

DIABETES SCREENING AND REFERRAL AMONG PATIENTS WITH TUBERCULOSIS: A CROSS-SECTIONAL STUDY IN PURI DISTRICT, ODISHA

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ABSTRACT

Background: Effective diabetes screening within tuberculosis (TB) services requires linkage to continuing care. This quantitative operational research study assessed facility readiness, diabetes screening, detection and early linkage to care across all 11 TB units in Puri district, Odisha. A cross-sectional assessment conducted from 1 December 2023 to 31 January 2024 included facility assessments and 220 consecutively enrolled adults aged >18 years with newly diagnosed TB, with telephone follow-up of reported care. Although a mixed-methods study was originally planned, no qualitative interviews were conducted. Indicators were summarised using explicit denominators and Wilson 95% confidence intervals (CIs). All units reported trained testing personnel and essential screening supplies at assessment. Screening was reported for 215/220 patients (97.7%; 95% CI 94.8–99.0). Ten patients had previously known diabetes and 22 had newly detected diabetes; the combined recorded proportion was 14.5% (32/220; 95% CI 10.5–19.8). Referral and diabetes treatment were reported for 19/22 newly detected cases (86.4%; 95% CI 66.7–95.3), while three had neither reported. All previously known cases received treatment for both conditions. High reported screening coverage coexisted with incomplete early linkage to diabetes care. Linked records and referral feedback could help identify and follow patients missing subsequent care steps. Programme-recorded diagnoses and short-term treatment reports require clinical verification; these findings do not establish reasons for missed care or effects on glycaemic control and TB outcomes.

INTRODUCTION

Diabetes mellitus complicates tuberculosis (TB) prevention and care. A meta-analysis of cohort studies found that diabetes was associated with approximately three times the risk of active TB.^[1] A separate systematic review identified increased risks of death, relapse and the combined outcome of treatment failure or death among patients with diabetes receiving TB treatment.^[2] Identifying diabetes during TB care is therefore relevant to clinical management, but screening has limited programmatic value unless patients also receive appropriate assessment and continuing care. The World Health Organization (WHO) and the International Union Against Tuberculosis and Lung Disease established a collaborative framework for

TB and diabetes in 2011.^[3] India's National Framework for Joint TB–Diabetes Collaborative Activities subsequently described arrangements for screening, referral and coordinated management.^[4] The 2025 WHO operational handbook places diabetes care within a broader approach to the early detection, assessment and management of TB comorbidities.^[5] These policies require coordination between TB services and noncommunicable disease (NCD) clinics.

Indian operational research has demonstrated the feasibility of incorporating diabetes assessment into routine TB services. In a multicentre study, diabetes status was assessed in 98% of 8,269 patients with TB, identifying both previously known and newly diagnosed disease.^[6] However, screening coverage alone does not show whether supplies remain

available, referrals are completed or diabetes treatment begins. District evaluations that examine these successive steps can identify practical gaps between service availability and reported receipt of care.

We assessed facility readiness, diabetes screening, recorded diabetes detection, referral and reported treatment across all TB units in Puri district, Odisha. This operational research examined the implementation of diabetes services within routine TB care and identified gaps warranting programme review. It did not evaluate TB screening among people attending diabetes clinics.

MATERIALS AND METHODS

This quantitative operational research study used a cross-sectional design across all 11 TB units in Puri district, Odisha, from 1 December 2023 to 31 January 2024. Services comprised the district TB centre and 10 peripheral units. The study was undertaken through the Indian Council of Medical Research (ICMR) Short Term Studentship (STS) programme, reference 2023-06736. Although mixed methodology was initially planned, no qualitative interviews were conducted; the present manuscript reports only the quantitative facility and patient assessments, including telephone follow-up of care indicators.

Adults aged >18 years with newly diagnosed TB were enrolled consecutively at participating centres. The analysed cohort included pulmonary and extrapulmonary TB. The protocol listed HIV positivity, pregnancy, immunosuppressive therapy and refusal of consent or diabetes testing as exclusions. The planned sample size was 246, calculated using $n = Z^2 p(1 - p)/d^2$, with an anticipated proportion of 20%, 95% confidence and absolute precision of 5%. The study enrolled 220 patients, representing 89.4% of the planned sample.

