Predictors of tuberculosis incidence and the effects of multiple deprivation indices on tuberculosis management in OR Tambo district over a 5-year period

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Ntandazo Dlatu
Walter Sisulu University

Benjamin Longo-Mbenza
Walter Sisulu University

Teke Apalata
Walter Sisulu University

ruffinapalata@gmail.com*Corresponding Author*

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TB incidence, index of multiple deprivations, HIV associated TB deaths, healthcare expenditures

Abstract

Background

This study investigated the associations between socio-economic deprivation and tuberculosis (TB) treatment outcomes, alongside well-known TB risk factors. The effects of healthcare expenditures and their growth on trends in TB incidence from 2009 to 2013 were also assessed.

Methods

Secondary data analysis was performed on data obtained from various sources including governmental, non-governmental and research institutions. Indicators for TB treatment outcomes included rates of TB deaths, TB case finding index, TB treatment failure, HIV associated TB deaths, TB defaulter rate, and new TB smear positive cases. Analysis of variance (ANOVA) and Post-Hoc Bonferroni pairwise tests were used to compare means of variables of interest considering a type I error rate of 0.05. Regression models and canonical discriminant analysis (CDA) were used to explore the associations between trends in TB incidence and independent TB predictors. During CDA, Fischer's linear functions, Eigen values, and Mahalanobis distances were determined with values of Wilk's Lambda closer to zero being the evidence for well discriminated patient groups. Data analysis was performed using SPSS® statistical software version 23.0 (Chicago, IL).

Results

In total, 62 400 records of TB notification were analyzed for the period 2009-2013. The TB incidence rate reduced by 80% at the end of the evaluation. After adjusting for confounders, expenditure per patient day equivalent (PDE) and PHC expenditure per capita were significantly and independently associated with the decline of incident TB cases (adjusted R^2 = 60%; ρ = 0.002) following the equation: *Y= (- 209× Expenditure per PDE) + (- 0.191 × PHC expenditure per capita)*. CDA showed that TB cases in the most socio-economically deprived communities (quintile 1) were significantly more likely to have high HIV and TB co-infection death rates as compared to the least socio-economically deprived group (quintile 5) [Eigen value (12.95), function coefficient (1.49) > (.77); Wilk's Lambda = .019, p < .0001].

Conclusions

Although TB control programs in OR Tambo district have averted thousands of TB incident cases, their effects on HIV associated TB deaths among the most deprived communities remain insignificant. There is an urgent need for strengthening integration of TB/HIV services in most deprived settings.

Background

According to the 2015 Global TB report, South Africa is ranked number two, with a TB incidence estimated to reach 834 cases per 100 000 populations (1). This is despite the fact that TB incidence in South Africa has been drastically decreasing since 2009 (2). Among the key driving factors, we have high rate of HIV co-infection, poverty and the emergence of multidrug-resistant TB (MDR-TB) and extensively-drug resistant TB (XDR-TB) (1, 2).

Health expenditure, expressed as total percentage (%) of the gross domestic product (GDP) in South Africa was reported at 8.797 % in 2014, according to the World Bank (3). However, its impact on trends of TB incidences in the country is not well documented.

Studies have shown that presently, KwaZulu-Natal, Eastern Cape, and Western Cape have the highest TB incidence rates in South Africa (4, 5). Eastern cape remains one of the poorest South African provinces characterized by disconnected and inadequate healthcare services. In recent years, attention has turned to the contributions made by the mismanagement of healthcare expenditures and poor service delivery by local governments (according to unverified reports) and the index of multiple deprivation in fueling both TB and HIV epidemics (4, 5). Unconfirmed evidence also suggests that in the OR Tambo district of the Eastern cape SA province, the expansion of TB services for people living with HIV has been slower particularly among communities living under extreme poverty.

Although the World Health Organization (WHO) and the South African National Department of Health (NDoH) have issued strategic guidelines for the integration of TB and HIV services, yet these guidelines remain poorly implemented, especially among the most socio-economically deprived areas (6, 7). Hence, the present study sought to investigate the associations between socio-economic deprivation and tuberculosis (TB) treatment outcomes, alongside other TB risk factors such as population density, number of people living in poverty, poverty gap, supervision rate in primary healthcare (PHC) facilities, and PHC work load. In addition, the effects of healthcare expenditures

(expenditure per capita, expenditure per patient day equivalent – PDE, and the local government expenditure) and their growth over the years on trends in TB incidences over a 5-year period were also assessed.

Methods

Description of the study settings

O.R Tambo district (see map below) is one of the 7 districts of the Eastern Cape province of South Africa. The seat of O.R Tambo is in Mthatha. The vast majority of its population of about 1 676 463 speak Xhosa (8). The district is named after Oliver Reginald Tambo, who was the South African anti-apartheid politician and central figure in the African National Congress (ANC).

