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Meta-analysis of diabetes mellitus prevalence among tuberculosis patients in Asia and Africa

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Abstract

Objective: To determine the prevalence rate of diabetes mellitus among active tuberculosis patients, and to assess the impact of age in this regard.

Method: The meta-analysis study was conducted at Sialkot, Pakistan from 2018 to 2019, and comprised studies conducted in Asian and African countries from 2012 to 2018. Data was extracted from the selected studies and was analyzed using the Meta extension of Excel.

Results: Of the 200 studies reviewed, 15(7.5%) were selected for further analyses. The selected studies involved a total of 28,055 patients. Of the selected studies, 8(53%) were from Asia and 7(47%) were from Africa. The overall pooled prevalence of diabetes among tuberculosis patients was 26% (95% confidence interval: 14.62 to 35.34). Age had a significant negative effect on the prevalence rate (95% confidence interval: -0.634 to 4.179).

Conclusion: Diabetes was found to be widely spreading among Asian and African people, and age was found to be a significant negative factor.

Key Words: Meta-analysis, Tuberculosis, Diabetes mellitus, Forest plot, Moderator analysis.

Introduction

A statistical analysis to combine data of multiple scientific studies is called meta-analysis[1]. Data in such a scenario is extracted from published or unpublished multiple studies in order to explore general trends or to evaluate overall effect[2-3]. It provides a consistent method for inspecting the existing study's literature on any specific field and the results from such analysis can provide proof for or against expert opinion or popular belief. While conducting meta-analysis, the methods and interpretations need to be revisited to re-evaluate the results of previous research to derive conclusions on the topic concerned. Systematic review methodology is at the heart of meta-analysis.[4-7]

According to a report of World Health Organisation (WHO), 10.4 million new tuberculosis (TB) cases and 1.7 million deaths were registered in 2017.[8] Moreover, 415 million cases and 5 million deaths due to diabetes mellitus (DM) were also registered.[9] Unfortunately, 95% people living in middle-rated countries, like those in Africa and southeast Asia, were affected by TB and DM cases were 75%.[10]

TB disease is caused by a bacteria called mycobacterium tuberculosis which affects all parts of the body and spreads by air when a person with TB coughs, sneezes or talks. People are infected by TB complex by one of three routes: inhalation, ingestion and inoculation[11]. TB bacteria mostly increases in the lungs, and identification of TB can be done by bad cough that lasts 3 weeks or longer, pain in the chest and coughing up blood or saliva with mucus deep inside the lungs.[12]

TB bacteria affects all ages and is active in people who are smokers, or working close to chemicals, or in areas with more dust and perfume particles[13]. The most common investigative test for TB, **purified protein derivative** (PPD) tuberculin, is the originator of TB bacteria. Tactlessly, the skin test is not 100% good and has been known to give false positive (FP) and false negative (FN) readings.[14]

DM is a recorded disorder due to high or low blood sugar levels for a long period. If the identification of diabetes is not done in time, it can create more complexity for human body because it can badly attack other parts of the body. Insulin and some oral medication can lower blood sugar level[15-16].

A systematic review about the prevalence of TB among diabetic patients included 15 studies for meta-analysis in order to find the pooled overall prevalence rate of TB in DM cases[17].

A systematic review conducted on the management of TB healthcare practitioners in Pakistan observed that patients' compliance was low <50% for the use of sputum microscopy in the diagnosis of TB in Pakistan, and 50% practitioners correctly identified cough as the main TB symptom[18].

It was screened for DM during TB diagnosis and highlighted the association between genetic diversity and DM in Ghana and other countries[19-20]. Consistent results showed the increased risk of TB among DM patients and association between TB and DM.[21]

DM among TB patients in sub-Saharan Africa was significantly high. The pooled prevalence of DM among TB patients was 9% (95% confidence interval [CI]: 6-12%), while the highest prevalence of DM in TB patients was 15% in Nigeria[22]. The study found that there was a high prevalence of DM among human immunodeficiency virus (HIV)-infected compared to those not infected. Besides, the prevalence of DM among HIV-infected TB patients was 8.9% which is slightly higher than HIV-uninfected 7.7% TB patients. It was strongly recommended by the authors to screen TB patients for DM, and special emphasis should be given for early screening of DM among TB/HIV co-infected patients.[23]

The current meta-analysis was planned to determine the prevalence rate of DM among active TB patients, and to assess the impact of age in this regard.

Materials and Methods

The meta-analysis study was conducted at Sialkot, Pakistan from 2018 to 2019 and comprised studies conducted in Asian and African countries from 2012 to 2018. The study was conducted in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines[24].