Facility visits assessed the availability of designated testing personnel, training, glucometers, test strips, lancets and swabs. A predesigned, pretested questionnaire collected demographic and clinical information, anthropometry, previously known diabetes, family history of diabetes and screening status. Screening was defined in the study assessment as random blood glucose testing within 24 hours of TB diagnosis. The questionnaire specified a random blood glucose value above 140 mg/dL as a referral trigger and recorded whether fasting and postprandial testing occurred within seven days of referral. It also recorded the subsequent diagnosis and whether diabetes medication began within seven days of confirmation. These were assessment windows in the study instrument; the aggregate results did not establish completion within these intervals.

Previously known and newly detected diabetes were analysed as separate programme-recorded categories.

Newly detected diabetes was based on the diagnosis recorded following referral for further glucose assessment. The available study documentation did not specify the confirmatory biochemical thresholds, repeat-testing procedure or management of a random blood glucose value exactly equal to 140 mg/dL. Consequently, recorded diagnoses were not independently adjudicated, and newly detected diabetes was not interpreted as incident disease. Telephone follow-up assessed reported referral and receipt of TB and diabetes treatment.

Screening coverage and the principal diabetes-detection proportion used all 220 enrolled patients as the denominator. The proportion of newly detected cases among the 215 reported screened patients was also described. Because the report did not link previously known diabetes to screening status, this latter measure was not interpreted as screening yield among people without a previous diagnosis. Referral and treatment among newly detected cases used 22 as the denominator; combined treatment coverage among all recorded diabetes cases used 32. Patients outside the two diabetes categories were described as having no recorded diabetes, rather than a confirmed negative test. Referral, clinic attendance, treatment initiation and continued treatment were considered distinct measures.

The original analysis used Microsoft Excel and R version 4.4.0. Continuous variables are presented as means and standard deviations (SDs), and categorical variables as counts and percentages. For this manuscript, percentages were checked against the reported counts and Wilson 95% confidence intervals (CIs) were calculated for key proportions. These intervals describe binomial uncertainty without adjustment for clustering by unit. Unit comparisons were descriptive; no hypothesis tests, multivariable analyses or imputations were undertaken. Reporting was informed by the STROBE recommendations [7]. The Institutional Ethics Committee of Shri Jagannath Medical College and Hospital, Puri, approved the study (37/IEC SJMCH; letter dated 16 October 2023). The report states that participants received study information and provided informed consent before inclusion. No identifiable participant information is presented.

RESULTS

The study included 220 patients from 11 TB units. Mean age was 40.15 years (SD 18.85), and 122 patients (55.5%) were male. Pulmonary TB accounted for 135 cases (61.4%) and extrapulmonary TB for 85 (38.6%). Mean age was 34.62 years among female participants and 44.58 years among male participants. Demographic and clinical characteristics are presented in Table 1.

Table 1: Demographic and clinical characteristics of patients with tuberculosis by sex.

Characteristic	Female n = 98	Male n = 122	Total N = 220
Age in years, mean (SD)	34.62 (17.33)	44.58 (18.91)	40.15 (18.85)
Pulmonary TB	54 (55.1)	81 (66.4)	135 (61.4)
Extrapulmonary TB	44 (44.9)	41 (33.6)	85 (38.6)
Weight in kg, mean (SD)	41.79 (15.20)	49.23 (15.14)	45.91 (15.58)
Height in cm, mean (SD)	147.42 (17.50)	152.60 (15.66)	150.29 (16.66)
BMI in kg/m ² , mean (SD)	19.17 (7.49)	21.11 (6.80)	20.25 (7.16)
Previously known diabetes	3 (3.1)	7 (5.7)	10 (4.5)
Age over 30 years	56 (57.1)	96 (78.7)	152 (69.1)
Family history of diabetes	8 (8.2)	13 (10.7)	21 (9.5)

Values are n (%) or mean (SD); percentages use column totals. BMI, body mass index; SD, standard deviation; TB, tuberculosis.

