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Research Article

Retrospective Study on the Incidence of Tuberculosis Cases in Pakistan

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ABSTRACT

Tuberculosis (TB) is a serious infection or disease that directly affects the lungs. Pakistan stands 5th ranks amongst the high burden countries in the world. This study addresses the relationships between different tuberculosis cases in the province of Pakistan. The study is used to find which province reported high tuberculosis cases like (bacteriologically confirmed, clinically diagnosed, extra pulmonary and retreated tuberculosis). The main objective of this study is to know which tuberculosis case has significant effect among the provinces. For this purpose, we find the mean difference among the province of Pakistan with concern to tuberculosis cases in this study. The secondary data is used in this study. Further we find the correlation between tuberculosis cases and then used factor analysis. The dataset is taken by the website of the national TB data and Pakistan bureau of statistics. The dataset includes four different cases of tuberculosis (bacteriologically confirmed, clinically diagnosed, extra pulmonary and retreated tuberculosis) in provinces of Pakistan during the period of 2019. For achieving the objectives of the study, different techniques are used such as graphical representation, descriptive statistics, two-way ANOVA, LSD Test, correlation matrix, and factor analysis. The study shows highly significant results and concluded that the highest numbers of cases and deaths are reported in Punjab. Correlation matrix shows strong positive correlation between the four cases of tuberculosis. From factor analysis, there is only one factor is extracted that explains 82.872% of the total variation and all the cases have strong correlation with the factor.

Keywords: Tuberculosis, Bacteriologically Confirmed, Clinically Diagnosed, Extra Pulmonary, Provinces, Two-Way ANOVA, Factor Analysis.

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INTRODUCTION

Tuberculosis (TB) is a serious infection or disease that directly infects our lungs and all other body parts or organs, like spine, kidneys, brain and liver. TB is a mainly spread disease, such as, when an infected person coughs, sing, sneezes or laughs, it varies from person to person in a flying manner. This disease does not spread through personal items, such as (clothing, bedding, a drinking glass, eating utensils, a handshake, a toilet) or other items that have been touched by TB person. It can also cause an active infection in someone who was exposed to it in the past. Mycobacterium TB (MTB) is the main bacterium of TB. Most of the people infected with MTB never show an active TB. They remain at an inactive or latent stage of TB. On the other hand, the people especially with human immunodeficiency virus (HIV), or those taking medicines with weak immune systems show an active TB, because TB organisms can overcome the body resistance and multiply. Good ventilation is the most important measure to prevent the spreadness of TB. The following are the main cases of TB discussed here and are used in this study.

Bacteriologically Confirmed Case

In this case, a parson whose biological specimen has been confirmed as positive by smear microscopy.

All these types of cases should be noticed, in spite of whether the treatment has been started.

Clinically Diagnosed Case

In this case, a healthcare professional has determined that a patient needs a full course of TB therapy even when the patient does not meet the requirements for bacteriological confirmation but has been diagnosed with active TB. This definition covers extra-pulmonary instances diagnosed without laboratory confirmation. The classification of clinically diagnosed that are later determined to be bacteriologically positive (before or after starting treatment) should change to bacteriologically confirmed.

Extra Pulmonary Case (EPTB)

Any case of TB involving organs other than lungs, (e.g. pleura, abdomen, lymph nodes, skin, genitourinary tract, joints and bones) that has been clinically or bacteriologically diagnosed is referred to as an extra-pulmonary case.

Retreated Case

Patient with retreatment TB is those who have been received at least one month of prior anti-TB treatment and have developed the disease again.