Map of OR Tambo District Municipality. Source: http://isrdp.dplg.gov.za/documents/IDP/ ISRDP/ OR_ Tambo_IDP.pdf. (open access).

The district code is DC 15 and within Wild Coast Region. It is surrounded by Alfred Nzo district (DC44 to the North), Sisonke district (DC43 to the North), Ugu district (DC21 to the North-East), Amathole district (DC12 to the South-West), Chris Hani district (DC13 to the West), and Joe Gqabi district (DC14 to the North-West). Local Municipalities under O.R Tambo district include Ngquza Hill, Port St. Johns, Nyandeni, Mhlontlo and King Sabata Dalindyebo (8).

OR Tambo district has a total area of 54.97 Km^2 with a population estimated to 210,783 and an overall density of 3,800/ Km^2. The racial makeup consists of the following: Black African 90.6%,

Coloured 6.7%, Indian/ Asian 1.2%, White 1.0%, of which based on language Xhosa is the most dominating language spoken by 85% of people, followed by English 8.6% (8). The district is made up of 4 health sub-districts: King Sabata Dalindyebo sub-district with a population of 442318, Mhlontlo sub-district and its population is 221827, Nyandeni sub-district and its population is 436813, and Qaukeni sub-district with a total population of 659431 (8). OR Tambo district has been reported to bear the following basic indicators: 64.6% of people are living under poverty with an estimated unemployment rate of 65.5% and the literacy rate of 42.2%. The average annual income of a Black resident is R15,762. Health services are delivered by one central hospital, 1 regional hospital, 12 district hospitals; 11 community health centers, 49 clinics, 52 health posts and 15 mobile health services.

Study design, data sources and description of variables of interest

Secondary data review was performed on the OR Tambo TB data obtained between 2009 and 2013 from various sources including governmental, non-governmental and research institutions. Those included data from the 2009–2013 District Health Barometer by the Health System Trust (HST); the 2017 Global Monitoring Report by the WHO and the World Bank; the 2015 WHO End TB Strategy; the 2014–2015 Eastern Cape Department of Health Annual Reports and TB health records from healthcare facilities in the OR Tambo district; the 2015 Re-engineering of Primary Healthcare Strategy by the EC DoH; the 2017 Eastern Cape Socio-economic Consultative Council (ECSECC); the 2012 South African National HIV Prevalence, Incidence and Behaviour Survey by the Human Sciences Research Council (HSRC); the 2015 Guide to Monitoring and Evaluation for collaborative TB/HIV Activities by the WHO and the Global Funds; the 2015–2016 Adequacy and Efficiency in PHC Financing by the SA National Treasury; and the 2017/2018 to 2019/2020 Annual Performance Plan (APP) by the SA NDoH.

The following variables of interest were extracted from the above data sources**:**

a) Description of independent variables:

Independent variables	Definition(s)
Index of multiple deprivation	The deprivation index and socio economic quantiles comprise a new index of multiple deprivation developed by Noble et al. (2013), according to basket of variables from South African Census 2011 and South African Index of Multiple Deprivation (SAIMD) with four domains: income and material deprivation, employment deprivation, education deprivation, and living environmental deprivation, individual or household using equal weights in terms of socio economic quantiles (SEQ) : SEQ 1st = most deprived, SEQ 2 = deprived, SEQ 3 = intermediate, SEQ 4 = well off, and SEQ 5 = least deprived (9).
Population density	Number of individuals per square kilometre.
People living in Poverty	In October 2015, the World Bank defines the new international poverty line (below which there is absolute poverty) as $1.90 a day (this was equivalent to $1.25 a day in 2008). Relative poverty views poverty as socially defined and dependent on social context, hence relative poverty is a measure of income inequality. Usually, relative poverty is measured as the percentage of the population with income less than some fixed proportion of median income.
Poverty gap	An indicator that incorporate both the depth and incidence of poverty, indicating the proportion of households living in poverty as well as how far they are below the poverty line; it is calculated by summing the difference between the incomes of each poor households and poverty line.
Supervision visit rate in primary healthcare (PHC) facilities	This is the number of fixed PHC facilities visited by a clinical supervisor at least once a month, to interact with peripheral health care workers in order to monitor work processes, understand the causes of problems and provide possible solutions (10).
PHC work load	An indicator that measures the average number of patients per day seen by a professional nurse at a PHC facility. Its purpose is to analyse utilisation patterns, efficiency and equity in terms of staff distribution.
PHC Expenditure per capita	It measures the total amount of money spent annually by each district divided by the total population in the district (10).
expenditure per patient day equivalent (PDE)	A composite process indicator that connects financial data with service-related data from the hospital admissions and outpatients. This indicator measures how the resources available to the hospital are being spent and is a marker of efficiency.
Local government expenditure	A total amount of money spent on district health services per person without medical scheme coverage.

