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Original Article

Referral care utilization and financial burden of comorbidities among individuals with pulmonary tuberculosis: A two-part model analysis of Indonesia's national health insurance data, 2022

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ABSTRACT

Background: Pulmonary tuberculosis remains a leading infectious disease globally. In Indonesia, coexisting noncommunicable diseases are increasing referral care use and total spending in the National Health Insurance program. Using 2022 national insurance claims data, this study aimed to estimate the financial impact of noncommunicable comorbidities among individuals with pulmonary tuberculosis.

Methods: This study follows cross-sectional study design, utilizing the Indonesian National Health Insurance contextual tuberculosis sample data. The study included individuals newly diagnosed with pulmonary tuberculosis in 2022. Individuals were classified into three categories based on the presence of noncommunicable comorbidities: none, single, and multiple. A marginalized two-part model was applied. First, logistic regression was fitted to estimate the likelihood of any referral care utilization. Second, a generalized linear model with a log link and log-normal distribution to analyze positive healthcare expenditures.

Result: Noncommunicable comorbidity was strongly associated with higher referral care utilization and greater healthcare expenditures. Compared with individuals without noncommunicable comorbidities, those with one noncommunicable disease had an adjusted odds ratio of 201.22 (95 % CI, 148.77–272.16) and a cost ratio of 1.63 (95 % CI, 1.59–1.68). Individuals with multiple noncommunicable diseases had an adjusted odds ratio of 206.69 (95 % CI, 121.32–352.13) and a cost ratio of 3.23 (95 % CI, 3.10–3.37). The average annual expenditure increased from 188.48 USD among individuals without noncommunicable diseases to 416.85 USD for those with single, and 762.80 USD for those with multiple noncommunicable diseases. A significant (78.23 %) pulmonary tuberculosis individuals without noncommunicable disease comorbidity utilized referral care.

Conclusions: This study reports that individuals with pulmonary tuberculosis who also have noncommunicable diseases face a much heavier financial burden within Indonesia's National Health Insurance program. Strengthening primary care and integrating tuberculosis and noncommunicable disease management should be implemented to reduce costs and improve health outcomes.

Background

Tuberculosis (TB) remains a leading infectious disease globally, with Indonesia ranking among the countries with the highest TB burden. The WHO global TB report in 2024 reported that Indonesia was responsible for roughly ten percent of the global TB cases, making it the second-place country with the highest TB prevalence [1]. This ranking has shown little change, as Indonesia consistently ranks in the same position in the WHO global TB report in 2020 [2].

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The persistence of high TB burden raises a critical need to address the underlying mechanisms that contribute to poor TB treatment outcomes. Factors affecting TB outcomes are essential indicators of TB management success, ranging from the social determinants of health to other risk factors, including the existence of other diseases [3]. In recent years, growing evidence has also highlighted the dual burden of TB and noncommunicable disease (NCD) [4,5]. The convergence of the NCD with TB poses a growing public health challenge, not only complicating diagnosis and treatment but also increasing the demand for healthcare resources and costs [5,6].

Analysis from Indonesia's National Health Insurance (*Jaminan Kesehatan Nasional*, JKN) claim data reported that more than ten percent of beneficiaries with pulmonary TB referred for higher-level care had at least one NCD comorbidity [7]. The National Health Insurance program (JKN) functions as the main mechanism of healthcare financing in Indonesia that covering comprehensive treatment from simple outpatient services to advanced clinical treatment [8]. Most of the infectious diseases are covered by JKN packages, including TB. Yet, many individuals reported facing financial hardship, especially individuals with noncommunicable diseases face an even greater burden, as their conditions require more complex and continuous care [9].

In 2023, JKN reported that it had covered roughly 95 % of the Indonesian population, making it the largest single-payer national health insurance system globally [10]. However, ensuring the long-term financial sustainability of JKN has emerged as a persistent concern due to the recurrent financial deficits [11,12]. Under the JKN system, primary healthcare providers are reimbursed through capitation, while referrals for more complicated cases are financed using the Indonesian Case-Based Groups (INA-CBGs) system. Similar in design to the Diagnosis-Related Groups (DRG) model used internationally, INA-CBGs allocate bundled payments according to diagnosis and case severity. This referral and reimbursement structure often escalates government healthcare spending and underscores the need for more efficient strategies to manage tuberculosis within the broader health system [13].

