Original Article

Predictors for Concurrent Diabetes in Tuberculosis Patients. Perspectives from Two Mining Districts of Eastern Tribal State Jharkhand, in India

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Abstract

Background: Tuberculosis and diabetes both diseases are present in large numbers in the country and we are major contributors to both globally. With the objective to understand the various traits of patients having both tuberculosis and diabetes and to ascertain various possible predictors for such occurrence based on the public health database we carried out this study. We seek answers to questions like they have any effects? Are they having any additive role to play? **Methods:** One-year data from the NIKSHAY portal of both districts were analyzed to look for possible associations and other variable traits. Data were analyzed using standard methods to express data in frequency and percentage. Chi-square test was used to establish association, while step-wise approach was used to calculate univariate and multivariate logistic regression analysis for knowing various predictors. *P*-value of <0.05 was considered statistically significant. **Results:** Concurrent diabetes in tuberculosis patients was close to 294 (6%) in the 4933 individuals. In total, 65.2% of the study population were male. Diagnosis of tuberculosis was made most of the time by chest X-ray (49.4%) followed by Microscopy ZN staining and cartridge-based nucleic acid amplification test (CBNAAT). Death was more among diabetics (4.4%) as compared to nondiabetics (3.5%). **Conclusion:** Diabetes is increasing in tuberculosis patients; improvement in data quality is needed. More research is required to reveal various other reasons that make tuberculosis patients more prone to develop diabetes.

Keywords: Diabetes in tuberculosis, mining districts, Nikshay 2.0, tribal state, tuberculosis

Introduction

India is one of the leading contributors of active tuberculosis patients across the globe. Most recent estimates put that figure around 27% of the total global load.[1] Along with various interventions taken by the Government of India, creating a database for documenting all TB-positive cases being screened and then uptake by the health system in India has been the mainstay in this ongoing fight to end the disease by 2025. Nikshay (2.0) web-based portal is the database in which all TB-positive patients are registered and have all other relevant details about them including end-to-end services provided to them.[2,3] Tuberculosis has been known to manifest in individuals when their immunity is lowered due to various reasons.[4] Incidentally, India is also known to have the largest population of diabetes across the globe and once it was termed to be the "diabetic capital of the world".[5] It is imperative to observe and deduce that if both diseases are present in such large numbers in the country then are they having any effects? are they having any additive role to play?

As early as 2008 the term Diabetes Tuberculosis Synergy was coined based on metanalysis where they observed a threefold increase in odds of having tuberculosis if someone is having diabetes mellitus type 2 and suggested possible linkages between the two diseases.[6] Possible explanations for this include the established fact of decreased immunity owing

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to chronic, systemic, and nonantigen specific, low-grade inflammation.[7] There is also the fact of heightened redox stress fueling above-mentioned inflammation, thus, by reducing immunity.[8] Among the various possibilities to explain the diabetes tuberculosis, synergy pancreatic beta cell loss also has been demonstrated due to tuberculosis infection, thus, by worsening the prediabetics and increasing glucose intolerance for chronic diabetics.[9]

The eastern state of Jharkhand in India is a mineral-rich state with a predominantly tribal population.[10] TB has been knowing to be relatively higher in the population working near or inside the mining areas.[11]

Studies on the concurrent presence of diabetes and tuberculosis in mining areas are limited in an Indian setting. The goal of this study was to describe from an epidemiological point of view the patients who had both diabetes and tuberculosis and were listed on the Nikshay (2.0) portal. The other goal of the study was to find out what factors could make it more likely that TB patients would also be diabetic.

We believe our study will help in policy decision-making regarding early diagnosis and treatment for individuals who might be at risk of getting diabetes after having tuberculosis.

Methods

The study was done after the Institutional Ethical Committee of the institution approved the study, which required access to the Nikshay data. Data from the Nikshay (2.0) portal was retrieved for the selected two districts. The two districts (Dhanbad and Pakur) were chosen using convenience sampling. Coal mines in the district of Dhanbad and stone mines in the district of Pakur are both similar in this way. Data sets were deidentified by removing all individual identifiers like name, phone numbers and any specific personal identifiers, before being used for analysis. The time period for data from both districts was from January 21 to December 21. All entries were collected as such for the said time period. Data collection was done following complete enumeration. Tuberculosis was defined as per Nikshay's data entry, which was either new or retreatment. While outcomes of the treatment were categorized as per the national tuberculosis elimination program as "cured," "treatment completed," "treatment failed," "dead," "lost to follow-up," and "not evaluated."[12] Various terms were used to describe referring facilities as public health institution, private chemist, etc. Treatment was based on diagnostic modalities in the program as per the modalities being used like cartridge-based nucleic amplification test, line probe assay (LPA), chest X-ray, culture, and histopathology, drug sensitivity testing (DST), microscopy with ZN staining, and Trunat testing methods.[12] A total of 4933 entries were obtained from the two districts for analysis. We included all entries in the Nikshay (2.0) for study period in study districts.