All 11 units reported designated trained testing personnel and the availability of essential glucose-

testing equipment and consumables at the assessment visit (Table 2). These observations describe readiness at that visit; continuity of availability over time was not measured.

Table 2: Facility readiness for diabetes screening across tuberculosis units

Readiness indicator	Units, n/N	Percentage
Designated testing personnel	11/11	100.0
Personnel trained in testing	11/11	100.0
Glucometer available	11/11	100.0
Test strips available	11/11	100.0
Lancets available	11/11	100.0
Swabs available	11/11	100.0

Availability at the assessment visit; continuity of supplies was not measured. TB, tuberculosis.

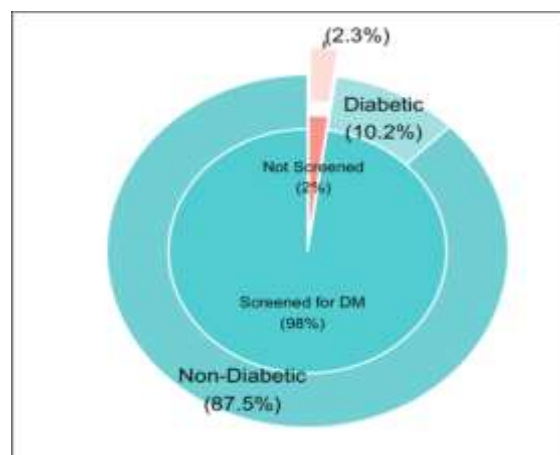
Diabetes screening was reported for 215/220 patients (97.7%; 95% CI 94.8–99.0); five patients had no screening reported. Ten patients had previously known diabetes and 22 had newly detected diabetes. Newly detected cases represented 10.0% of all

enrolled patients (95% CI 6.7–14.7) and 10.2% of those reported screened. Overall, 32/220 patients had recorded diabetes (14.5%; 95% CI 10.5–19.8). Table 3 presents the exact indicators and denominators. Screening and newly detected diabetes are illustrated in Figure 1.

Table 3: Diabetes screening, detection and reported treatment among patients with tuberculosis

Indicator	Numerator / denominator	Percentage	95% CI
Screening reported	215/220	97.7	94.8–99.0
Previously known diabetes	10/220	4.5	2.5–8.2
Newly detected diabetes per registered patient	22/220	10.0	6.7–14.7
Any recorded diabetes	32/220	14.5	10.5–19.8
NCD referral among newly detected diabetes	19/22	86.4	66.7–95.3
Both treatments among newly detected diabetes	19/22	86.4	66.7–95.3
Both treatments among previously known diabetes	10/10	100.0	72.2–100.0
Both treatments among all recorded diabetes	29/32	90.6	75.8–96.8

CI, confidence interval; NCD, noncommunicable disease. Wilson 95% CIs are unadjusted for clustering. Recorded diabetes includes 10 known and 22 newly detected cases. Both treatments refers to reported receipt of TB and diabetes treatment, not completion.

**Figure 1: Diabetes screening and newly detected diabetes among patients with tuberculosis.**

Puri district TB centre contributed 84/220 patients (38.2%) and 12/22 newly detected diabetes cases (54.5%). Eight units reported screening all enrolled patients. The five without reported screening were from Charichhak (two), Mangalpur (two) and

Sakhigopal (one). Newly detected diabetes ranged from no cases in Gop, Chilikanuapada and Sakhigopal to 2/8 patients in Astaranga. Table 4 presents unit-level screening, detection and referral; small denominators limit comparisons between units.