Inclusion criteria was to include studies that had ethnical approval, related to TB and DM and were carried out among diverse age groups under different conditions in African and Asian countries. The included studies could be be either cross-sectional or case studies and involved primary outcomes of interest. Studies excluded were those that only reported incidence, anti-drug resistance mainly focussing on TB without reporting prevalence rate of DM among TB patients.

Data extracted included country, area and the year of publication. The number of DM and TB cases were also recorded to estimate an overall CI for the prevalence rate.

The data was analysed using a systematic review of the selected studies. Meta-analysis was conducted for the collected data to assess pooled prevalence of DM in TB patients using random effect model through Meta-Excel software. Subgroup analysis was carried out using Asia and Africa as the regions[25-39]. The role of age was analysed using meta-regression.

Results

After screening 1110 research papers, 200(%) were fully reviewed. After applying the inclusion/exclusion criteria, 15(7.5%) of them were included which comprised 28,055 participants (Figure 1).

Of the 15 selected studies, 8(53%) were from Asia, and 7(47%) were from Africa (Table 1). The overall pooled prevalence of DM among TB patients was 26% (95% CI: 14.62-35.34 overall; 27.472-32.528 Asia; 12.992-16.008 Africa).

Forest plot suggested that within 95% CI the combined effect size for all the included studies were significant except one (Figure 2).

Subgroup analysis showed the significance of studies done in Asia (Figure 3) and Africa (Figure 4) separately

Subgroup analysis also extracted different parameters, like CI, standard weights and Q statistics (Table 2).

Data for moderate analysis included standard error (SE) and weights for prevalence rate, and used age as the moderator variable which was extracted from al the included studies (Table 3).

Coefficient of meta-regression indicated that A 1.7 unit change in moderator variable resulted in 1.7 unit change in the prevalence rate ($p<0.05$) (Table 4).

The CI for intercept ranged from -156.672 to 52.601, while for moderator it was between -0.634 and 4.179 (Table 5).

There existed a significant negative relationship between the prevalence rate and age (Figure 5)

Discussion

Evidence based on the 15 included studies with 28,055 participants revealed 14% prevalence of DM among TB patients in countries where the studies were conducted. This rate also justifies other studies.[40] Forest plot indicated that there was no non-significant studies in data except one[39], and that was significant in subgroup analyses

There was almost no heterogeneity in the included studies. To examine heterogeneity and significance of the results within groups, subgroup analysis was also conducted because it is more reliable to draw conclusions on the basis of subgroups. Meta-regression analysis revealed that age was playing a significant role in the analysis. Likewise, prevalence of DM among TB patients could also be affected by the age factor which is in line with past studies.[41]

Conclusion

DM was found to be widely spreading among Asian and African people, and age was found to be a significant negative factor. The findings are expected to be helpful in examining the rate of DM among TB patients.

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Table 1: Extracted data set for meta-analysis

Study Name	Country Region	DM	TB	Prevalence (%)	Moderate
Ashok Bhardwaj India [22]	Asia	54	346	14%	42
Chagas ACF [23]	Asia	374	1262	30%	42
Pavlovic AD [24]	Africa	88	889	19%	50
Tripati Pande [25]	Asia	184	720	25.30%	45
nagozi ekeke, kingsley N. Ukwaja [26]	Africa	311	2094	14.50%	45
Shibu Balakrishnan [27]	Asia	243	552	44%	50
Mohsen Gadallah [28]	Africa	173	1608	10.76%	40
vijay Viswanathan [29]	Asia	209	827	25.30%	40
Anthonia Okeoghene Ogbera [30]	Africa	480	3263	12.30%	40
Mahteme hail Workneh [31]	Africa	109	1314	8.30%	45
Hardy Kornfeld MD [32]	Asia	113	209	54.10%	40
Daniel Grint [33]	Africa	283	2185	34%	40
Muhammad Atif [34]	Asia	690	969	71%	50
Claudia Caroline Dobler [35]	Africa	681	11317	6%	45
Zarfishan Tahir [36]	Asia	74	500	1.30%	35

DM: Diabetes Mellitus; TB: Tuberculosis.

