World Applied Sciences Journal 12 (9): 1580-1584, 2011
ISSN 1818-4952

Modelling Associated Factors of HIV-Infected Tuberculosis (TB) Patients Using Path Model Analysis

[1]*Wan Muhamad Amir W. Ahmad,* [1]*Nor Azlida Aleng,*
[2]*Zalila Ali and* [1]*Arif Bin Awang Nawi*

[1]Jabatan Matematik, Fakulti Sains dan Teknologi, Malaysia,
Universiti Malaysia Terengganu (UMT), 21030 Kuala Terengganu, Terengganu, Malaysia
[2]Pusat Pengajian Sains Matematik, Universiti Sains Malaysia (USM),
11800 Minden Pulau Pinang, Malaysia

Abstract: In medical statistics research, path analysis is always used to find out the directed dependencies among a set of interest variables. Actually, path analysis technique is an idea of how we interpreting the extension results of the linear regression model. It goes beyond regression in that it allows for the analysis of more complicated models. In particular, it can check situations in which there are several final dependent variables and those in which there are "chains" of influence, in that variable *X* influences variable *Y*, which in turn affects variable *Z* and so on. Besides that, the path analysis is also powerful for examining complex models, comparing the efficiency of different gained models and to asses which models gives the best fits for the data. The objective of this study is to model the associated factors of TB among HIV positive patients using Statistical Modeling (Path Analysis). We used logistic regression method and multiple linear regression method to gain the path model. Both methods were compared based on their results.

Key words: Path Analysis

INTRODUCTION

Tuberculosis or *tubercles bacillus* is a common and often deadly infectious disease which is caused by various strains of *Mycobacterium tuberculosis* in humans. This bacterium usually attacks lungs, heart and other parts of the body. TB is spread through the air from one person to another (spread through the air with coughing or sneezing). Tuberculosis (TB) and human immunodeficiency virus (HIV) infections are the deadliest chronic infections globally. Although each is deadly alone, they are deadlier together, with TB causing one-quarter of AIDS-related deaths and HIV infecting at least 15% of patients with TB worldwide.

Prevalence of Tb Infected Hiv

World wilde: Worldwide, one out of three people are infected with Mycobacterium tuberculosis (MTB). Approximately 7 million new cases of TB and 1.7 million deaths due to TB were reported in 2006, the last year that global epidemiological data for TB is available [1]. The HIV epidemic has fuelled the current TB epidemic worldwide and in particular in sub-Saharan Africa. HIV is the strongest factor in the development of active TB; it is estimated that only one out of ten immunocompetent persons infected with TB develops active TB in his/her lifetime; whereas, one out of ten HIV-infected persons infected with TB will develop active TB every year. Autopsy studies have shown that 30 to 40.0% of HIV-infected adults die from tuberculosis in Africa. On the other hand TB has been shown to accelerate HIV disease progression to AIDS and probably early death [2,3].

Asian: In Asia, where the HIV epidemic is still at early stage, the rate of HIV infection in tuberculosis patients has been lower [5]. A HIV-positive person infected with Mycobacterium tuberculosis has a 50-60.0% lifetime risk of developing TB disease as compared to an HIV-negative person who has only a 10.0% risk. This is especially important in India where it is estimated that 40.0% of the adult population harbors Mycobacterium tuberculosis. Hospital based HIV seroprevalence studies amongst

Corresponding Author: Wan Muhamad Amir W Ahmad, Jabatan Matematik, Fakulti Sains dan Teknologi, Malaysia, Universiti Malaysia Terengganu (UMT), 21030 Kuala Terengganu, Terengganu Malaysia

tuberculosis patients from different regions of India have shown a great variation -the prevalence rates varying from 0.4% - 28.1% have been reported. The prevalence of HIV infection among patients of tuberculosis is rising at an alarming pace in the western parts of the country like Mumbai (2.56-10.15%), Pune (10-25.75%) and south India (0.59-8.89%) but at a much slower pace in north India. A rising trend of HIV infection in patients of pulmonary tuberculosis has also been seen in Lucknow (1.25% in 1996 to 4.28% in 2001). In India, there were an estimated 5.1 million people living with HIV at the end of the year 2002. Assuming that about 40.0% of these persons are co-infected with TB, the estimated TB-HIV co-infection figures will be around 2 million [5].