b) Description of dependent or outcome variables**:**

Independent variables	Definition(s)
Rates of TB deaths	Number or proportion of TB patients who died for any reason during the course of the TB treat
TB case finding index	PTB case index is defined as the earliest identified onset of TB according to WHO principles an confirmed TB patient who already had at least two acid-fast bacilli (AFB)-positive smears and
TB treatment failure	TB patient whose sputum smear or culture is positive at 5 months or later during treatment. A multidrug-resistant (MDR) strain at any point of time during the treatment (11).
HIV associated TB deaths	Case of HIV-positive TB patients that were bacteriologically confirmed or clinically diagnosed c conducted at the time of TB diagnosis or other documented evidence of enrolment in HIV care register once ART has been started, and died (12).
TB defaulter rate	Number of TB patients whose treatment was interrupted for 2 consecutive months without me rate is the ratio of patients who defaulted TB treatment in a given year to the total number of
New TB smear positive cases	TB patients who have never had treatment for TB or who have taken TB drugs for less than 4 PTB or Extra Pulmonary Tuberculosis (13).

Data analysis and statistical methods

Continuous indicators of TB management were presented as mean ± standard deviation (SD) for bivariate analysis. Pearson's correlation coefficient was used to measure the degree of linear association between variables in general and between TB indicators and deprivation-concentration in particular, ranging in magnitude on interval scale from -1 to +1. Analysis of variance (ANOVA) and Post-Hoc Bonferroni pairwise tests were used to compare means of variables of interest considering a type I error rate of 0.05. Regression models and canonical discriminant analysis (CDA) were used to explore the associations between trends in TB incidence and independent TB predictors. The regression coefficient represented the increase or decrease in the absolute magnitude of the independent variable for each unit of increase in the dependent variables such as deprivation using the equation: $Y = constant\ (slope) \pm ax$. The slope index of inequality represented the linear regression coefficient that showed the relationship between the level of implementation, the burden of TB and deprivation. Unstandardized coeffients (B and Standard Error), standardized coefficients (Beta and 95% confidence interval/ CI), regression standardized residual, observed cumulative probability (Com Prob), studentized deleted residual and partial regression plot were determined during multivariate associations.

The major underlying assumptions of canonical discriminant analysis (CDA) were: (i) each predictor variable is normally distributed; (ii) there must be homogeneity of covariance across the groups; (iii) there must be at least two groups or categories, with each study case belonging to only one group so that the groups are mutually exclusive and collectively exhaustive; (iv) the groups or categories should be defined before collecting the data; (v) the predictor variable(s) used to separate the groups should discriminate quite clearly between the groups so that group or category overlap is clearly non-existent or minimal; (vi) group sizes of the dependents should not be grossly different and should be at least five times the number of independent variables.

The Box's Test of Equality of Covariance Matrices was used to check the assumption of homogeneity of covariance across the groups using $p < .001$ as a criterion.

Mahalanobis distances were used for supporting the classification of canonical variates into distinct groups and for comparing divergence among populations' group centroids in order to determine the degree of segregation with values of Wilk's Lambda closer to zero being the evidence for well-separated groups. In addition, during CDA, Fischer's linear functions and Eigen values were determined considering values of Wilk's Lambda. Data analysis was performed using SPSS® statistical software version 23.0 (SPSS Inc; Chicago, IL).

Results

In total, 62 400 records for TB notification were analyzed for the period 2009-2013. The following findings were obtained:

1. **Predictors of TB incidence in O.R. Tambo district**

Figure 1A and **1B** show comparisons of mean values of incident TB cases from 2009 to 2013. The incidence curve of TB trends dropped abruptly and significantly from 2010 until 2013 ($\rho < 0.00001$). During the univariate analysis of predictors of incident TB cases from 2009 to 2013 (**Table 1A and 1B**), the study found a significant ($\rho < 0.05$) bivariate (univariate) positive correlation between population density ($r = 0.812$; $\rho < 0.0001$), poverty gap ($r = 0.210$; $\rho < 0.01$), and mean number of TB cases. However, there was a significant ($\rho < 0.05$) negative correlation between supervision rate ($r = - 0.173$; $\rho = 0.030$), PHC professional nurse clinical workload ($r = -0.164$; $\rho = 0.021$), expenditure per patient day equivalent ($r = -0.282$; $\rho = 0.015$), PHC expenditure per capita ($r = -0.159$; $\rho = 0.034$), local government expenditure on PHC ($r = -0.244$; $\rho = 0.022$), and the mean number of TB cases.