Evidence from international studies has consistently shown that individuals with tuberculosis who also have additional health conditions, especially diabetes and other chronic diseases, face significantly higher healthcare costs and require more frequent medical services compared to those diagnosed with tuberculosis alone. Research from developing countries such as the Philippines and India demonstrates that the combination of TB and diabetes leads to increased medical expenses as well as greater use of healthcare resources [14–16]. To effectively address the dual burden of tuberculosis and noncommunicable diseases, it is essential to understand the economic impact of these NCD comorbidities.

This study aims to investigate the financial consequences of noncommunicable disease among individuals with pulmonary tuberculosis enrolled in Indonesia's National Health Insurance system. The results are intended to inform policy decisions and improve tuberculosis service delivery. In addition, this study contributes to the broader global discussion on managing the dual challenges of infectious and chronic diseases, offering insight applicable to other low-and middle-income countries (LMICs) facing similar health system challenges.

Method

This study follows cross-sectional study design. The contextual tuberculosis sample database from the 2023 Indonesia National Health Insurance claim dataset was used. The dataset is available upon request from the Social Security Administration for Health (*Badan Penyelenggara Jaminan Sosial or BPJS Kesehatan)* official web page. The 2023 contextual tuberculosis sample dataset consists of JKN beneficiaries diagnosed with tuberculosis from 2019 through 2022, and health service utilization histories [17]. The contextual tuberculosis employed a stratified random sampling approach at the household level. Strata were defined based on the district of residence, type of tuberculosis diagnosed within the household, and the category of healthcare facility accessed. A semi-proportional allocation method was applied to balance population differences across strata. To ensure the findings are representative at the national level, sampling weights were provided [17]. Further details on the sampling methodology of Indonesia's national health insurance claim dataset have been published elsewhere [18].

For this study, the focus was narrowed to individuals newly diagnosed with pulmonary TB in 2022, identified through ICD-10 codes A15 and A16, with diagnoses recorded in both primary and referral healthcare settings. After the weight application, the 7449 individuals included in the analysis correspond to an estimated 67,679 pulmonary TB cases nationwide diagnosed in 2022. The study population selection is shown in Fig. 1.

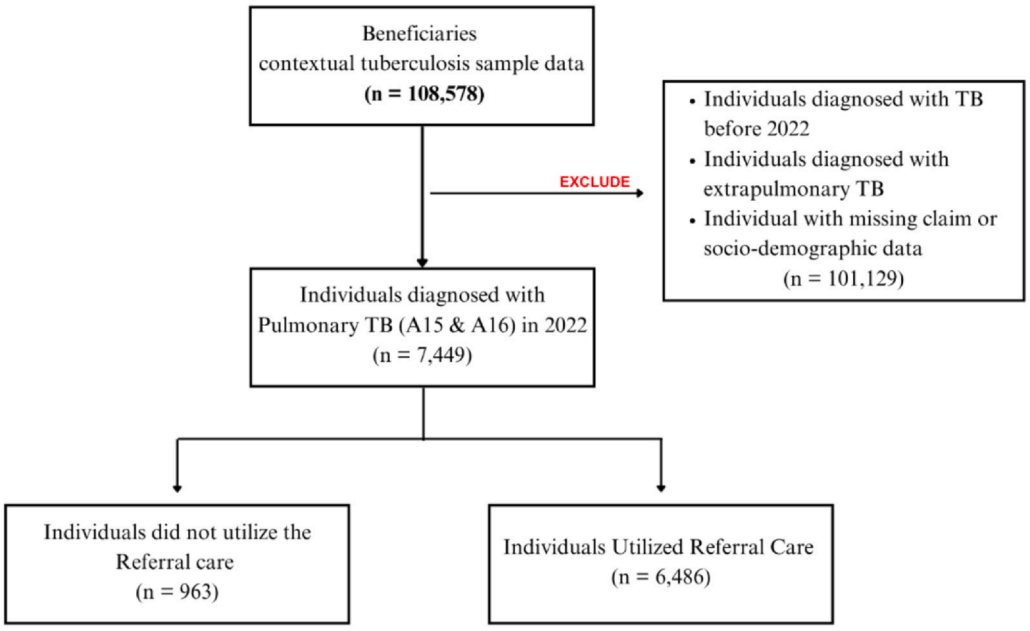

Fig. 1. Flowchart study population selection.

Table 1
Baseline characteristics of pulmonary tuberculosis individuals by comorbidity status.