Malaysia: Globally, Ziehl-Neelsen staining and culture were performed when tuberculosis was suspected. Cases of TB were classified as definite, probable, or possible were 7% (10/135) patients of Mycobacterium tuberculosis positive. In other word, 9% of all deaths due to TB occur in HIV-infected persons and will be increased to 17% by the year 2000 due to the increasing occurrence of HIV infection in populations already infected with *M* tuberculosis. AIDS-related tuberculosis was 123/406 (30.3%) in Malaysia [4]. This result is much lower than a previous study showed in the prevalence of tuberculosis was 56.0%. In 1990 there were only six cases of TB-co-infection with HIV cases reported among the 10,873 TB cases registered. In 1999 the number had escalated to 690 cases or 4.6% of the total number of TB cases (14,908 cases). Cumulatively in the last 9 years TB/ HIV cases had contributed about 16.95% of the total TB cases detected in Malaysia. However, different studies showed varying figures of tuberculosis i.e. 32% in Brazil, 61.0% in India, 18.0%-28.0% in Sub-Saharan Africa, 31.0% in Thailand [4].

In Malaysia, the annual reported cases of HIV infections and AIDS has shown an increasing pattern for the last ten years [3]. HIV infections have increased from 778 in 1990 to 5,107 cases with 1,168 reported AIDS cases in 2000. The trend of TB with HIV co-infection has also increased and has contributed to nearly 5.0% of the total TB cases in the country [3].

Based on Fig. 1, list of HIV positive patients diagnosed with TB status was obtained from HUSM record's office from 2001-2010. Identify the prevalence of TB among HIV patients based on demographic characteristic. HIV infected with TB is divided into two parts; HIV positive with TB and HIV positive without TB. The associated factors of HIV positive with TB such as CD4 Count, Age, Sex, Heterosexual, IVDU and Blood Transfusion were collected to analyzed using SPSS.

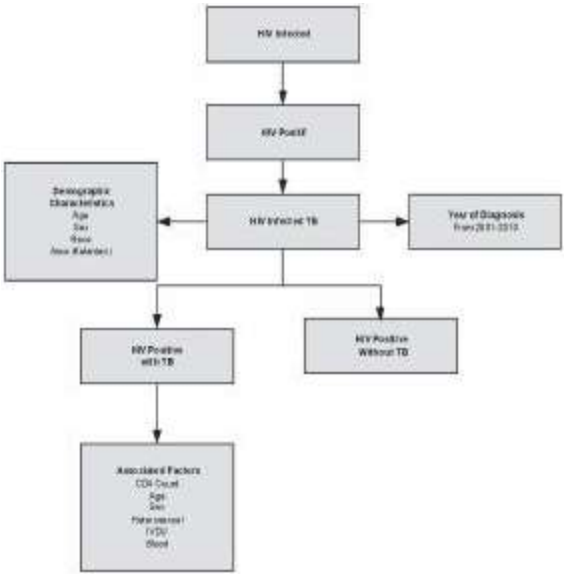

Fig. 1: Conceptual Framework of the Study

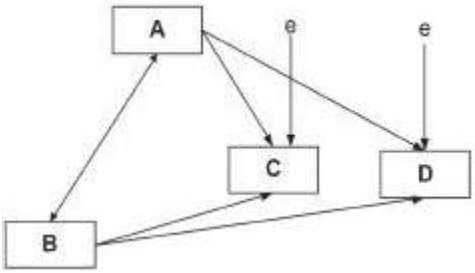

Fig. 2: Simple Path Analysis

MATERIAL AND METHODS

Wright [7] is the person who developed path analysis around 1918 and more extensively in the 1920s. It has since been applied to a vast array of complex modeling areas, including medical, sociology, econometrics and many more. Figure 2 illustrated a simple path model [7].

In the Fig. 2, A and B are the two exogenus variable and they are modeled as being correlated and as having both direct and indirect effects (through C) on D (the two dependent or 'endogenous' variables). In most real models, the endogenous variables are also affected by factors outside the model (including measurement error). The effects of such extraneous variables are depicted by the "e" or error terms in the model. Using the same variables, alternative models are conceivable. For illustration, it may be hypothesized that A has only an indirect effect on D, thus the arrow from A to D would be deleted and the likelihood or 'fit' of these two models can be compared statistically [6].

Path Tracing Rules: In 1934, Wright has proposed a simple set of path tracing rules, for calculating the correlation between two variables [6]. The rules for path tracing are:

- We can trace backward up an arrow and then forward along the next, or forwards from one variable to the other, but never forward and then back.
- We can pass through each variable only once in a given chain of paths.
- No more than one bi-directional arrow can be included each path-chain.