The Nikshay portal is used by trained government staff, and it also stores information about patients who are being treated by private doctors. We downloaded the data as Excel sheets with all the patient-relevant details like age, gender, residence, referred by, diabetic status, etc. As the status of diabetes entered in the data set was the main focus we noted, 1431 (29.01%) of data entered were not having status of diabetes and, thus, were excluded. We included 3502 (81%) of all the entries [Figure 1].

Data analysis

The Nikshay portal has the option to extract/download all data in Excel format. We downloaded the data of the two districts and used the deidentification of personal identifiers as mentioned above. Data were cleaned for obvious entry errors. Apart from that, we analyzed the data as we got it from the database. We analyzed the data using JASP, a free software based on R. Univariate analysis was done for categorical variables, and results were expressed as numbers and percentages. A Chi-square test was employed to test the association between two variables. A predictor analysis was done using binary logistic regression to ascertain the various predictors of having diabetes in TB-positive patients living in these areas. A *P*-value of <0.05 was considered statistically significant.

Results

We noted that diabetes prevalence was close to 294 (8.39%) in the 3502 individuals analyzed for one year from two mining districts. In the data set we noted, the status of diabetes was entered as Diabetic, Nondiabetic, or Unknown. We included all categories for diabetes in our analysis.

We found 2258 (64.47%) male participants in 3502 tuberculosis patients, while in patients who were concurrent diabetics, we noted the male population to be 217 (73.8%) out of 294 patients. Among all patients, maximum were in the age group of 18–50 years followed by 50–65 years age. In diabetes, 50.0% were in the age group of 18–50 years, while the maximum percentage of patients (76.90%) were in the weight category of 20–50 kg, and it was similar in the concurrent presence of diabetes (59.50%) followed by weight cat of 50.0–65.0 kg (35.4%). Facilities

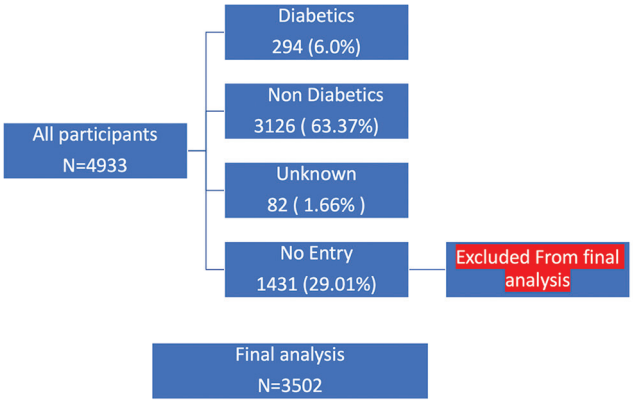

Figure 1: A tree diagram showing the final number of entries analyzed after exclusion of blanks

which were enrolling the patients were maximum from public health institutions (64.04%), while facilities where the diagnosis of diabetes and tuberculosis was made were from public health facilities. However, in the case of concurrent diabetic patients, diagnosis was made almost equally in private facilities. Diagnosis of tuberculosis was made most of the time by chest X-ray (60.88%) followed by Microscopy ZN staining and CBNAAT. Among patients having concurrent diabetes, the situation was similar. Overall, 57% of patients were confirmed microbiologically about the presence of tuberculosis [Table 1]. Maximum cases (>90%) in both the types of patients who were either having diabetes or not having diabetes were of new type and classified as New type of case. Most of the cases (>85%) were of pulmonary type for both cases. In total, 26.32% outcomes of treatment were left blank, while 48.25% of the total study population were reported to have completed the treatment. Death (4.42%) was more in diabetics when compared with nondiabetic (3.5%); 0.25% were wrongly diagnosed as having tuberculosis [Table 2].