Variables		Total	No Comorbidity		1 NCD Comorbidity		≥ 2 NCD Comorbidity	
			n	%	n	%	n	%
Sex	Male	4411	2685	57.7	1355	58.5	371	56.3
	Female	3038	1877	42.3	897	41.5	264	43.7
Age	< 18	1721	1480	36.9	236	9.4	5	0.2
	18–30	980	769	14.5	197	7.9	14	0.6
	31–45	1347	842	16.7	437	18.6	68	15.8
	46–60	1831	831	16.5	714	32.3	286	47.6
	> 60	1570	640	15.4	668	31.8	262	35.8
Marital Status	Single	2750	2185	49.9	509	18.1	56	8.6
	Married	4250	2178	45.9	1559	72.7	513	80.5
	Divorced	449	199	4.2	184	9.2	66	10.9
Subsidization	Subsidized	3997	2493	51.2	1177	49.3	327	48.6
	Unsubsidized	3452	2069	48.8	1075	50.7	308	51.4

*Percentages are weighted; counts are unweighted. NCD indicates noncommunicable disease.

Variables

The primary outcome was annual healthcare expenditure, divided into total expenditure, which included both outpatient and inpatient expenditures, outpatient expenditure only, and inpatient expenditures only. Expenditure was calculated based on the Indonesian Case-Based Groups tariffs. The main exposure was noncommunicable comorbidity, categorized as none (without NCD comorbidity), single (one NCD comorbidity), and multiple (≥2 NCD comorbidities). Noncommunicable diseases included diabetes mellitus, cardiovascular disease, cancers, and other chronic conditions identified by ICD-10 codes listed in Supplementary Table S1. To contextualize referral care use among participants without noncommunicable comorbidity, indicators were also constructed for communicable comorbidities, including HIV or AIDS, hepatitis, acute respiratory infections, pneumonia, sepsis, and COVID-19, using ICD-10 codes in Supplementary Table S2. Covariates included age, sex, marital status, and subsidy status. Subsidized participants received government assistance through the national or regional budget. Unsubsidized participants were independent or employment-based contributors. Records with incomplete demographic or claims data or without pulmonary tuberculosis as the primary diagnosis in either primary or referral care were excluded.

Statistical methods

Healthcare costs were treated as semi-continuous [19]. A marginalized two-part model was fitted. Part one applied logistic regression to estimate any referral care utilization. Part two used a generalized linear model with a log link and log-normal distribution to model positive costs. Model performance was assessed using Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and the –2 log-likelihood value to determine the best-fitting distribution, with results shown in Supplementary Table S3. Costs were converted to 2022 USD at 1 USD equals 14,853 IDR. Analyses applied the provided sampling weights. Statistical significance was set at p-value < 0.05. Estimation was performed in SAS version 9.4 (SAS Institute Inc., Cary, NC, USA) [20] with PROC NLMIXED following established methods [21].

Ethics approval and reporting

The analysis used publicly available anonymized claims data and met ethical standards for secondary data use. The Health Research Ethics Committee, Faculty of Public Health, University of Jember, Indonesia, granted an ethics exemption under approval No. 569/KEPK/FKM UNEJ/XII/2024. Individual consent was not required because no identifiable information was accessed. Reporting follows the STROBE checklist for observational studies, summarized in Supplementary Table S4.

Result

Table 1 summarizes baseline characteristics by comorbidity status. Of 7449 Individuals, 59.2 % were male and 40.8 % were female. Marriage was more common with increasing comorbidity, rising from 45.9 % in the no NCD group to 72.7 % with single NCD and 80.5 % with multiple NCDs. Older ages are concentrated in higher comorbidity strata. In the multiple NCD group, 47.6 % were aged 46–60 years, and 35.8 % were above 60 years, compared with 16.5 % and 15.4 % in the no NCD group. Subsidization was similar across strata. Category frequencies for noncommunicable diseases were led by other NCD group, cardiovascular disease, diabetes mellitus, and cancer, as detailed in Supplementary Table S5.

Mean annual referral care expenditure rose significantly with comorbidity count, as shown in Fig. 2. Individuals without noncommunicable comorbidity incurred 188.48 USD on average, increasing to 416.85 USD with single noncommunicable comorbidity and 762.80 USD with multiple. Outpatient spending was modest but higher with comorbidity, from 39.17 USD to 62.24 USD and 136.87 USD. Inpatient spending comprised the majority, rising from 149.30 USD to 339.90 USD and 625.93 USD across the same groups.