Table 2: Subgroup Analysis

Studies Name	**P%**	**p**	**L Limit**	**U Limit**	**WS**	**To**	**T**	**Q**
Shibu Balakrishnan	44	0.44	39.86	48.141	2240.3	985.7	—	19.795
Muhammad Atif	71	0.71	68.13	73.8571	4706.2	3341		623.55
Hardy Kornfeld MD	54	0.541	47.34	60.856	841.66	455.3		32.004
vijay Viswanathan	25	0.253	22.34	28.2629	4375.9	1107		37.847
Chagas ACF	30	0.3	27.47	32.5283	6009.5	1803		12.717
Tripati Pande	25	0.253	22.12	28.4755	3809.7	963.9		32.950
Zarfishan Tahir	1.3	0.031	-1.2809	3.88085	2415.7	74.79		584.13
Ashok Bhardwaj India	14	0.14	10.34	17.6562	2444	342.2		103.71
A		2.768	246.7	306.865	26843	0.347	0.35	974.24
Anthonia Okeoghene	12	0.123	11.17	13.4269	30249	3721		21.726
Mohsen Gadallah	11	0.108	9.245	12.2746	16746	1802		29.822
Nagozi ekeke, kingsley N. Ukwaja	15	0.145	12.99	16.0081	16891	2449		0.3892
Mahteme Haile Workneh	8	0.083	6.808	9.7917	17264	1433		77.037
Pavlovic AD	19	0.19	10.8	27.1966	571.8	108.6		0.9241
Daniel Grint,	34	0.34	32.01	35.9863	9737.1	3311		352.25
a nationwide cohort	6	0.06	5.562	6.43755	200656	12039		1618.1
B		1.049	88.6	121.122	292115	0.085	0.15	2100.4
combined effect size		3.817	335.3	427.987	318958	0.432	0.5	3074.5

Table 3: Moderate Analysis

Study Name	Moderator	Prevalence (%)	S.E	Weights
Ashok Bhardwaj India	42	14	0.04722	448.505
Chagas ACF	42	30	0.0129	6009.52
Pavlovic AD	50	19	0.013157	5775.478
Tripati Pande	45	25.3	0.016201	3809.705
Nagozi ekeke, kingsley N. Ukwaja	45	14.5	0.007694	16890.5
Shibu Balakrishnan	50	44	0.021128	2240.26
Mohsen Gadallah	40	10.76	0.007728	16746.12
Vijay Viswanathan	40	25.3	0.15117	4374.87
Anthonia Okeoghene Ogbera	40	12.3	0.00575	30249.09
Mahteme Haile Workneh	45	8.3	0.007611	17264.26
Hardy Kornfeld MD	40	54.1	0.034469	841.6593
Daniel Grint	40	34	0.010134	9737.077
Muhammad Atif	50	71	0.01458	4706.17
Claudia Caroline Dobler	45	6	0.002232	200656
Zarfishan Tahir	35	1.3	0.0131	5756.282

Table 4: Coefficients of Meta- Regression

Model		Un-standardised Coefficients		Standardised Coefficients	Sig.
		B	Std. Error	Beta	
1	(Constant)	-52.035	48.435		.302
	moderate	1.773	1.114	.404	.040