On performing a binary logistic regression keeping dependent outcomes as having diabetes, we analyzed various factors. Odds of having concurrent diabetes with tuberculosis is more in the age group of 18–50 followed by 50–65 and kept on increasing as age increased. This odds ratio (OR) is of high statistical significance. While odds of having the same concurrence was more in weight categories of 50–65 and 65–80. They were statistically significant as *P*-value <0.00. Male sex was having higher odds of having the concurrent diabetes relative to female OR 1.61 (1.23–1.53) which was of high statistical significance. Site of disease and type of facility which enrolled the clients were significant predictors for diabetes in TB patients [Table 3].

We adjusted the significant predictors for other variables to calculate the adjusted OR. Age categories were found to be significant predictors with a decreasing trend when compared with 5–20 years as a reference. Only weight band 50–65 aOR 3.45 (2.94–5.90) was having a higher odds of developing concurrent diabetes compared to other weight categories. Males were having a higher odds aOR 1.20 (0.90–1.60) of having concurrent diabetes when odds were adjusted for age which was not statistically significant. When adjusted to add site of disease and facility type were having a higher odds aOR 1.72 (1.03–2.89) and aOR 1.24 (1.09–1.42), this was of high statistical significance [Table 3]. Compared to the male population females were only 34.8% of the total study participants, but for younger age groups, i.e., age category (0–18 years) and (18.1–50 years) females were 18.5% vs 9.2% and 67.6% vs 66.2%, respectively, compared to males [Supplementary File Tables 1 and 2].

Discussion

We analyzed the data of 3502 known tuberculosis patients who are being given treatment, and these data were collected by a government institution. The data were from two mining districts in a tribal state of eastern India. To our knowledge, this is one of its own kind of study from these parts. We looked for the presence of concurrent diabetes in these patients and found it to be around 9%. We noted that more diabetic patients are referred by private institutions while majority of patients being diagnosed for tuberculosis are coming from public health institutions. Age of the patient, weight category, sex, site of disease, and enrolling institution are major predictors for concurrent presence of diabetes in tuberculosis patients.

Prevalence of diabetes in tuberculosis patients

Earlier studies based on large sets have put concurrent diabetes in tuberculosis patients in India to be round 20% with state-wise variation from 12.3% to 44%.[13,14] However, study in south India on tribal population have found the prevalence of diabetes in tuberculosis patients to be 5%.[15] In our study, we found about 30% of the patients have the status of diabetes missing. These missed diabetic status could have been diabetic or not diabetic. These missing data could have been one reason for such low prevalence of diabetes.

Age group of the diabetic patients

It has been observed in large sample size data from India like National Family health survey or Annual house hold survey, etc., that diabetes mellitus is more common in age group >30–50 years.[16] Pande *et al*.[17] in their study done in an hospital setting found higher odds of having diabetes in tuberculosis patients with age >40 years. Our findings are consistent with these findings.

Weight category

We found weight category as an important predictor for concurrent diabetes in tuberculosis patients, but the odds were not high if compared to the lowest weight category. Other studies have shown higher odds of having diabetes with more bulkier weight.[18] Possible explanation regarding different relationship of the weight category and being diabetic may be due to tribal/or miner population.

Sex of the diabetic patients

In our study, we found that the unadjusted odds of diabetes were higher in males. However, after adjusting for age, the adjusted odds were not of statistical significance. This might be explained due to the comparatively large percentage of females in the younger age group. This finding has been replicated in other studies and is consistent with global trends.[19,20]

Poor quality of data in Nikshay portal

Issues regarding poor quality of data being entered and Nikshay being hard to understand, etc., are there, such issues have been highlighted by other studies as well.[21-23] Our data gaps are, thus, self-explanatory and need more serious handling.

Other predictors and variables

We noted a strong association between diabetics and site of disease; in our case, in pulmonary tuberculosis, such associations can be found in other study as well.[23,24] As we noted in our study that most of cases are categorized as pulmonary or extrapulmonary. Studies done on Nikshay portal data set have given the similar percentage distribution regarding the diagnosis and outcomes.[24]