After adjusting for confounding variables using multiple linear regression analysis, only expenditure per patient day equivalent (PDE) and PHC expenditure per capita were identified as the most important, significant and independent predictors (adjusted $R^2 = 60\%$; $\rho = 0.002$) in terms of declining incident TB cases following the equation: $Y = (-209 \times \text{Expenditure per PDE}) + (-0.191 \times \text{PHC expenditure per capita})$.

1. **Association between socio-economic deprivation and TB care indicators in O.R. Tambo district**

The following TB care indicators were assessed in this study: TB deaths (all TB cases); TB case finding index; TB treatment failure (all TB cases); HIV and TB deaths; TB defaulter rate (all TB cases); and New TB smear positive cases.

The associations between the above TB care indicators and multiple deprivation index from 2009 to 2013 were measured as follows:

(a) Univariate analyses

On single variable analysis **(Figure 2A – 2F**), TB cases in the most socio-economically deprived group were significantly more likely to have a high TB death rates **(Figure 2A),** high PTB case finding index **(Figure 2B)** and high HIV and TB co-infection death rates **(Figure 2D)** as compared to the least socio-economically deprived group. However, individuals in the least deprived group were significantly more likely to be associated with high rates of TB treatment failure **(Figure 2C),** high rates of TB defaulter rates among TB smear positive group **(Figure 2E)** and high rates of new PTB smear positive results **(Figure 2F)** as compared to the most deprived individuals.

(b) Multivariate analysis

Using canonical discriminant analyses (CDA) on normally distributed variables that showed significant univariate associations, three canonical functions were identified as able to discriminate among the socio-economically deprived groups. The obtained 3 discriminant functions had Eigen values that are summarized in **Table 2**. The larger the Eigen value represents more shared variance in the linear combination of variables.

Of the 3 identified canonical functions, the first two functions contributed a total of 98.5% of the total variance, which easily stratifies into the 5 study groups (from quintile 1 to quintile 5). The Wilks' Lambda value was significant: 0.019; $\chi^2 = 137.62$; $\rho < 0.0001$ (**Table 3**).

Functions' coefficients were calculated and used to decide which variables predicted group membership. Comparing the values between groups, the higher coefficient means the predictor variable attributes more for that group (**Table 4** and **Table 5**).

Table 4 demonstrated Fisher's linear discriminant functions according to classification function coefficients. After adjusting for confounding factors (PTB case finding index, TB defaulter new smear

positive, TB death in all TB, TB defaulter all TB, and TB failure in all TB), only HIV and TB death and new TB smear positive cases were identified as the most important, significant, and independent indicators able to discriminate the most deprived communities with a deprivation index far from other deprivation-concentration-dispersion quintiles 2-5 **(Table 5 and Figure 3)**.

Standardized canonical discriminant function coefficients were used for predicting functions defining group centroids (**Figure 3**). The canonical group means (also called group centroids) are the mean for each group's canonical observation scores. The larger the difference between the canonical groups implies the better the predictive power of the canonical discriminant function in classifying observations.

In conclusion, CDA showed that TB cases in the most socio-economically deprived communities (quintile 1) were significantly more likely to have high HIV and TB co-infection death rates as compared to the least socio-economically deprived group (quintile 5) [Eigen value (12.95), function coefficient (1.49) > (.77); Wilk's Lambda = .019, $p < .0001$].

Discussion

There are two main findings of this study. First, data have shown substantial decrease of TB incidence from 2009 to 2013 due to increased healthcare expenditures, particularly expenditure per patient day equivalent (PDE) and PHC expenditure in OR Tambo district. Whilst PHC expenditure measures the total amount of money spent annually by each district divided by the total population in the district, expenditure PDE is a composite process indicator that connects financial data with service-related data from the healthcare facilities. This indicator measures how resources available to the healthcare facility are being spent, making expenditure PDE the most relevant marker of healthcare efficiency. Therefore, our findings suggest that coordinated efforts in TB control and prevention in the OR Tambo district yielded a remarkable number of TB cases averted.

Previous studies have shown that when healthcare expenditures are efficiently managed, TB cases will significantly decrease because health care providers will be trained to improve the ability to diagnose and treat persons with TB disease; there will be improvements in laboratory diagnostic methods with early testing and management of TB patients; implementation of appropriate infection

prevention and control precautions in health care facilities and other congregate settings in order to reduce TB transmission rates; as well as strengthening of local health facilities and TB control programs in order to undertake monitoring and evaluation of TB patients on therapy (14 – 16).