Table 5: Confidence Interval for the Parameters of Meta- Regression

Estimates	Lower 95%	Upper 95%
Intercept	-156.672	52.601
Moderator	-0.634	4.179

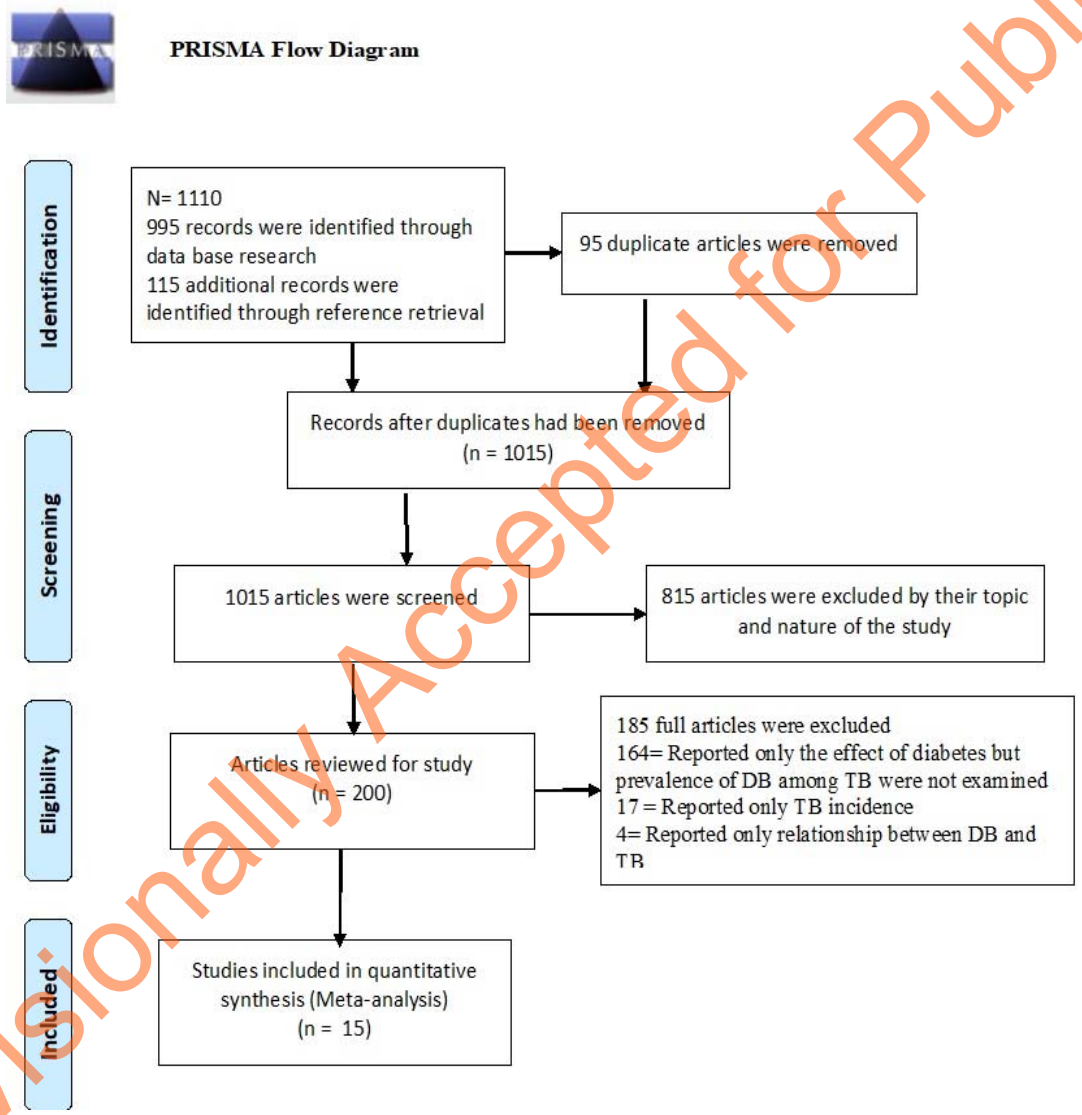

Figure 1: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Flow Chart.

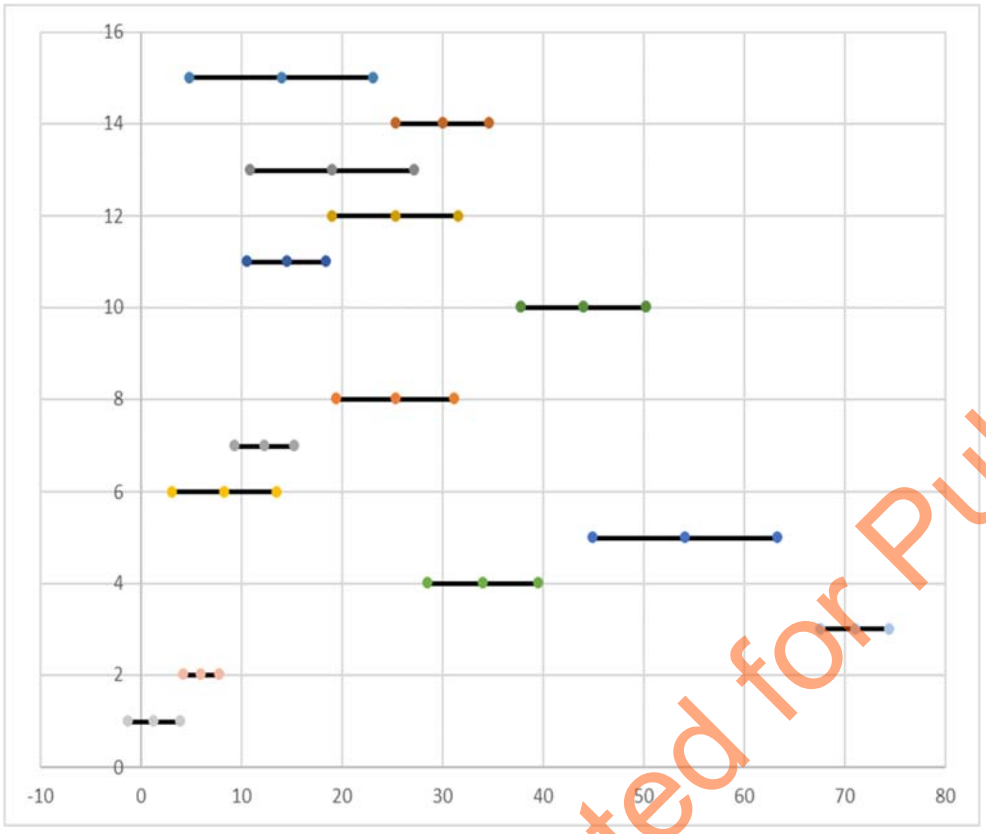

Figure 2: Forest Plot.