Table 1: Characteristics of entries as per their diagnosis

	Diabetes Classified as				
	Diabetic	**Nondiabetic**	**Unknown**	**Total**	***P***
Sex					
Female	77	1134	33	1244	<0.00
	26.19%	36.27%	40.24%	35.52%	
Male	217	1992	49	2258	
	73.81%	63.72%	59.75%	64.47%	
Age Cat			Mean=37.30, SD=15.76		
0–18	6	401	10	417	<0.00
	2.0%	12.80%	12.20%	11.90%	
18–50	147	2112	64	2323	
	50.00%	67.6%	78.0%	66.30%	
50–65	118	503	6	627	
	40.10%	16.1%	7.3%	17.9%	
65–80	21	104	2	127	
	7.1%	3.3%	2.4%	3.6%	
>80	2	6	0	8	
	0.7%	0.2%	0.0	0.2%	
Weight Cat*			Mean 43.77, SD=11.65		
20–50	175	2455	64	2694	<0.00
	59.50%	78.50%	78.00%	76.90%	
50.1–65.0	104	557	16	677	
	35.40%	17.8%	19.50%	19.30%	
65.1–80.0	14	104	1	119	
	4.82%	3.30%	1.28%	3.41%	
80.1–100	1	7	0	8	
	0.34%	0.20%	0.00%	0.20%	
100.1–150	0	3	1	4	
	0.00%	0.10%	1.20%	0.10%	
Enrollment Facility Type					
Public Health Institution	146	2064	33	2243	<0.00
	49.66%	66.02%	40.24%	64.04%	
Private Chemist	0	2	0	2	
	0.00%	0.06%	0.00%	0.05%	
Private Health Facility	148	1060	49	1257	
	50.34%	33.90%	59.75%	35.89%	
Diagnosed On Basis					
CBNAAT	31	192	10	233	<0.00
	10.54%	6.14%	12.19%	6.65%	
Chest X-Ray	179	1731	42	1952	
	60.88%	55.37%	51.22%	55.74%	
Culture	1	2	1	4	
	0.34%	0.06%	1.22%	0.11%	
Cytopathology	1	1	0	2	
	0.34%	0.03%	0.00%	0.05%	
DST	0	3	0	3	
	0.00%	0.09%	0.00%	0.08%	
Microscopy ZN and Fluorescent	48	697	9	754	
	16.32%	22.29%	10.97%	21.53%	
Other	13	266	12	291	
	4.42%	8.50%	14.63%	8.31%	
S Line LPA	0	1	0	1	
	0.00%	0.03%	0.00%	0.02%	
Trunat (MTB-RIF)	4	46	1	51	
	1.36%	1.47%	1.22%	1.45%	
Trunat (MTB)	17	187	7	211	
	5.78%	5.98%	8.53%	6.02%	
Total	294	3126	82	3502	
	100.00%	100.00%	100.00%	100.00%	

SD=Standard Deviation. Table presented as *n* (Numbers)/% (percentage%)

Table 2: Treatment outcome, type of case, and other intervention variables for all patients in the database

	Diabetes Classified as			Total	*P*
	Diabetic	Nondiabetic	Unknown		
Type of case					
New	281	2898	70	3249	<0.05
	95.57%	92.70%	85.36%	92.77%	
PMDT	2	27	1	30	
	0.68%	0.86%	1.22%	0.85%	
Retreatment: Others	9	174	9	192	
	3.06%	5.56%	10.97%	5.48%	
Retreatment: Recurrent	1	24	1	26	
	0.34%	0.76%	1.22%	0.74%	
Retreatment: Treatment after failure	1	2	1	4	
	0.34%	0.06%	1.22%	0.11%	
Retreatment: Treatment after lost to follow-up	0	1	0	1	
	0.00%	0.03%	0.00%	0.02%	
Site of Disease					
Not Specified	3	13	2	18	<0.00
	1.02%	0.41%	2.43%	0.51%	
Extra Pulmonary	17	354	14	385	
	5.78%	11.32%	17.07%	10.99%	
Pulmonary	274	2759	66	3099	
	93.19%	88.26%	80.48%	88.49%	
Treatment Outcome					
No Entry	78	819	25	922	>0.05
	26.53%	26.20%	30.48%	26.32%	
CURED	41	446	10	497	
	13.94%	14.26%	12.19%	14.19%	
DIED	13	104	4	121	
	4.42%	3.32%	4.87%	3.45%	
Lost to follow-up	19	142	4	165	
	6.46%	4.54%	4.87%	4.71%	
Not evaluated	3	67	3	73	
	1.020%	2.143%	3.659%	2.085%	
Patient refused	1	0	0	1	
	0.34%	0.00%	0.00%	0.02%	
Treatment complete	137	1518	35	1690	
	46.59%	48.56%	42.68%	48.25%	
Treatment failure	0	4	0	4	
	0.000%	0.12%	0.00%	0.11%	
Treatment regimen changed	2	17	0	19	
	0.68%	0.54%	0.00%	0.54%	
Untraceable incorrect address	0	1	0	1	
	0.000%	0.03%	0.00%	0.02%	
Wrongly diagnosed	0	8	1	9	
	0.00%	0.25%	1.22%	0.25%	
Total	294	3126	82	3502	
	100.000%	100.000%	100.000%	100.000%	