Referral care utilization by individual characteristics is summarized in Table 2. Referral care utilization was high across all subgroups. Utilization is 88.0 % among females and 86.8 % among males. By marital status, divorced individuals have the highest use at 89.7 %. By age, use is 91.2 % for those younger than 18 years. Unsubsidized members use referral care more often than subsidized members. A steep comorbidity gradient is evident: 78.2 % with no NCD, 99.8 % with single NCD, and 99.7 % with multiple NCDs.

Table 3 presents the results of the marginalized two-part model estimating annual total expenditures in referral healthcare. The first part applied logistic regression to estimate any referral care utilization, reported as adjusted odds ratios (aOR). NCD Comorbidity effects were significant. Individuals with single NCD comorbidity had over 200 times higher odds of using referral care (aOR 201.22; CI: 148.77–272.16), and those with multiple NCDs had similarly elevated odds (aOR 206.69; 95 % CI: 121.32–352.13) compared to those without NCD. Females had slightly higher odds of referral care utilization (aOR 1.09; 95 % CI: 1.03–1.14).

The second part of the analysis used a generalized linear model featuring a log link and log-normal to assess positive costs, reported as cost ratios. The presence of NCD comorbidities was shown as the main factor associated with the healthcare costs. Individuals with single NCD comorbidity faced 63 % higher (cost ratio 1.63; 95 % CI: 1.59–1.68), and having multiple NCD comorbidities experienced more than threefold higher (cost ratio 3.23; 95 % CI: 3.10–3.37).

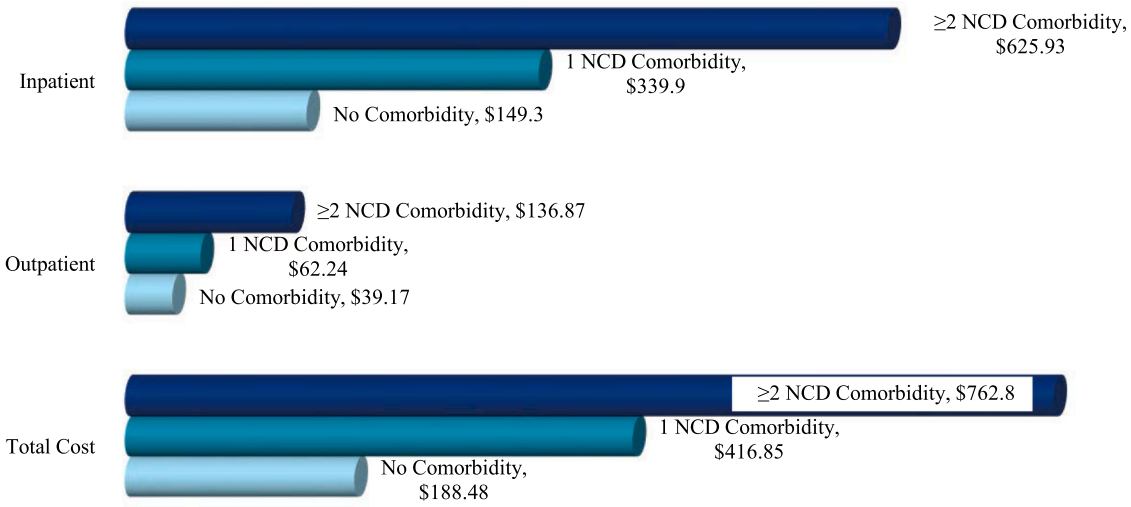

Fig. 2. Unadjusted Mean of Annual Healthcare Cost of Pulmonary TB Individuals in USD.

Table 2
Referral care utilization by individual characteristics.

Variables		Total	Not Utilized Referral Care		Utilized Referral Care	
		n	n	%	n	%
Sex	Male	4411	585	13.3	3826	86.8
	Female	3038	378	12.0	2660	88.0
Age Category	< 18	1721	154	8.8	1567	91.2
	18–30	980	164	19.6	816	80.4
	31–45	1347	202	15.8	1145	84.2
	46–60	1831	236	11.5	1595	88.5
	> 60	1570	207	12.6	1363	87.4
Marital Status	Single	2750	290	11.3	2460	88.7
	Married	4250	624	13.9	3626	86.1
	Divorced	449	49	10.3	400	89.7
Subsidization	Subsidized	3997	603	14.2	3394	85.8
	Unsubsidized	3452	360	11.2	3092	88.8
NCD Comorbidity	No NCD Comorbidity	4562	952	21.8	3610	78.2
	1 NCD Comorbidity	2252	10	0.2	2242	99.8
	≥ 2 NCD Comorbidity	635	1	0.3	634	99.7

*Percentages are weighted; counts are unweighted. NCD indicates noncommunicable disease.