LITERATURE REVIEW

Rao, (2009) studied patients of pulmonary TB with respect to gender and its implication in TB controlled. The data was collected from dots center at a tertiary teaching hospital in south India. He concluded that the observation that 2/3 of all smear-positive female patients were detected in young and reproductive age group. He also found that the strong association in TB controlled strategies, because of more chances of mother to child transmission. Lin et al, (2009) studied extra-pulmonary TB manifest with protean symptoms and establish a diagnosis of extra-pulmonary were more difficult or challenging than pulmonary TB (PTB). The main objective is to analyze the exposures of extra-pulmonary TB compared with pulmonary TB. The retrospective study analyzes their demographic data and clinical underlying diseases and compared patients with extra-pulmonary TB and pulmonary TB in southern Taiwan. The exposures related to extra-pulmonary TB were analyzed. They concluded that physicians needed to be aware of risk factors in order to have a high index of suspicion for accurate and prompt diagnosis. Ryu et al. (2015) studied the problem of pulmonary TB and their increase in the overall age of the population in Korea. The standard procedures and latest methods for the diagnosis of pulmonary TB were summarized. They used different diagnostic test like (chest x-ray, sputum microscopy, culture in both liquid and solid media, and nucleic acid amplification) and recognized an accurate and timely diagnosis of pulmonary TB. They concluded that some diagnostic test such as (histopathological examination of biopsy samples, chest computed tomography, and new molecular diagnostic tests) could have been used for accurate and timely diagnoses. Wang et al. (2017) studied the retreatment of TB frequently fails in China and the risk factors related with the treatment failure remains unclear. They analyzed the data of patients received retreatment between the years (July 2009 to July 2011) in China and used the sample of 395 retreated pulmonary TB patients to identify the risk factors for the treatment failure. The patients were classified into ‘successes or ‘failure’ by treatment. Univariate and multivariate logistic regression techniques were used to find the association between treatment outcome and clinical factors. Atif et al. (2018) looked at the monitoring of treatment outcomes for TB and identifying the causes of treatment failure in order to assess the effectiveness of the national TB controlled program. The objective of this study was to assess the treatment outcomes among the patients having pulmonary TB. It was found that the treatment success rate among these patients was less than the suggested 85% success rate. They concluded that to increase the success rate of TB management in Pakistan, the TB patients who were more likely to have unsuccessful treatment outcomes were given more supervision and treatment monitoring. Saqib et al. (2018) studied that a delay in diagnosis and treatment worsens the condition and clinical results, thereby enhancing TB transmission in the community. For the purpose, they studied the risk factors associated with treatment delay among the patients with pulmonary TB in Pakistan. Binary and multivariate logistic regressions techniques were used to explore the data. They concluded the reason for the treatment delay is that mostly patients were from low socio-economic backgrounds. The important delays were revealed that 160 patients had more than 4 weeks delay, whereas the median delay was 5 weeks by this study. However, the patients with high socio-economic status experienced less delay. Moyo et al. (2022) examined that TB is globally a leading cause of death and they found that this is a third major cause in Zimbabwe. The cause of death following a diagnosis of TB was named as a TB death. They characterize the patients dying and made implication to improve treatment outcomes. A cross-sectional studied was conducted to analyzed TB deaths in the Bulawayo province. They used chi-square tests for trends and found the high death rates.

After studying a literature review, this study was intended to evaluate the impact of all TB cases among provinces in Pakistan by taking four cases of TB. The four cases or variables of the study are bacteriologically confirmed, clinically

diagnosed, extra pulmonary and re-treated TB patients. The significance of the study is that no literature found in Pakistan in which all four cases are simultaneously studied. We recommended from this study that the findings will help to deal with the early diagnosis and controlling the spread of TB by using effective planning for health facilities for disease diffusion.

DATA COLLECTION

Secondary data set is taken from Pakistan Bureau of Statistics through internet. The dataset consists of four cases of tuberculosis (bacteriologically confirmed, clinically diagnosed, extra pulmonary and retreated tuberculosis) in the provinces (AJK, Balochistan, FATA, GB, KPK, Punjab, Sindh and ICT) of Pakistan. The dataset is taken for one year of 2019. The data consists of 189,666 total patients in which 71204 patients of bacteriologically confirmed, 78347 patients of clinically diagnosed, 35263 patients of extra pulmonary and 4852 patients of re-treatment.