Table presented as *n* (Numbers)/% (*x*%)

Limitations of the study

As our study was done on data from database it was having some limitations. We could not illicit the patients' occupation in the abstract form of their relationship to mining industry as against nonmining industry. We did not perform any Oral glucose tolerance test (OGTT) or HbA1C tests for getting the extent of diabetes, its type, and for how long was it present. We did not follow any individual. We were dependent on the data which were entered, which could potentially alter the real situation owing to the poor quality of data. We were not asking anything from the patients. These were some of the major limitations in this study. A possible bias is also there as our data are from persons seeking health care so we are seeing data of such individuals who are having a positive health

Table 3: Binary Logistic regression analysis for predictors of having diabetes for patients having TB

	P	OR (95% CI)	*P*	aOR (95% CI)
Age Cat				
0–18		1		1
18–50*	<0.00	4.62 (2.02–10.53)	<0.00*	4.10 (1.79–90.51)
50–65*	<0.00	15.88 (6.92–36.43)	<0.00*	11.50 (4.96–26.67)
65–80*	<0.00	13.57 (5.34–34.46)	<0.00*	9.83 (3.81–25.26)
>80*	<0.00	22.83 (3.80–137.00)	<0.00*	26.17 (4.33–158.18)
Constant	<0.00	0.02		
Weight Cat				
20–50		1		1
50.1–65.0*	<0.00*	2.61 (2.06–3.38)	<0.00*	3.45 (2.94–5.90)
65.1–80.0*	<0.05	1.91 (1.07–3.42)	>0.05	2.93 (0.74–8.76)
80.1–100	>0.05	2.05 (0.25–16.80)	>0.05	1.54 (0.94–11.0)
100.1–150	-	-	-	-
Constant	0	21.218		
Sex				
Female (Ref)		1		1
Male*	<0.00	1.61 (1.23–2.11)	>0.05	1.20 (0.90–1.60)
Constant	0	13.816		
Site of Disease*	<0.05	1.60 (1.05–2.46)	<0.05*	1.72 (1.03–2.89)
Constant	0	73.918		
Enrollment Facility PHI Type*	<0.00	1.36 (1.20–1.53)	<0.00*	1.24 (1.09–1.42)

Variables having *signify *P*<0.05 for their ORs and aOR

seeking behavior; we will be missing all such cases who did not seek health care.

Strengths of the study

The sample size of 3502 tuberculosis patients from two nearby mining districts in a tribal state is a fair representation of population residing in these areas with inclusiveness of various important factors as possible predictors. We were able to identify major predictors for the concurrent presence of diabetes in tuberculosis based on the available data.

Conclusion

Our study gave important insights regarding concurrent presence of diabetes in tuberculosis patients from these parts. These findings in itself should alert the policy makers to lay more emphasis on stricter adherence for screening of diabetes and its proper documentation in all portals offline or online. Data entry operators need more monitoring/hand holding support for effective data entry. More research of various methodologies involving patients from these parts will reveal various other reasons that make tuberculosis patients roe prone to develop diabetes.

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Conflicts of interest

There are no conflicts of interest.

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Supplementary Files

Table 1: Age Category wise distribution of participants as per Sex

Age category	Years	Female	Male	Total
	0-18	318 (18.5)	295 (9.2)	163 (12.4)
	18.1-50	1161 (67.6)	2127 (66.2)	1204 (24.4)
	50.1-65	195 (11.4)	653 (20.3)	848 (17.2)
	65.1-80	41 (2.4)	133 (4.1)	174 (3.5)
	80.1-100	3 (0.2)	7 (0.2)	10 (0.2)
Total		1718 (34.8)	3215 (65.2)	4933

P<0.00

Table 2: Distribution of Diabetics (As per data entry) of all participants as Male/Female

Gender	Diabetic Status (As per data records)				Total
	Diabetic	Non Diabetic	Unknown	No Entry	
Female	77 (26.2)	1134 (36.3)	33 (40.2)	474 (33.1)	1718 (34.8)
Male	217 (73.8)	1992 (63.7)	49 (59.8)	957 (66.9)	3215 (65.2)
Total	294	3126	82	1431	4933

P<0.00