuberculosis Report 2012 and World Data Bank 2012 respectively.

The variables are as follows:

- (1) patients undergoing treatment for such disease
- (2) health expenditure, which determines the sum of public and private health expenses as a ratio of total population

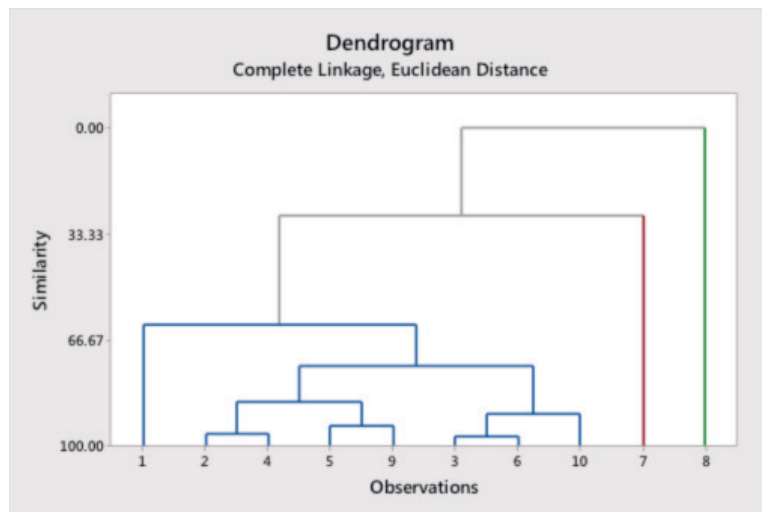
- (3) literacy rate, which denotes the percentage of the population, aged 15 and above, who can comprehend, read and write a short, simple statement

**4.0 Results and Discussion**

The following results show the cluster and principal component analyses on the level of MDR-TB treatment success of ASEAN countries regarding the patients undergoing the treatment, health expenditure (US\$) and adult literacy rate (%). The ASEAN countries are also arranged in alphabetical order: (1) Brunei Darussalam, (2) Cambodia, (3) Indonesia, (4) Lao People Democratic Republic, (5) Malaysia, (6) Myanmar, (7) Philippines, (8) Singapore, (9) Thailand and (10) Vietnam.

**Cluster Analysis of ASEAN Countries Based on the Aspect of Patients Undergoing Treatment, Literacy Rate, and Health Expenditure**

Figure 2 below is the dendrogram depicting the grouping of the ASEAN countries considering the three identified factors namely the number of patients undergoing the treatment, literacy rate, and health expenditure.



**Figure 2.** Dendrogram of the ASEAN countries displaying the groups they belong

The clustering of ASEAN countries in Table 1 determines the number of ASEAN countries to what particular cluster they are grouped. It is based on the similarities of the three factors—number of patients undergoing MDR-TB treatment, health expenditure, and literacy rate.

Cluster 1 consists of Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Thailand and Vietnam, which they share a common level on the stated factors. While Philippines belong to Cluster 2, and Singapore in Cluster 3, which they show discrete levels in favor of the three factors.

**Table 1. Final Partition**

No. of Clusters	No. of Countries	Within Cluster Sum of Squares	Average Distance from Centroid	Maximum Distance from Centroid
Cluster 1	8	1199709	345.907	738.012
Cluster 2	1	0	0	0
Cluster 3	1	0	0	0

**Table 2. Cluster Centroids**

Variables	Cluster 1	Cluster 2	Cluster 3	Grand Centroid
Number of Patients Undergoing MDR-TB Treatment	221.75	1918	22	371.4
Literacy Rate (%)	88.438	95.4	95.9	89.88
Health Expenditure (US\$)	242.125	115	2287	433.9

Table 2 represents the cluster centroids of each group with respect to the three factors more specifically patients undergoing MDR-TB treatment, literacy rate, and health expenditure.

**Table 3. Distances between Cluster Centroids**

No. of Clusters	Cluster 1	Cluster 2	Cluster 3
Cluster 1	0	1701.02	2054.62
Cluster 2	1701.02	0	2883.12
Cluster 3	2054.62	2883.12	0

Table 3 shows the distances between cluster centroids for the three groups of ASEAN countries across the three factors.

The clustering of ASEAN countries is mainly determined by the number of patients undergoing MDR-TB treatment. Cluster 2, with Singapore as the only member state, is deduced to have the least member of patients who have undergone MDR-TB treatment while Cluster 3, with Philippines as its sole member state, is found to have the most number of patients undergoing such treatment.

Furthermore, the success of MDR-TB treatment of patients is depending on the amount of health expenditure provided by either ASEAN member states. However, the literacy rate doesn't necessarily affect on the quality and success of the treatments.

Thus, the level of success of patients undergoing the MDR-TB treatment varies inversely with the number of patients to avail such treatment. But, the success of treatment varies directly with the nation's level of investments for health expenditure. MDR-TB treatment success, therefore, achieved at higher economic price.

**Principal Component Analysis: Number of Patients Undergoing Treatment, Literacy Rate, Health Expenditure**

The following results depict the principal

component analysis on the three identified factors that determines the level of MDR-TB treatment success of ASEAN member countries.

**Table 4.** Eigen analysis of the Covariance Matrix

Eigen value	578599	279449	52
Proportion	0.674	0.326	0
Cumulative	0.674	1	1

The findings revealed that the first eigenvector on principal components represents 67.40% of the total variance. This result is sufficient as representations of all three identified factors of the levels of MDR-TB treatment of the ASEAN nations namely, the number of patients undergoing treatment, literacy rate, and health expenditure.

