

Cost-Effectiveness of Follow-Up of Chronic Coughers in Detecting Smear-Positive Tuberculosis in South Ethiopia

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Introduction: In Ethiopia, no studies assessing the cost-effectiveness of follow-up of smear-negative chronic coughers in detecting smear-positive tuberculosis (TB) (PTB+) cases have been reported.

Objective: This article describes the cost-effectiveness of community-based follow-up of smear-negative chronic coughers in detecting PTB+ cases.

Methods: Two alternative strategies of TB case finding, namely community-based follow-up of smear-negative chronic coughers and passive TB case finding, were compared. Participants were selected randomly in the active TB case finding approach, while purposively in the passive TB case finding strategy. In November 2012 and January 2015, costs related to TB diagnosis were collected using structured questionnaires from sample of 60 patients in each strategy. Data on health system cost and direct and indirect costs incurred by patients and their caretakers were collected in Ethiopian Birr and converted into USD for analysis. Exchange rate for the data collection period of chronic coughers was 1 USD = 18.16 ETB and for passive case finding period was 1 USD = 20.24 ETB. Cost-effectiveness was calculated in terms of cost per PTB+ cases detected.

Results: The overall cost of TB case finding was lower under active case finding approach than under passive TB case finding approach (USD 27.4 vs. 27.6). Active case finding approach was cost-effective by 43.4% and it is highly cost-effective when the duration of follow-up is reduced to 7 months or less.

Conclusion: Active case finding approach is a cost-effective approach of TB case finding. The cost benefit obtained could be even higher when the follow-up duration is minimized.

Keywords: cost, effectiveness, chronic coughers, smear-positive TB

Introduction

The incidence of all forms of tuberculosis (TB) in Ethiopia was $140/10^5$ in 2019.¹ According to the 2011 national TB prevalence survey, prevalence of smear-positive TB (PTB+) was 108/100,000.² Low socio-economic condition is one of the contributing factors for acquiring TB infection,³ developing the disease⁴⁻⁶ and low TB case detection.⁷ Despite “free service” for TB care, TB patients incur substantial cost for care seeking and treatment.⁸ The disease imposes high economic burden on the poor households for seeking TB care.⁹⁻¹³

In Ethiopia, sputum microscopy is the standard way of diagnosis of pulmonary TB and Directly Observed Treatment Short course (DOTS) is the standard approach

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for its treatment.¹⁴ Despite the implementation of DOTS, low case findings persisted to be the challenge of TB care in southern Ethiopia.

Delay in diagnosis is the main reason of low TB case finding, which could be related to low income, use of traditional medicines, low health-seeking behaviour, inaccessibility of diagnostic facilities and weak screening system.^{7,15,16} Active case finding of TB aims to minimize such barriers with an ultimate goal of reducing TB transmission.¹⁷ The main study showed that, community-based follow-up of smear-negative people with cough of two weeks or more improves PTB+ case detection. A detailed description of the study is published elsewhere.¹⁸

In Ethiopia, no studies assessing the cost-effectiveness of follow-up of smear-negative people with cough of two weeks or more in detecting PTB+ case have been reported. Conducting cost-effectiveness study is useful before implementation of any new intervention in the society. In this study, comparison of the cost effectiveness of diagnosis of TB under community-based follow-up of smear-negative people with cough of two weeks or more and passive TB case finding was done. The objective of the study was to investigate the cost-effectiveness of follow-up of smear-negative people with cough of two weeks or more in detecting PTB+ cases which could help in improving TB control program in South Ethiopia.

Methods

Study Setting

This study was conducted in six rural communities of Dale district. Dale district is one of the 19 districts in Sidama zone, South Ethiopia. In 2011, the district has a population of above 250,000 people. It consists of rural people, settled for one or more years, who are mainly farmers. TB is one of the major public health problems in the district and its diagnosis is primarily carried out in health centers and hospitals.