Conversely, factors such as being female, older, married, or an unsubsidized participant were linked to lower average spending.

Table 4 highlights key factors influencing outpatient utilization and expenditures in referral care. The marginalized two-part model showed that outpatient referral care utilization was strongly associated with the presence of NCD comorbidity. Individuals with single NCD comorbidity were over four times more likely to use outpatient referral services (aOR 4.24; 95 % CI 4.05–4.44), and those with multiple NCD comorbidities had sixfold higher odds (aOR 6.18; 95 % CI 5.71–6.70) compared to those without NCD comorbidities. Females had higher odds of utilization (aOR 1.30; 95 % CI 1.25–1.35), while younger, particularly those under 18 years, showed markedly greater likelihood (aOR 2.59; 95 % CI 2.41–2.78). In contrast, older adults aged over 60 years were less likely to use outpatient referral care (aOR 0.74; 95 % CI 0.70–0.79).

In the expenditure component, the presence of NCD comorbidity emerged as the strongest predictor of higher outpatient expenditure. Individuals with single NCD comorbidity had 51 % higher mean expenditures (cost ratio 1.51; 95 % CI 1.48–1.55), while those with multiple NCD comorbidities spent 2.5 times more (cost ratio 2.51; 95 % CI 2.43–2.59). Costs declined with increasing age, with individuals aged over 60 years spending nearly half as much as those aged 31–45 years (cost ratio 0.54; 95 % CI 0.53–0.56). Female Individuals and those unsubsidized under the national health insurance scheme also had marginally higher expenditures.

Table 5 summarizes the marginalized two-part model results for inpatient referral care. NCD Comorbidity status showed a pronounced effect on utilization. Individuals with single NCD comorbidity were more than twice as likely to access inpatient services compared with those without comorbidities (aOR 2.16; 95 % CI 2.08–2.24), and those with multiple NCD comorbidities had nearly threefold higher odds (aOR 2.99; 95 % CI 2.82–3.17). Females were less likely to utilize inpatient care (aOR 0.80; 95 % CI 0.77–0.83), as were married (aOR 0.76; 95 % CI 0.72–0.80) and divorced (aOR 0.85; 95 % CI 0.79–0.93) compared with single individuals. Younger individuals, particularly those under 18 years, were substantially less likely to use inpatient referral care (aOR 0.51; 95 % CI 0.48–0.54).

In the expenditure model, NCD comorbidity is consistently a determinant of higher expenditure. Individuals with single NCD comorbidity incurred 25 % higher inpatient costs (cost ratio 1.25; 95 % CI 1.22–1.28), while those with multiple NCD comorbidities spent 61 % more (cost ratio 1.61; 95 % CI 1.56–1.66) than those without NCDs.

Discussion

This study shows that people with pulmonary tuberculosis who also have noncommunicable diseases face far higher healthcare costs and are much more likely to use referral-level services in Indonesia. Managing both TB and NCD, such as diabetes and cardiovascular disease, remains a serious challenge for the health system [22–24], particularly as the number of NCD cases continues to grow. The existence of dual burden disease escalated the healthcare spending and further strained the healthcare budget due to the complex and complicated care [25,26]. Our analysis results showed that pulmonary TB individuals with a single NCD spent about 63 % higher, and multiple NCDs spent more than three times higher than pulmonary TB individuals without NCD comorbidity. This pattern is consistently observed across inpatient and outpatient services, showing that NCD comorbidity significantly influences healthcare costs. Similar findings have been reported in other developing countries, confirming that dual burden disease is a consistent financial challenge across low- and middle-income settings [14–16,27].