Second, whilst milestones in reduction in TB cases are significantly progressing towards their achievements, findings from this study have unfortunately revealed that HIV associated TB deaths particularly among the most socio-economically deprived communities in OR Tambo district remain high, hence a cause for concern. The present study demonstrated that highest level of deprivation, concentration, and dispersion index was associated with the highest numbers of death among TB patients who are co-infected with HIV. Similar findings have been previously reported elsewhere (16 – 19).

In explaining this disparity, it is possible that either health resources are not evenly distributed between the most and the least socio-economically deprived communities to combat both TB and HIV diseases or TB and HIV health services are not fully integrated in settings where individuals are the most deprived. Either way, it is clear that TB disproportionately affects the socially and economically marginalized, with a recognized role for HIV co-infection in addition to traditional factors such as poverty and overcrowding, characterized by high population density (11, 17 – 20). Since the South African provincial and local government health expenditure per headcount does provide insight into equity in justice and resources distribution (6, 9, 10), there is therefore an urgent need for addressing TB and HIV health services integration in most deprived geographical areas in the OR Tambo district in order to curb HIV associated TB deaths. Previous studies have shown that strengthening of HIV and TB services integration plays a positive role in reducing both TB/HIV incidence and mortality among individuals living under conditions of highest deprivation-concentration-dispersion (6, 15, 16, 20).

South Africa has more people living with HIV and the vast majority are on ART (8). Despite the fact that the study by Williams demonstrated that the successful roll-out of ART has been associated with a 72% reduction in the incidence of HIV among adults from 1996 to 2016 and a 74% reduction in AIDS-related mortality from 2006 to 2016 (21), integrating TB and HIV health services is thought to actually play a major role, and might substantially reduce TB/HIV mortality in South Africa by 2030

irrespective of other traditional risk factors. Unfortunately, high rates of TB and HIV co-infection, poverty, inadequate training and supervision of the health professionals, absence of staff and material resources, and lack of infection prevention and control policies might be barriers to the implementation of HIV/TB integration, particularly among the most socio-economically deprived communities (22) such as in the O.R Tambo District as demonstrated by this present study.

Conclusions And Recommendations

The study found out that the health burden due to tuberculosis is closely correlated to expenditure per patient day equivalent, a strong indicator of healthcare efficiency. On the other hand, HIV associated TB deaths particularly among the most socio-economically deprived communities in OR Tambo district remains high. This health outcome provides a more encompassing view on the devastating effect of TB and HIV co-infection among the poorest communities. These findings highlight the importance of expanding coverage of TB and HIV integrated services to ensure prompt diagnosis and initiation of treatment among the most deprived people in resource-limited settings. Public and private partnership should be strengthening in order to develop comprehensive, collaborative and holistic approaches toward TB elimination by bringing together key stakeholders among policy makers, researchers, health professionals, civil society, non-governmental organizations (NGOs) and private sector. It is evident that that combined and coordinated efforts are the only way to halt the dual epidemics of TB and HIV by integrating healthcare services. However, further studies are warranted to address barriers and opportunities for integrating TB and HIV services among the most socio-economically deprived communities of OR Tambo district.

Abbreviations

AFB: acid-fast bacilli

ANC: African National Congress

APP: Annual performance plan

ANOVA: Analysis of variance

CDA: canonical discriminant analysis

DC: District code

ECSECC: Eastern Cape Socio-economic Consultative Council

GDP: gross domestic product

HIV: human immunodeficiency virus

HST: Health System Trust

HSRC: Human Sciences Research Council

MDR-TB: multidrug-resistant tuberculosis

NDoH: National Department of Health

PDE: patient day equivalent

PHC: primary healthcare

SA: South Africa

SAIMD: South African Index of Multiple Deprivation

SEQ: Socio-economic quintile

SPSS: Statistical Package for the Social Sciences

TB: Tuberculosis

WHO: World Health Organization

XDR-TB: extensively-drug resistant tuberculosis

Declarations

Ethics approval and consent to participate

The Research Ethics and Biosafety Committee of the Walter Sisulu University approved the study (ethical clearance No. 29/2014) and permission to conduct the study was obtained from the Eastern Cape Department of Health. This was a secondary data analysis, hence no consent from patients were obtained.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that there are no competing interests.

Funding

Not applicable.

Authors' contributions

ND: designed the study, collected data from various data sources, contributed in data analysis and interpretation of findings, and drafted the manuscript. **BL:** revised the study design and analysed data. **TA:** contributed in data analysis and interpretation of findings, and also edited the final version of the manuscript.

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Tables

Table 1A Shows the number of population density, number of people in poverty, poverty gap, and TB incidences between 2009 and 2013.