**Table 5.** Principal Components Analysis Results among the Three Distinguished Factors of the Level of MDR-TB Treatment Success

Variables	PC1	PC2	PC3
Patients Undergoing MDR-TB Treatment	-0.505	0.863	-0.007
Literacy Rate (%)	0.002	0.009	1
Health Expenditure (US\$)	0.863	0.505	-0.006

Using, the first principal component analysis results then the index of the level of the MDR-TB treatment success of an ASEAN member can be modeled by the equation:

#### Index of Level of MDR-TB Treatment

$$\text{Success} = -0.505 \text{ Patients Undergoing Treatment} + 0.002 \text{ Literacy rate} + 0.863 \text{ Health Expenditure}$$

Hence, the lesser the number of patients undergoing treatment, the higher is the index of the level of MDR-TB success, the greater investments on health expenditure, the more successful will be the MDR-TB treatment of patients. On the other hand, literacy rate slightly affects the level of success of MDR-TB treatment as evidenced by an almost negligible impact of the factor.

Thus, the level of MDR-TB treatment success varies inversely with the number of patients undergoing the treatment. However, such success of MDR-TB treatment varies directly with the nation's investment in health expenditure and literacy rate. Moreover, the success of MDR-TB treatment is mainly characterized by the health expenditure's investment of ASEAN member states.

**Table 6:** Different Index on the Level of Treatment Success among ASEAN Countries

ASEAN Countries	Cluster #	Level of MDR-TB Treatment Success	Interpretation
1. Singapore	3	2.55391	Very Highly Successful
2. Brunei Darussalam	1	0.93931	Highly Successful
3. Malaysia	1	0.23313	Moderately Successful
4. Thailand	1	0.08762	Moderately Successful

5. Lao PDR	1	-0.19264	Slightly Successful
6. Cambodia	1	-0.22672	Slightly Successful
7. Indonesia	1	-0.44245	Slightly Successful
8. Myanmar	1	-0.56319	Least Successful
9. Vietnam	1	-0.69258	Least Successful
10. Philippines	2	-1.69640	Least Successful

Legend:

**Hypothetical Range**

1.03 and Above

0.52 - 1.02

0.01 - 0.51

-0.50 - 0.00

-0.51 and Below

**Interpretation**

Very Highly Successful

Highly Successful

Moderately Successful

Slightly Successful

Least Successful

Table 6 shows that Singapore, the only nation in Cluster 3, is found to be the most successful in treatment success in multidrug-resistant tuberculosis among ASEAN countries. It was deduced to have a relatively successful MDR-TB treatment as compared to Cluster 2 member state. However, cluster 2, with Philippines as its sole member state, is determined to be least successful in terms of success on MDR-TB treatment.

According to Cutter et al (2010), Singapore has the lowest number of cases of tuberculosis among the Southeast Asia. Drug-resistant tuberculosis has never been their major problem that the government complied immediately a strong support on the drug supply through DOT (Directly Observed Treatment) in Singapore's TB control programme to lessen the number of patients diagnosed of such disease. They also indicate that some residents infected by MDR-TB were mostly immigrants and not naturally-born in Singapore. Some went there to seek treatment after failed TB

treatment in their home countries. But what only details on the efforts of TB control programmes worldwide were the global emergence of multidrug-resistant tuberculosis and extensively drug-resistant tuberculosis (XDR-TB, which a few only reached on this condition) such that either these conditions are acquired by Singapore-born diagnosed patients, they are given the top priority toward the proper treatment of drug-susceptible TB cases and hence, should be under strict programme conditions to prevent the spread of MDR-TB in the first place (Chee et al., 2012; Chee et al., 2013). These are the possible reasons as to why Singapore is the country that ranked as the very highly successful in terms of treatment success.

Philippines, on the other hand, ranked as the least successful on the MDR-TB treatment level among ASEAN countries. It is one of the highest burden countries in the world (WHO, 2008) due to its large number of cases of tuberculosis recorded by National TB Control Programme (NTP)

surveillance data, which one of the probable reasons why there is a low treatment success during year 2003 up to the present is the difficult access of services due to complex and scattered geographic and socioeconomic settings (Vianzon et al., 2013). Hence, Philippines is still on the process of improving capabilities to reach out different areas and islands to respond for patients needed to undergo treatment, better facilities, hospitals, follow-up examinations, referrals and strict compliance of medication to avoid the severity or the spread of tuberculosis within the country.

### 5.0 Conclusion

The country has the responsibility to care its people in terms of public health. In such way, it should implement actions to respond to any spreading diseases within or all over the world. This study focused on MDR-TB cases which the key factors to successful treatment outcome is not the medication itself, but the public given with proper orientation or health education and the country acquired with higher health expenditure to financially support its people. Although, literacy rate doesn't affect too much on the treatment success level, however, larger investments on the health expenditure of a certain country will exhibit the most successful one. Singapore, which has been known the most progressive country in ASEAN, has the capacity to support their constituents in any obstacles especially public health. Nonetheless, this study encouraged countries to have key strategies on how to attain a TB-free country through informing its people on the DOTS (Directly Observed Treatment, Short-Course) implementation to prevent the continuing generation of MDR-TB cases and should develop human resources to provide the services that the people need.

### 6.0 Recommendations

The study is purely meta-analysis which the data used were from different databases and literatures, which create amount of limitations and gaps. For further study, the researchers recommend the following:

- (1) Look for other factors in determining country's treatment success of multidrug-resistant tuberculosis,
- (2) have a survey of the latest cases and expense of the said disease per country
- (3) designation of the country's budget for the treatment of MDR-TB to those less privilege patients
- (4) indicate a flow chart of certain offices of the government agencies that holds the responsibilities for the treatment programmes

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