RESULTS AND DISCUSSION

Graphical Representation

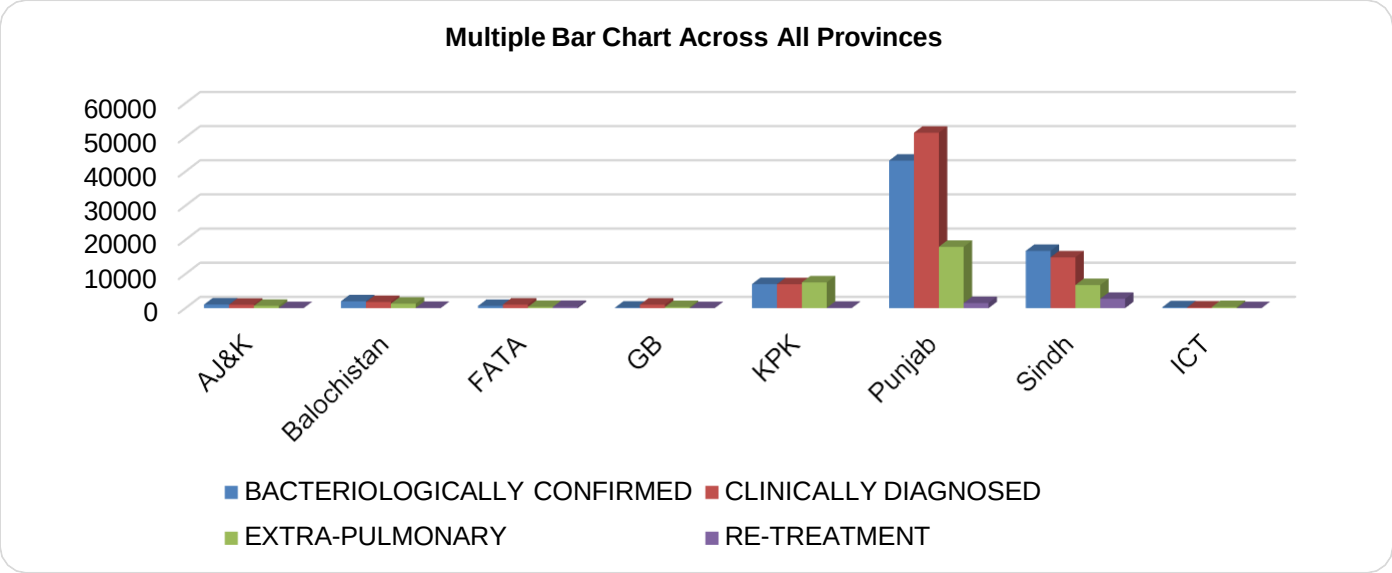

Figure 1. Multiple Bar Chart for Tuberculosis Cases among Provinces.

Figure 1. shows that Punjab reported highly tuberculosis cases, in which clinically diagnosed cases are highly reported, and re-treatment cases are the less reported. Sindh is the second province reported second highest tuberculosis cases, in which bacteriologically confirmed cases are highly reported and re-treatment cases are the least reported. KPK is the third province reported third highest tuberculosis cases, in which extra-pulmonary cases are highly reported while Islamabad reports lowest tuberculosis cases. So, Punjab is the dominant province among all with respect to the tuberculosis cases.

DESCRIPTIVE STATISTICS

To achieve the objective of the research, descriptive analysis is carried out in terms of the mean, standard deviation, and coefficient of variation of the tuberculosis reports cases.

Table 1. Descriptive Statistics of TB Cases.

Variables	Mean	S. D	C.V
Bacteriologically Confirmed	8900.5	14972.23	168.2178529
Clinically Diagnosed	9793.38	17516.36	178.8591886
Extra-Pulmonary	4407.88	6236.924	141.4948683
Re-Treatment	606.5	997.041	164.3925804
S.D= Standard Deviation and C.V= Coefficient of Variation			

In table 1, the mean, standard deviation and coefficient of variation is presented. It can be observed that the highest variation (178%) observed is in clinically diagnosed data series while the lowest variation (141%) observed is in extra-

pulmonary data series. In comparison among the data series of all four cases, it can be seen that extra-pulmonary data series is the best series because it has smallest coefficient of variation.

Two-Way Anova

For achieving the next objective of the study, two-way ANOVA is conducted. Two-way ANOVA is used to check the effect of two factors or groups on a dependent variable and to compare the mean difference between two groups. In this study we use one group as provinces and the other group as tuberculosis cases. Our dependent variable is total number of cases reported under the following hypothesis

H_0: All provinces' effects are same.

H_1 : All provinces are not effects the same.

H_0': All tuberculosis cases effects are same.

H_1': All tuberculosis cases effects are not same.

Table 2(a). Results of Two-Way ANOVA.

Source of Variation	Sum of Squares	Dr	Mean Square	F-ratio	P-value
Province	435248151.1	3	145082717	2.312092614	0.105452601
Tuberculosis Cases	2678447165	7	382635309.3	6.097819854	0.000562789
Error	1317740059	21	62749526.64		
Total	4431435376	31			

From table 2, it is observed that the p-value corresponding to province is greater than 0.05, that's why it is concluded that the provinces wise effects are same, and the variation is found to be insignificant. While the p-value corresponding to tuberculosis cases patients is less than 0.05, thus the variation is found to be significant and concluded that the effects of tuberculosis cases vary as the province's changes. So, the results are significant for tuberculosis cases. Moreover, to check the significant difference between the pairs of tuberculosis cases we make use of multiple comparison tests in the study. In this we used the least significant difference (LSD) test.

Table 2(b). Results of LSD test using Provinces and Tuberculosis Cases

(I) TB	(J) TB	Mean Difference (I-J)	Std. Error	Sig.
Clinically	Bacteriologically	11848.00*	4661.569	0.019
	Extra-Pulmonary	9461.25	4661.569	0.055
	Re-Treatment	14614.50*	4661.569	0.005

In table 3, we see the values of LSD test to detect which pair of treatment differ from each other. In this we find that the significant mean difference is between clinically diagnosed with bacteriologically and re-treatment among all provinces.

Correlation Matrix

Table 3. Correlation Matrix between all the Tuberculosis Cases.