Year	Population Density	Number of People in Poverty	Poverty Gap (%)	TB incidence
2009	112.51	1 196 446	31.3	953.4
2010	113.61	1 183 517	32.8	922.3
2011	114.76	1 188 933	33.5	913.7
2012	115.84	1 186 284	35.2	862.7
2013	117.10	1 183 635	36.1	823.1

Table 1B Shows number of supervision rate, PHC workload, PHC Expenditure per PDE, PHC expenditure per capita and Local government expenditure between 2009 and 2013.

Year	Supervision Rate by District	PHC work load	PHC expenditure per capita (Rands)	Expenditure per PDE (Rands)	Local governm expenditure (R
2009	50.0%	19.5%	500	543	569.3
2010	87.3%	16.9%	500	1400	685.4
2011	89.6%	39.8%	595	1597	673.6
2012	83.0%	43.7%	626	1645	666.8
2013	80.8%	45.7%	647	1645	646.6

Table 2 Eigenvalues functions 1-3, % of variance, Cumulative variance (%), and Canonical Correlations at 1st, 2nd, 3rd

Function	Eigen value	% of Variance	Cumulative %	Canonical Correla
1	12.954[b]	84.5	84.5	
2	2.142[b]	14.0	98.5	
3	.232[b]	1.5	100.0	
a. Province = Eastern Cape Province (OR Tambo district)				
b. First 3 canonical discriminant functions were used in the analysis.				

Table 3 Wilks' Lambda with test of functions and statistical significance from DA

Test of Function(s)	Wilks' Lambda	Chi-square	Df	S
1 through 3	.019	137.615	15	
2 through 3	.258	46.681	8	
3	.812	7.188	3	
a. Province = Eastern Cape Province (OR Tambo district)				

Table 4 Structure Matrix following CDA

	Function		
	1	2	3
TB deaths all TB	.763*	-.059	.161
TB case finding index	.302*	-.130	.246
TB failure all TB	-.230	.578*	.093
HIV and TB deaths	-.046	-.224*	-.169
TB defaulter all TB	-.403	.378	.785*
New TB smear positive	-.087	.412	-.670*
Seropositive HIV status[c]	.123	.137	.211*
Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions variables ordered by absolute size of correlation within function.			
*Largest absolute correlation between each variable and any discriminant function			
a. Province = Eastern Cape Province (OR Tambo district)			
c. This variable not used in the analysis.			

Table 5: Classification of Function Coefficients

	Deprivation Quintiles			
	Most Deprived Quintile 1	Less Deprived Quintile 2	Less Deprived Quintile 3	Less Deprived Quintile 4
HIV and TB deaths	1.489	1.174	1.165	.959
New TB smear +	-.001	.000	.000	.000
(Constant)	-24.481	-16.033	-15.986	-11.330
Fisher's linear discriminant functions				