Table 4: Diabetes screening, detection and referral by tuberculosis unit

TB unit	Registered n	Screened n (%)	New DM n (%)	Referred n/N (%)
Astaranga	8	8 (100.0)	2 (25.0)	2/2 (100.0)
Bangurigaon	17	17 (100.0)	2 (11.8)	2/2 (100.0)
Charichhak	22	20 (90.9)	1 (4.5)	0/1 (0.0)
Chilikanuapada	10	10 (100.0)	0 (0.0)	0/0 (NA)
Delanga	11	11 (100.0)	1 (9.1)	1/1 (100.0)
Gop	15	15 (100.0)	0 (0.0)	0/0 (NA)
Kanas	14	14 (100.0)	1 (7.1)	1/1 (100.0)
Mangalpur	13	11 (84.6)	2 (15.4)	2/2 (100.0)
Puri DTC	84	84 (100.0)	12 (14.3)	10/12 (83.3)
Rebonanuagaon	16	16 (100.0)	1 (6.2)	1/1 (100.0)
Sakhigopal	10	9 (90.0)	0 (0.0)	0/0 (NA)
Total	220	215 (97.7)	22 (10.0)	19/22 (86.4)

Screening and detection percentages use registered patients; referral percentages use newly detected cases. DM, diabetes mellitus; DTC, district tuberculosis centre; TB, tuberculosis; NA, no newly detected cases.

Among 22 patients with newly detected diabetes, 19 had referral to NCD services and diabetes treatment reported (86.4%; 95% CI 66.7–95.3). Three had neither referral nor diabetes treatment reported: one from Charichhak and two from Puri district TB centre (Table 4). Referral among newly detected cases is illustrated in Figure 2. All 10 patients with previously known diabetes received treatment for both conditions. Across all recorded diabetes cases, combined treatment was reported for 29/32 patients (90.6%; 95% CI 75.8–96.8; Table 3). TB treatment was reported for all 220 participants. These measures concern reported receipt of care and do not establish adherence or treatment completion.

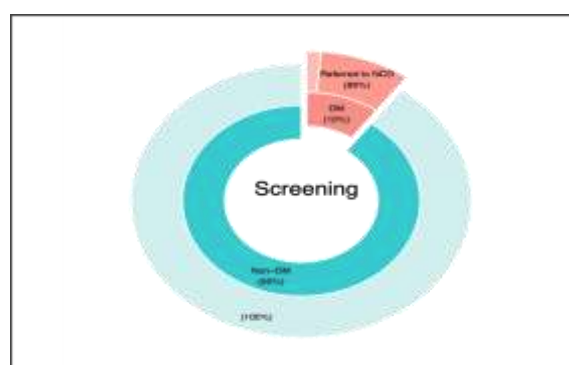


Figure 2: Referral to noncommunicable disease services among patients with newly detected diabetes.

Note on image labels. The supplied images are reproduced unchanged. Figure 1 mixes denominators; its “Non-Diabetic (87.5%)” label is unsupported by the aggregate counts, and known diabetes is not separately shown. In Figure 2, “DM (10%)” means newly detected diabetes (22/220); “Non-DM (90%)” includes previously known cases.

Its “100%” annotation does not represent verified complete care. Table 3 provides the validated counts and percentages.

DISCUSSION

This quantitative operational research study identified high reported diabetes screening coverage alongside incomplete early linkage to diabetes care. Although 215 of 220 patients were reported screened, three of the 22 patients with newly detected diabetes had no reported referral or diabetes treatment. All facilities reported basic screening resources at assessment. Together, these findings distinguish service readiness and screening coverage from subsequent receipt of care. The absence of qualitative interviews means that explanations for missed screening or referral cannot be established from this study.

Screening coverage of 97.7% was similar to the 98% diabetes assessment coverage reported by the India Tuberculosis-Diabetes Study Group.^[6] That multicentre study recorded diabetes in approximately 13% of patients, comprising approximately 8% previously known and 5% newly diagnosed cases. The corresponding proportions in Puri were 14.5%, 4.5% and 10.0%. Differences in case mix, eligibility, prior access to diagnosis and testing procedures prevent attributing the larger newly detected proportion in Puri to better programme performance. The combined proportion and its components should be reported separately to avoid confusing newly detected disease with total diabetes burden.