Sample Size Required: The calculation of sample size was done using Power and Sample Size Calculation (PS) software with the significance level (α) 0.05 and the power of study (1-β) of 80.0%, see Dupont [1]. Parameter involved:

i. Type I Error = 5.0%
ii. Power = 80.0%
iii. M = 1
iv. P_0 = Based on literature review
v. P_1 = Based on Expert Opinion

We choose the largest sample size is taking into the account. From the Table 1, we choose n =152 patients.

RESULTS AND DISCUSSION

To compare logistic regression method and multiple linear regression method to gain the path model.

Step 1: Perform Path Model Using Logistic Regression Analysis
Step 2: Drawing the Path Model
By Investigating the above Path Model We Would Note That:

- IVDU and CD4 influence HIV status.
- Smoking gender and heterosexual have no direct effect upon HIV status but has indirect effect through IVDU.
- CD4 has only a direct effect upon HIV status.

Table 1: Explanation of the Variables

Variables	Explanation of the Variables
Age	Age of Patients
Gender	Patient's Gender
Ethnic	Patient's Ethnic
Area	Area of the Study
CD4 Count	Reading of Low CD4 Count
Heterosexual	Sexually Attracted to Members of the Opposite Sex
IVDU	Intravenous Drug Use

Table 2: Sample Size Calculation

No. Variables	*P_1	P_0	M	Type 1 error	Power	Sample Size
1 CD4 Cell count [4]	0.52	0.36	1	5%	80%	150 patients
2 Heterosexual [4]	0.44	0.28	1	5%	80%	140 patients
3 Intravenous drug user (IVDU) [4]	0.56	0.4	1	5%	80%	152 patients
4 Blood transfusion [4]	0.41	0.25	1	5%	80%	134 patients
5 Age [4]	0.53	0.37	1	5%	80%	151 patients

**Determined by expert opinion*

Table 3: Variables IVDU and CD4 In The Equation

Predictors	B	S.E	Wald	df	Sig.	Exp(B)
IVDU(1)	0.830	0.3396	4.404	1	0.036	2.294
CD4(1)	0.969	0.3344	7.936	1	0.005	2.636
Constant	-1.932	0.407	22.551	1	0.000	0.145

Dependent Variable: HIV Status

Table 4: Variables HETEROSEXUAL and SMOKING In The Equation

Predictors	B	S.E	Wald	df	Sig.	Exp(B)
HETEROSEXUAL(1)	1.858	0.654	8.073	1	0.004	6.412
SMOKING (1)	-4.323	0.582	55.235	1	0.000	0.013
Constant	1.190	0.449	7.023	1	0.008	3.288

Dependent Variable: IVDU

Table 5: Variables GENDER In The Equation

Predictors	B	S.E	Wald	df	Sig.	Exp(B)
GENDER (1)	2.726	0.463	34.643	1	0.000	15.278
Constant	-0.894	0.396	5.103	1	0.024	0.409

Dependent Variable: HETEROSEKSUAL

Table 6: Variables GENDER In The Equation

Predictors	B	S.E	Wald	df	Sig.	Exp(B)
GENDER (1)	-3.035	0.531	32.713	1	0.000	0.048
Constant	1.649	0.488	11.398	1	0.001	5.200

Dependent Variable: SMOKING

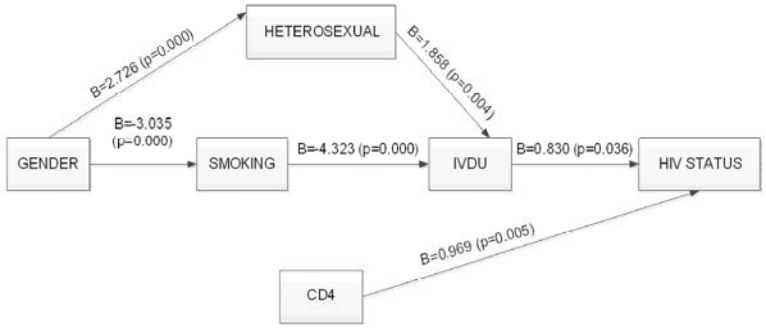

Fig. 3: Path Analysis for Factors of HIV-Infected Tuberculosis Patients Using Logistic Regression Analysis