Figures

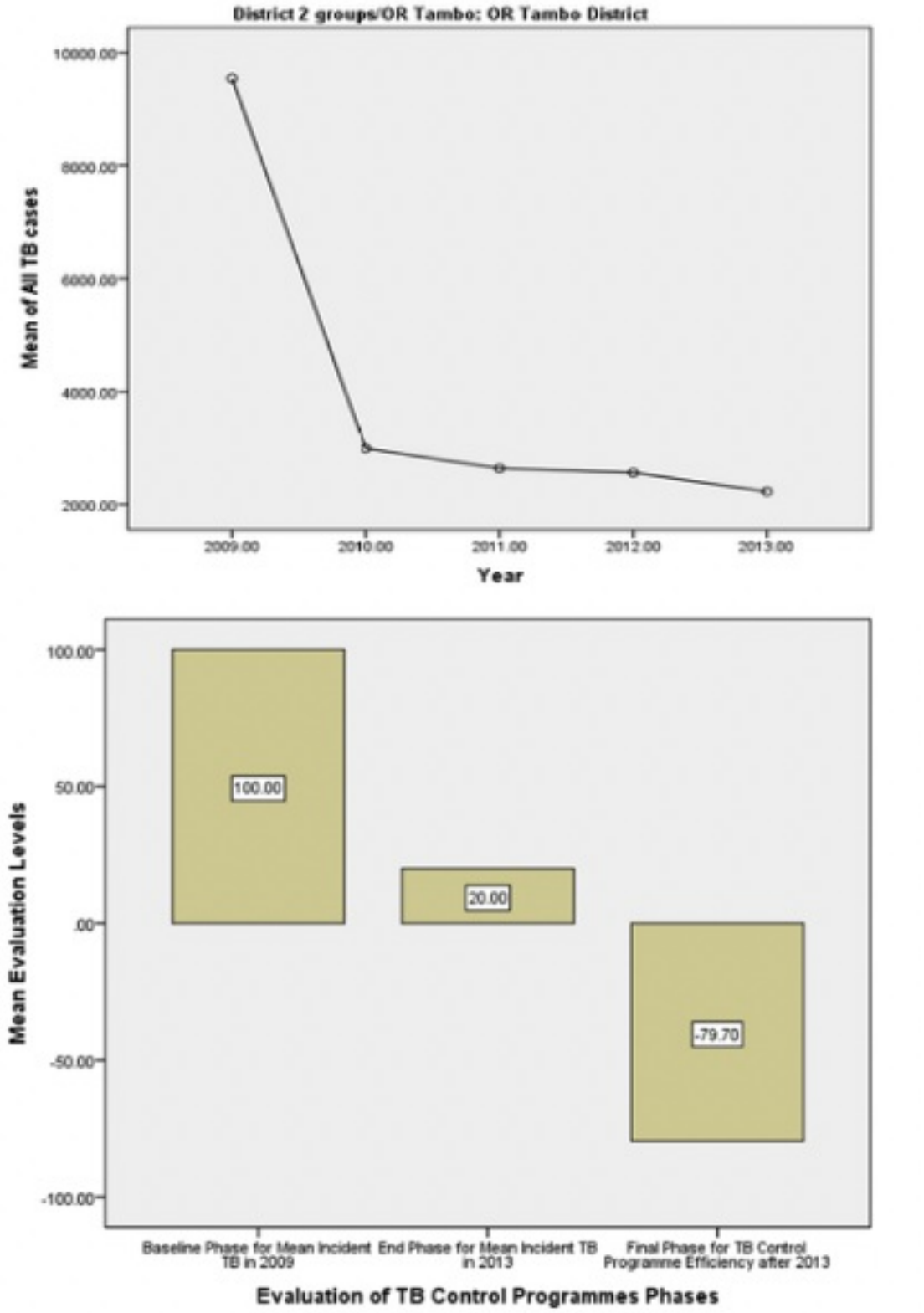

Figure 1

Figure 1A Trend of Incident Pulmonary Tuberculosis from 2009 to 2013.. Figure 1B Evaluation of the implementation of TB control program with performance efficiency defined

by reduction of 80% of incident TB cases.