Table 3
Marginalized two-part model of annual total expenditure in referral care

Variables		aOR / Cost Ratio	CI 95 %	P-value
Referral care Utilization				
NCD Comorbidity	No NCD Comorbidity	REF		
	1 NCD Comorbidity	201.22	(148.77, 272.16)	< .0001
	≥ 2 NCD Comorbidity	206.69	(121.32, 352.13)	< .0001
Sex	Male	REF		
	Female	1.09	(1.03, 1.14)	0.0013
Age	< 18	2.76	(2.52, 3.02)	< .0001
	18–30	0.98	(0.90, 1.06)	0.5817
	31–45	REF		
	46–60	1.02	(0.94, 1.10)	0.654
	> 60	0.89	(0.83, 0.97)	0.0047
Marital Status	Single	REF		
	Married	0.69	(0.64, 0.74)	< .0001
	Divorced	0.86	(0.75, 0.97)	0.0179
Subsidization	Subsidized	REF		
	Unsubsidized	1.27	(1.21, 1.33)	< .0001
Expected cost ratio				
NCD Comorbidity	No NCD Comorbidity	REF		
	1 NCD Comorbidity	1.63	(1.59, 1.68)	< .0001
	≥ 2 NCD Comorbidity	3.23	(3.10, 3.37)	< .0001
Sex	Male	REF		
	Female	0.82	(0.80, 0.84)	< .0001
Age	< 18	0.48	(0.46, 0.50)	< .0001
	18–30	0.68	(0.65, 0.72)	< .0001
	31–45	REF		
	46–60	0.79	(0.77, 0.83)	< .0001
	> 60	0.67	(0.65, 0.70)	< .0001
Marital Status	Single	REF		
	Married	0.84	(0.81, 0.87)	< .0001
	Divorced	0.78	(0.74, 0.83)	< .0001
Subsidization	Subsidized	REF		
	Unsubsidized	0.81	(0.79, 0.83)	< .0001

*Estimates obtained from a weighted marginalized two-part model. Logistic coefficients are reported as adjusted odds ratios (aOR), and log-normal coefficients as cost ratios representing mean outpatient expenditure among users. Costs are shown in 2022 USD

JKN has been reported to be facing financial stress due to continuous deficits, as the NCD treatment shares the largest part of the claims [28,29]. Current initiatives, such as performance-based incentives [30] and chronic disease management initiatives such as PROLANIS (Chronic Disease Management Program) [31], have not substantially reduced dependence on higher-cost referral care. Strengthening early detection of NCD and integrating TB–NCD management at the community and primary care levels will be essential to control costs and improve service efficiency.

One notable result of this study was the high rate of referral care utilization (78.23 %) among pulmonary TB individuals who did not have any NCD comorbidity (see Table 2). More than three-quarters of this group used referral services, and nearly one-fourth had another communicable disease, such as acute respiratory infection or pneumonia. A high number of pulmonary TB individuals without any NCD comorbidity were also utilizing referral care (72.5 %), as shown in the Supplementary Table S6. This finding suggests that underlying factors may influence the referral care utilization aside from the existence of NCD comorbidity. Similar patterns have been observed in previous Indonesian studies; frequent referrals are highly associated with under-resourced primary care and poor implementation of the referral system [32,33]. Studies from China [34] showed comparable issues, health providers tend to refer patients quickly when diagnostic tools are limited or when fear of missing a serious case. A Study done in high-income countries like England reported that referral rates remain high despite diagnostic tools availability is due to diagnostic uncertainty in primary care, and referring patients is done to avoid missed diagnoses [35]. These mixed findings suggest that referral decisions are not solely based on resource availability and provider capability but also on risk management strategies.

Referral care utilization was observed to be high among children, as shown in the Supplementary Table S7. Almost all children with pulmonary TB are managed at the referral care, even without NCD comorbidity. This finding reflects the limitation of the pediatric TB diagnostic capacity and clinical training at primary care [1,36]. Strengthening these areas would reduce avoidable referrals and costs [37,38]. Align with the international evidence that consistently shows that health systems with strong primary care foundations achieve better health outcomes, lower overall costs, and fewer avoidable hospital admissions [39–41].

Sex and marital status also influenced the healthcare utilization pattern. Female patients sought outpatient care earlier and incurred lower inpatient costs, indicating more proactive health-seeking behavior or milder disease severity. In contrast, male patients often delay care, increasing their reliance on inpatient treatment. These gender differences are consistent with previous research showing that males delay care due to work obligations or social expectations [32,42], whereas females face barriers, including stigma, limited autonomy, and mobility challenges that may cause delayed access to healthcare or at lower-tier providers [43]. Marital status further influenced healthcare-seeking patterns; married individuals used referral services less frequently but had higher inpatient costs, possibly linked to delays caused by family responsibilities and financial constraints. Similar findings from the Challenge TB project reported that gender roles and family structure affect access to TB care [44].

This study result suggests that the dual burden diseases of pulmonary TB with NCD comorbidity significantly increase the need for high-level care and costs in Indonesia. Underlying mechanisms of high referral care have been reported, including limited diagnostic capacity, weak referral care system implementation, and provider payment mechanisms [45]. To address these challenges, policymakers should implement several actionable plans. First, strengthen the integration of TB and NCD services through routine two-way

Table 4
Marginalized two-part model of outpatient expenditure in referral care.