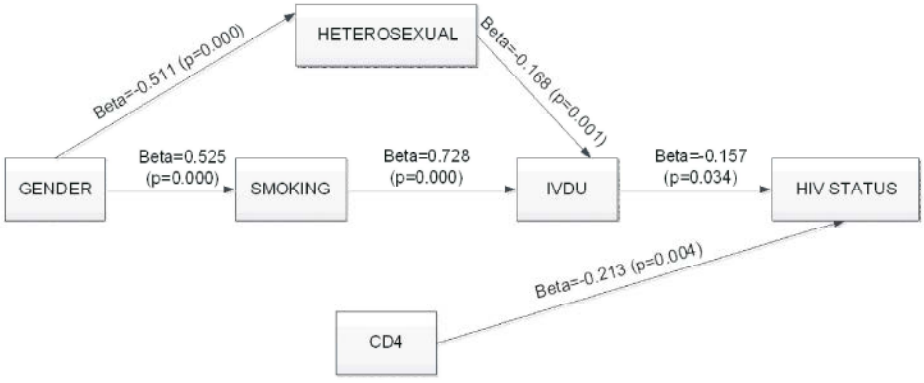

Fig. 4: Path Analysis for Factors of HIV-Infected Tuberculosis Patients Using Linear Regression Analysis

Step 1: Perform Linear Regression Analysis
By Investigating the above Path Model We Would Note That:

- IVDU and CD4 influence HIV status.
- Smoking gender and heterosexual have no direct effect upon HIV status but has indirect effect through IVDU.
- CD4 has only a direct effect upon HIV status.

Table 7: Variables GENDER In The Equation

Predictors	Unstandardized B	Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
Constant	0.862	0.031		28.170	0.000
Gender	-0.572	0.073	-0.511	-7.841	0.000

Dependent Variable: HETEROSEKSUAL

Table 8: Variables GENDER In The Equation

Predictors	Unstandardized B	Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
Constant	0.200	0.033		6.070	0.000
Gender	0.639	0.079	0.525	8.135	0.000

Dependent Variable: SMOKING

Table 9: Variables HETEROSEXUAL and SMOKING In The Equation

Predictors	Unstandardized B	Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
Constant	0.224	0.055		4.104	0.000
Heterosexual	-0.183	0.054	-0.168	-3.385	0.001
Smoking	0.728	0.050	0.728	14.638	0.000

Dependent Variable: IVDU

Table 10: Variables IVDU and CD4 In The Equation

Predictors	Unstandardized B	Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
Constant	0.456	0.054		8.518	0.000
CD4	-0.196	0.068	-0.213	-2.902	0.004
IVDU	-0.156	0.073	-0.157	-2.138	0.034

Dependent Variable: HIV Status

DISCUSSION AND CONCLUSION

A path analysis can be conducted as a hierarchical (sequential) multiple regression analysis.

For each variable we shall conduct a regression analysis in predicting that variable (Y) from all other variables which are hypothesized to have direct or indirect effects on Y. The beta weights from these regressions are the path coefficients shown in the typical figures that are used to display the results of a path analysis. In this paper, we show that path analysis is a very powerful in used to describe the directed dependencies among a set of variables. We have analyzed all that variables with regression analysis in order to reveal the logic that underlies the computations in dedicated packages. From here we are able to summaries the movements of variables and straightly know the overall impact of one variable on another; the total of direct and indirect effects.

REFERENCES

1. Dupont, W.D. and W.D. Plummer, 1990. Power And Sample Size Calculation: A Review And Computer Program, Controlled Clinical Trails, 11: 116-128.
2. Mugusi, F.M., S. Mehta, E. Villamor, W. Urassa, E. Saathoff, R.J. Bosch. and W.W. Fawzi, 2009. Factors Associated With Mortality In HIV-Infected And Uninfected Patients with Pulmonary Tuberculosis. BMC Public Health, pp: 409.
3. MOH, Ministry of Health Section of AIDS/STD, Division of Disease Control, Department of Public Health, Ministry of Health Malaysia, 2010.
4. Nissapatorn, V., C. Lee, I. Ithoi, F.M. Yik and K.A. Abdullah, 2003. Tuberculosis In Aids Patients. Malaysian J. Medical Sci., 10: 60-64.
5. Verma, S.K. and V. Mahajan, 2008. HIV-Tuberculosis Co-Infection. The Internet J. Pulmonary Med., 10: 1.
6. Wikipedia. Path analysis (Statistics). http://en.wikipedia.org/wiki/Path_analysis_(statistics)#cite_ref-0 . 2010. [6 January 2011]
7. Wright Sewall, 1921. Correlation and Causation, J. Agricultural Res., 20(7): 557-585.