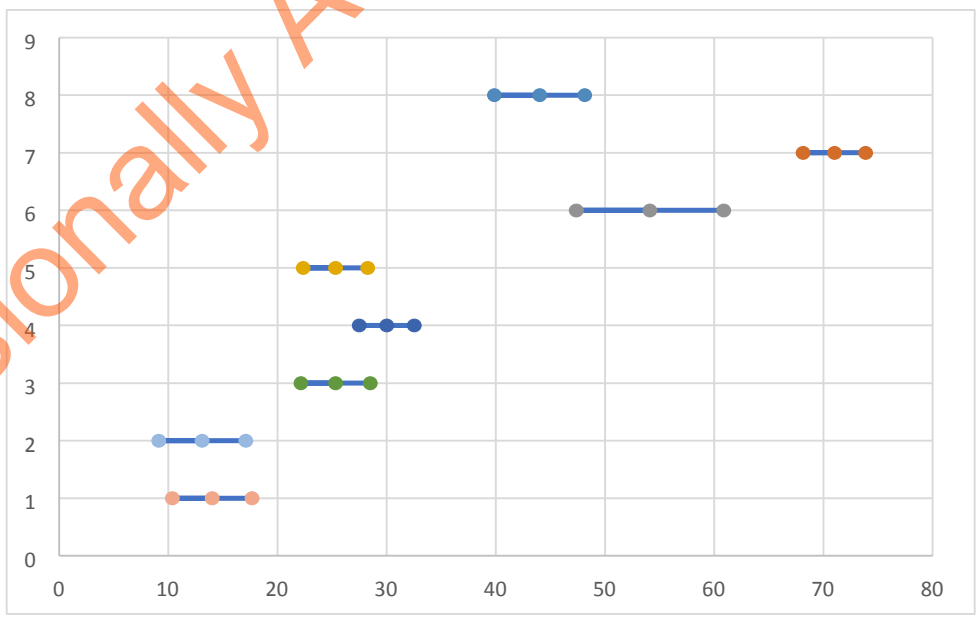

Figure 3: Forest plot for Asian Countries.

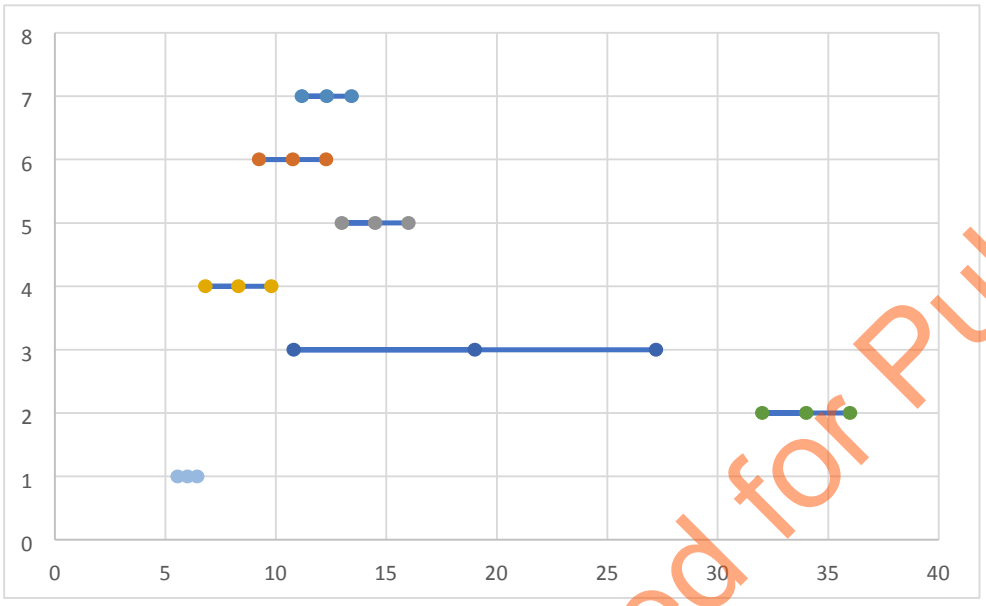

Figure 4: Forest Plot for African Countries.

Figure 5: Regression Plot.