Correlation	Bacteriologically Confirmed	Clinically Diagnosed	Extra-Pulmonary	Re-Treatment
Bacteriologically Confirmed	1			
Clinically Diagnosed	0.994673	1		
Extra-Pulmonary	0.967453	0.960489	1	
Re-Treatment	0.659281	0.586922	0.579181	1

In table 4, we see that all the cases are strongly positively correlated. Bacteriologically confirmed has a perfect positive correlation with clinically diagnosed (0.99), extra-pulmonary (0.97) and a strong correlation with re-treatment (0.66) respectively. Clinically diagnosed has a perfect positive correlation with extra-pulmonary (0.96) and a moderate correlation with re-treatment (0.58) respectively. Similarly, extra-pulmonary and re-treatment have moderate correlation (0.57) to each other. Furthermore, we use factor analysis to extract the number of factors associated with all the tuberculosis cases and find its communalities (the factor variance).

Factor Analysis

Factor analysis is a dimension reduction multivariate technique that enables a researcher to examine concepts that cannot be measured easily or directly.

Table 4. Communalities of Factor Analysis.

Communalities	Raw		Rescaled	
	Initial	Extraction	Initial	Extraction
Bacteriologically Confirmed	224167785.1	223456071.5	1	0.997
Clinically Diagnosed	306822796.8	305992610.8	1	0.997
Extra-Pulmonary	38899217.27	36535066.75	1	0.939
Re-Treatment	994090	379293.837	1	0.382

Table 5 shows that the variance or communality value, which is greater than 0.5 to be considered for analysis and else these variables are to be removed from further steps of factor analysis. 99% of the factor variance is explained by the first two factors (bacteriological and clinical) and 94% accounted for extra pulmonary, while 38% accounted for re treatment. Therefore, the first three factors are important in this case.

Table 5. Total Variance Explained of Factor Analysis.

Total Variance Explained							
	Component	Initial Eigen values			Extraction Sums of Squared Loadings		
		Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
Raw	1	566363042.8	99.208	99.208	5.66E+08	99.208	99.208
	2	2756086.61	0.483	99.691			
	3	1737150.075	0.304	99.995			
	4	27609.743	0.005	100			
Rescaled	1	566363042.8	99.208	99.208	3.315	82.872	82.872
	2	2756086.61	0.483	99.691			
	3	1737150.075	0.304	99.995			
	4	27609.743	0.005	100			

Table 6, gives the results for eigen values or amount of variance in the original variables, accounted for by each component. The first component has the highest eigen value and fourth component has the smaller Eigen value. The percentage of variance column gives the ratio of the variance accounted by each component to the total variance in all of the variables. The first component has 99% variance, and fourth component has the smaller variance. In this study, the total variation in original variables (tuberculosis cases) is 92% and the total variation of the factor extracted is 82%. There is only one factor extracted in this study which explains 82% of the original variation.

Table 6. Component Matrix of Factor Analysis/

Component Matrix		
	Raw Component 1	Rescaled Component 1
Bacteriologically Confirmed	14948.447	0.998
Clinically Diagnosed	17492.644	0.999
Extra-Pulmonary	6044.424	0.969
Re-Treatment	615.868	0.618

Table 7 shows the elements of the factor loading of the factor analysis. Factor loadings are the correlations between factor and the observed variable. In this case, all the observed variables are highly correlated with the factor extracted because its loadings greater than 0.5. So, the factor models associated with first factor can be written as:

$X_1 = 0.998 f_1 + e_1$

$X_2 = 0.999 f_1 + e_2$

$X_3 = 0.969 f_1 + e_3$

$X_4 = 0.618 f_1 + e_4$

CONCLUSIONS

Tuberculosis (TB) is a serious infection or disease that directly affects the lungs and it spread through cough and sneeze etc. In this study we focus on four cases of tuberculosis. The objective is to highlight the dominant province in Pakistan, which reported more cases and test the significant difference of province and tuberculosis cases on total number of cases reported. Moreover, finds the correlation between tuberculosis cases and extracted the factor. For this purpose, secondary data is used for one year of 2019 through website Pakistan Bureau of Statistics. The data consists of 189,666 total patients. The result shows that Punjab is the dominant province and reports the highest cases while Islamabad reports lowest tuberculosis cases. The reason is that Punjab has a large population and also high pollution in Punjab due to more industries in it. More variation can be seen in the clinically diagnosed and less variation is in re-treatment data series. The results of two-way ANOVA show that the significant mean difference among tuberculosis cases and insignificant among provinces. LSD test shows the significant mean difference is between clinically diagnosed with bacteriologically and re-treatment among all provinces. From correlation matrix, it can be seen that all the cases are strongly correlated. Factor analysis extracted one factor in this study that explains 82% of the original variation. In this case, all the observed variables are highly correlated with the factor extracted because its loadings greater than 0.5.

RECOMMENDATIONS

The study suggested that the findings will help to deal with the early diagnosis and controlling the spread of TB by using effective planning in the provinces of Pakistan for health facilities for disease diffusion.

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