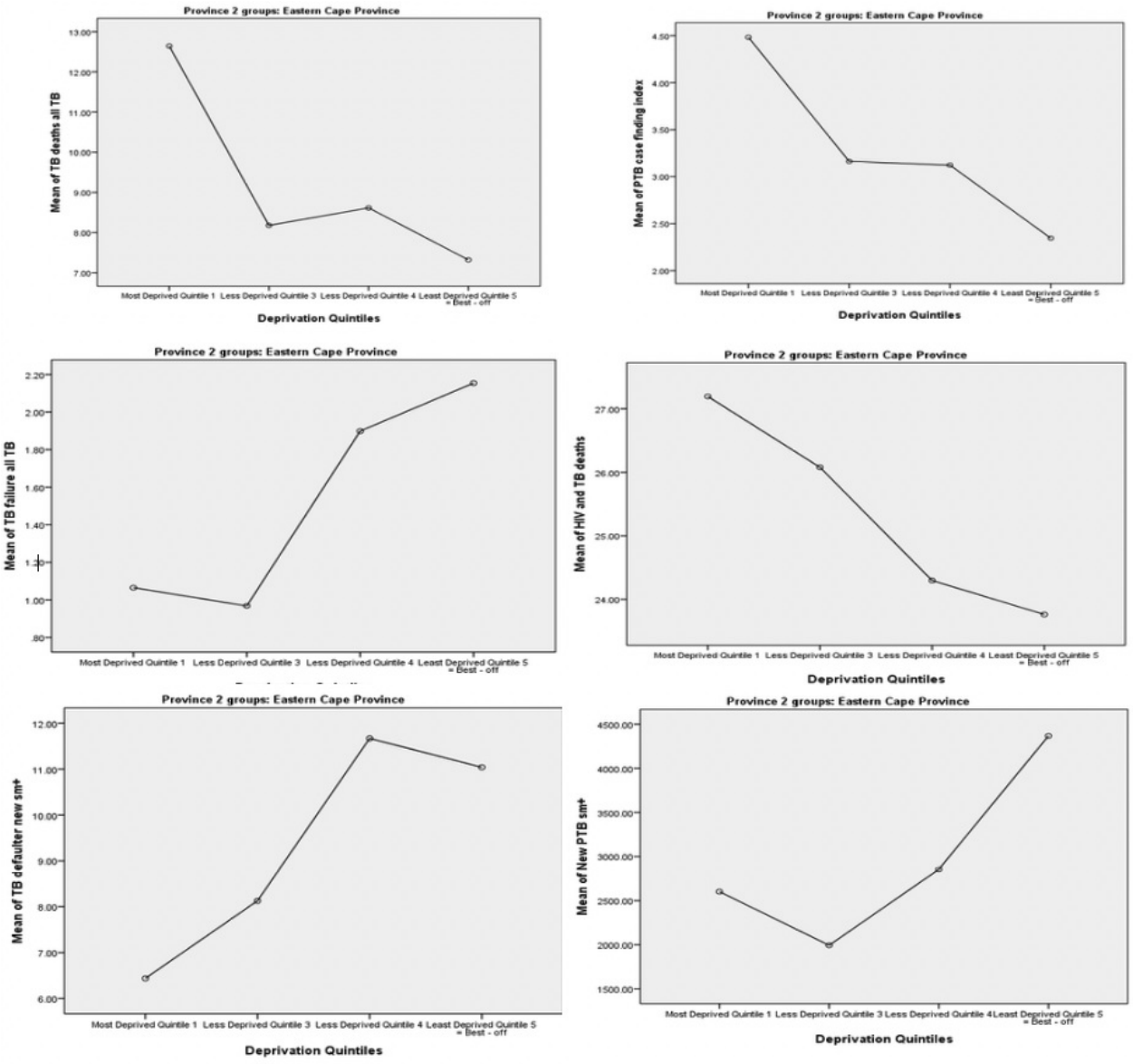

Figure 2

Figure 2A Correlation between deaths in all TB cases and deprivation index. Figure 2B Correlation between TB case finding index and deprivation index. Figure 2C Correlation between number of TB treatment failure and deprivation index. Figure 2D Correlation between mean HIV and TB death rates and deprivation index. Figure 2E Correlation between new smear positive TB defaulter rates and deprivation index.Figure 2F Correlation between No. of new TB smear positive cases and deprivation index.

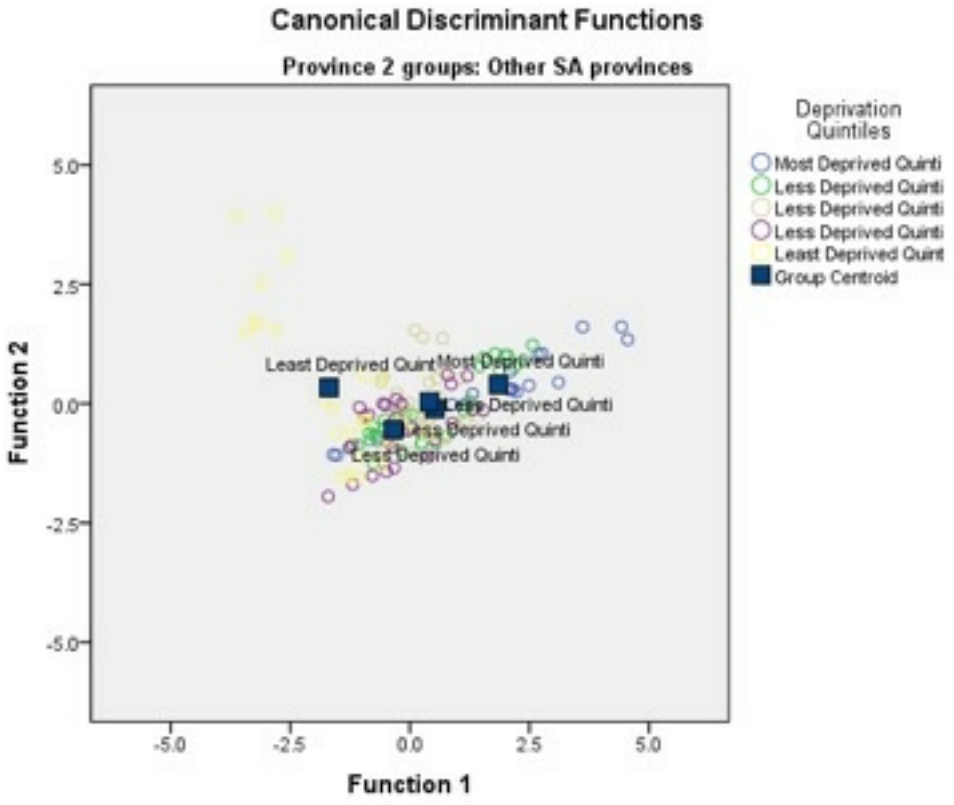

Figure 3

Socio-economic deprivation quintiles and TB care indicators reflecting the TB control program in OR Tambo district.