Variables		aOR / Cost Ratio	CI 95 %	P-value
Referral Care Utilization				
NCD Comorbidity	No NCD Comorbidity	REF		
	1 NCD Comorbidity	4.24	(4.05–4.44)	< .0001
	≥ 2 NCD Comorbidity	6.18	(5.71–6.70)	< .0001
Sex	Male	REF		
	Female	1.30	(1.25–1.35)	< .0001
Age	< 18	2.59	(2.41–2.78)	< .0001
	18–30	1.23	(1.15–1.32)	< .0001
	31–45	REF		
	46–60	0.95	(0.90–1.00)	0.0712
	> 60	0.74	(0.70–0.79)	< .0001
Marital Status	Single	REF		
	Married	0.73	(0.69–0.77)	< .0001
	Divorced	0.64	(0.58–0.70)	< .0001
Subsidization	Subsidized	REF		
	Unsubsidized	1.60	(1.54–1.66)	< .0001
Expected cost ratio				
NCD Comorbidity	No NCD Comorbidity	REF		
	1 NCD Comorbidity	1.51	(1.48–1.55)	< .0001
	≥ 2 NCD Comorbidity	2.51	(2.43–2.59)	< .0001
Sex	Male	REF		
	Female	0.92	(0.91–0.94)	< .0001
Age Category	< 18	0.68	(0.66–0.70)	< .0001
	18–30	0.71	(0.69–0.74)	< .0001
	31–45	REF		
	46–60	0.68	(0.66–0.70)	< .0001
	> 60	0.54	(0.53–0.56)	< .0001
Marital Status	Single	REF		
	Married	0.87	(0.85–0.90)	< .0001
	Divorced	0.79	(0.76–0.82)	< .0001
Subsidization	Subsidized	REF		
	Unsubsidized	1.07	(1.05–1.09)	< .0001

*Estimates obtained from a weighted marginalized two-part model. Logistic coefficients are reported as adjusted odds ratios (aOR), and log-normal coefficients as cost ratios representing mean outpatient expenditure among users. Costs are shown in 2022 USD

Table 5
Marginalized two-part model of inpatient expenditure in referral care.

Variables		aOR / Cost Ratio	CI 95 %	P-value
Referral care Utilization				
NCD Comorbidity	No NCD Comorbidity	REF		
	1 NCD Comorbidity	2.16	(2.08–2.24)	< .0001
	≥ 2 NCD Comorbidity	2.99	(2.82–3.17)	< .0001
Sex	Male	REF		
	Female	0.80	(0.77–0.83)	< .0001
Age	< 18	0.51	(0.48–0.54)	< .0001
	18–30	0.69	(0.65–0.74)	< .0001
	31–45	REF		
	46–60	1.02	(0.97–1.07)	0.469
	> 60	0.97	(0.92–1.02)	0.2427
Marital Status	Single	REF		
	Married	0.76	(0.72–0.80)	< .0001
	Divorced	0.85	(0.79–0.93)	0.0002
Subsidization	Subsidized	REF		
	Unsubsidized	0.63	(0.61–0.66)	< .0001
Expected cost ratio				
NCD Comorbidity	No NCD Comorbidity	REF		
	1 NCD Comorbidity	1.25	(1.22–1.28)	< .0001
	≥ 2 NCD Comorbidity	1.61	(1.56–1.66)	< .0001
Sex	Male	REF		
	Female	1.01	(0.99–1.04)	0.2027
Age Category	< 18	0.84	(0.81–0.88)	< .0001
	18–30	1.10	(1.06–1.15)	< .0001
	31–45	REF		
	46–60	1.01	(0.98–1.04)	0.6244
	> 60	0.95	(0.92–0.98)	0.0037
Marital Status	Single	REF		
	Married	1.07	(1.04–1.10)	< .0001
	Divorced	0.86	(0.82–0.91)	< .0001
Subsidization	Subsidized	REF		
	Unsubsidized	1.08	(1.06–1.10)	< .0001

*Estimates obtained from a weighted marginalized two-part model. Logistic coefficients are reported as adjusted odds ratios (aOR), and log-normal coefficients as cost ratios representing mean outpatient expenditure among users. Costs are shown in 2022 USD.

screening and expansion of disease management programs. Integrated care approaches have been reported to improve efficiency and outcomes in resource-limited settings [46]. Second, sustain investment in the primary care workforce, diagnostic infrastructure, and evidence-based clinical guidelines to enhance early detection and ensure continuity of care. Third, promote population-level prevention strategies targeting NCD risk factors, such as tobacco use, poor diet, and physical inactivity, while implementing family-centered community programs like PIS-PK (Healthy Indonesia Program with a Family Approach) [47]. Finally, multisectoral cooperation is essential to control both TB and NCD and to maintain the long-term financial sustainability of Indonesia's national health insurance.