Prakash and colleagues identified 15 additional diabetes cases among 478 TB patients without a previous diabetes diagnosis; 45 of 47 patients with known or newly detected diabetes were enrolled in diabetes care.^[8] Their separation of known cases from those undergoing diagnostic screening illustrates the importance of linked denominators. In Puri, the aggregate count of screened patients did not

distinguish those with and without known diabetes. Consequently, 22/215 describes newly detected cases among all reported screened patients, rather than a validated yield among previously undiagnosed patients.

In nearby Bhubaneswar, Das and colleagues reported diabetes in 17% and prediabetes in 28% of 350 patients with TB.^[9] These were different categories, and the Puri evaluation did not measure prediabetes. Regional comparisons therefore need to consider the tests used and the stage of disease captured. Diagnostic timing, test selection and integrated management remain recognised challenges in TB–diabetes programmes.^[10] The present estimates should be interpreted as programme-recorded diagnoses until confirmatory testing and subsequent glucose results are verified.

The referral gap suggests that monitoring should extend beyond the number of people screened. A shared record connecting screening, diagnostic confirmation, referral, attendance and treatment initiation would help the TB team identify patients who need follow-up. The national framework already provides for referral and feedback between services.^[4] Recording the reason for a missed step would support a more specific response than assuming that every absent referral or treatment record represents refusal or loss to follow-up. This evaluation does not establish which referral intervention would be most effective.

From an operational perspective, a shared register connecting screening, confirmatory testing, referral, attendance and treatment initiation would make the care pathway auditable. Periodic review could identify patients with incomplete records and distinguish documentation gaps from missed care. A one-time facility assessment cannot establish continuous supply availability; future evaluations could record stock-out days and resupply delays, without assuming that shortages occurred in this study. Such monitoring is consistent with integrated, people-centred care.^[5] Prospective assessment of verified treatment initiation, repeat glucose measurements and TB outcomes would be needed to test whether service changes improve patient outcomes.

Strengths and limitations

The study covered all 11 district TB units and assessed successive stages of routine diabetes care alongside facility readiness. Explicit denominators distinguish screening, newly detected diabetes and reported treatment. This districtwide service coverage is a strength, although consecutive enrolment does not provide a probability sample of all people with TB in Puri.

The short study period and enrolment of 220 patients against a target of 246 limit precision and generalisability. Numbers assessed for eligibility, excluded or declining participation were not reported. The analysed cohort included extrapulmonary TB despite the original protocol's smear-positive restriction; this difference should be considered when

interpreting the study population. Programme-recorded diabetes could not be independently checked against confirmatory glucose results or repeat tests. Persistent diabetes could not therefore be distinguished from transient hyperglycaemia, and incident disease was not measured.

Five patients lacked reported screening, but diabetes-status categories encompassed the whole cohort; their overlap could not be determined from aggregate results. Telephone ascertainment may be affected by recall and social desirability, and referral was not independently linked to clinic attendance. Small unit denominators and confidence intervals unadjusted for clustering limit unit comparisons. No qualitative interviews were conducted, so patient experiences, staff perspectives and reasons for incomplete care were not assessed. The cross-sectional design, absence of a comparator and limited clinical follow-up preclude conclusions about glycaemic control, mortality or TB treatment success.

CONCLUSION

Diabetes screening was reported for almost all enrolled patients across TB units in Puri district, but three of the 22 newly detected diabetes cases had no reported referral or diabetes treatment. This operational research identifies a gap between screening and reported early linkage to care. Linked records, active follow-up of incomplete care steps and referral feedback warrant programme consideration. Further evaluation should verify diagnostic criteria and sustained treatment and determine whether service improvements translate into better glycaemic and TB outcomes.

Conflict of interest: The authors declare no conflicts of interest.

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OpenAI ChatGPT assisted with language editing, literature identification, table formatting and manuscript preparation. The two figures were supplied by the corresponding author and reproduced unchanged. The authors must verify the final content and take responsibility for the submitted manuscript.

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