Strengths and limitations

This study utilized a nationally representative sample from Indonesia's National Health Insurance (JKN) claims data, which enhances the generalizability of the results. The stratified sampling design ensured strong demographic and geographic representation, minimizing selection bias. Analytical methods were tailored to fit the data structure, which effectively handles the skewed, semi-continuous nature of healthcare expenditure data. Detailed referral-level information enabled comparison of outpatient and inpatient expenditures precisely.

However, several limitations should be acknowledged. The cross-sectional design prevents drawing causal inference about the observed relationships. Misclassification might have occurred due to solely relying on ICD-10 codes for disease identification. Claims data also lacked detailed clinical indicators such as disease severity, drug resistance, or treatment adherence. Cost analysis was done using the combined diseases rather than by specific NCD, limiting disease-specific insights. Geographic analysis depended on province-level data and could not distinguish between rural and urban contexts. Important behavioral factors like smoking or alcohol use were unavailable, limiting the ability to adjust for these factors. The unavailability of out-of-pocket payment data prevented direct estimation of individuals' financial burdens. Additionally, the absence of COVID-19 cases among the study participants may have influenced the findings, as the pandemic could have influenced cost and utilization patterns. Furthermore, currency conversion based on official exchange rates may not reflect regional price variation. Future research should integrate richer clinical, behavioral, and spatial data to better understand complexity and regional differences in healthcare costs and healthcare utilization.

Conclusion

This study findings suggest that noncommunicable disease comorbidities influence healthcare utilization and financial burden on individuals with pulmonary tuberculosis in Indonesia. High referral care utilization was observed among those without NCD comorbidities, indicating ongoing gaps in primary healthcare capacity. Strengthening diagnostic and treatment services at the primary care level and integrating TB and NCD management should be essential strategies to improve both efficiency and health outcomes.

Expanding preventive actions through population-level prevention strategies targeting shared risk factors should be promoted. Policymakers should prioritize integrated service delivery, invest more in primary healthcare, and develop multisectoral cooperation that adapts to Indonesia's changing disease landscape. Together, these efforts will enhance health system performance and support the long-term sustainability of the national health insurance program in Indonesia.

Abbreviations

AIC	Akaike Information Criterion
BIC	Bayesian Information Criterion
BPJS	*Badan Penyelenggara Jaminan Sosial* (Social Security Administration for Health)
CBG	Case by Group
HIV	Human Immunodeficiency Virus
ICD	International Classification of Diseases
INA-CBGs	the Indonesian Case-Based Groups
JKN	*Jaminan Kesehatan Nasional* (National Health Insurance)
LMICs	Low- and Middle-Income Countries
NCD	Noncommunicable Diseases
PIS-PK	*Program Indonesia Sehat dengan Pendekatan Keluarga* (Healthy Indonesia Program with a Family Approach)
PROLANIS	*Program Pengelolaan Penyakit Kronis* (Chronic Disease Management Program)
TB	Tuberculosis
USD	United States Dollar
WHO	World Health Organization

Author contributions

SYJ conceptualized and supervised the overall process. DIP contributed to the literature review, data extraction, and conducted statistical analyses. WH contributed to preparing the first draft of the manuscript.

All authors participated in the interpretation of results, provided comments on manuscript drafts, and approved the final version for submission. The corresponding author attests that all listed authors meet authorship criteria and confirms that no individuals meeting these criteria have been omitted.

Consent for publication

Not applicable.

Ethical approval

The analysis used publicly available anonymized claims data and met ethical standards for secondary data use. The Health Research Ethics Committee, Faculty of Public Health, University of Jember, Indonesia, granted an ethics exemption under approval No. 569/KEPK/FKM UNEJ/XII/2024.

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Data availability

The anonymous Indonesian National Health Insurance (JKN) sample database used in this study is publicly available upon request from the Social Security Administration for Health (*Badan Penyelenggara Jaminan Sosial, BPJS Kesehatan*) via https://data.bpjs-kesehatan.go.id/. Access is currently limited to users within the territory of Indonesia.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Generative AI and AI-assisted technologies in the writing process

No AI was used to generate content, interpret data, or draft any sections of the manuscript.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.jiph.2025.103032.

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