Design and Population

Comparison of costing implication of active TB case finding and passive TB case finding was done. Under an active TB case finding approach, follow-up of chronic coughers (people with cough of two or more weeks) at community level was done and these cases were screened for TB. Every third or fourth month we interviewed them and did sputum investigations as required. The objective of

the study was to evaluate the usefulness of community-based follow-up of smear-negative chronic coughers in detecting PTB+ cases, where participants were followed for 10 months. Details of the study are available elsewhere.⁷ Under passive TB case finding schemes, patients with TB suggestive symptoms went to health facilities (health centers or hospitals) for TB diagnosis through self-referral or using advises patients obtained from health extension workers. Then TB cases were detected in health facilities among the self-referred patients.

Participants of this study were a sample of 60 randomly selected smear-negative chronic coughers, who were involved in a cohort study⁷ and another 60 PTB+ patients detected by a passive TB case finding approach, living in the same communities with the smear-negative chronic coughers. A list of smear-negative chronic coughers by kebele (community with an average population of 5000 people) was used to select study participants for active case finding approach (10 per community). A TB treatment register was used to recruit TB patients from the health facilities. Random sampling was used to select participants for active TB case finding approach. TB patients who were on DOTS during the period of data collection were included in the study under the passive TB case finding approach. TB patients for each community were recruited from TB registry found in health posts.

Costing

The mean cost value was calculated by dividing total cost values by total number of patients involved in the study. Patient costs includes costs used for buying medications, transportation costs, costs expended by the patient for buying of food and drinks, indirect costs and the cost used for an accompanying person. Direct cost implies out-of-pocket expenses for patients or an accompanying person during follow-up for diagnosis of TB. Indirect cost is the sum of costs due to loss of time by the patient or caretakers (working days lost due to travel time and staying in health facilities). Time spent in health facilities is converted in to money based on unskilled wage rate during the study period in the study area, which was 30 ETB (1.6 USD) per day for the chronic coughers and 35 ETB (1.7 USD) per day for TB patients involved from passive case finding. Capital investment cost includes costs used for construction of buildings, buying cars and motorcycles. Running cost reflects cost incurred by health facilities for consumption of electricity, water, telecommunication,

medicine transport, buying microscope and other laboratory equipment, buying furniture, buying other materials and services and training cost. Training cost includes costs used for TB-related training of health professionals which is invested by the district health office or each health facility. Program cost is the sum total of capital investment cost, running cost and salaries paid for personnel working in the health facilities. In addition to these costs it includes research cost expended for the patients under active TB case finding approach. Research cost is the cost expended for personnel (data collectors, supervisors and laboratory technicians), stationery cost, transport cost, printing and duplication. Total cost is the sum of patient cost, caretakers' cost and program cost. Under both strategies, average costs for specific cost items is calculated as the total cost of the item divided by total quantity of the item used or participants involved in the study. Costing annuitization was done; 30 years for buildings, 10 years for cars and equipment and 5 years for motorcycle.

To collect patients and caretakers' costs data, data collectors interviewed smear-negative chronic coughers, TB patients and their caretakers. Health system cost data was obtained through interviewing the health care provider. Data were collected in November 2012 for the active TB case finding approach. Data for the passive TB case finding was collected in January 2015. All costing data were collected, entered in to computer and analyzed in ETB. Then the output values were converted in to USD at the official exchange rate of the National Bank of Ethiopia for the data collection period of 1USD = 18.16 ETB for the chronic coughers and 1USD = 20.24 ETB for the passively identified TB cases.

Success in follow-up was calculated based on the mid-time population. Of 724 smear-negative chronic coughers who began their follow-up in 2012, 15 died and 7 missed their follow-ups. So 701 smear-negative chronic coughers were evaluated at the end of the cohort, which gave us 713 mid-time populations for the active TB case finding approach. During the same period, the total number of people among whom PTB+ cases could have been detected passively was 19,496. For this group, the assumption was made as a 99.9% successful follow-up rate, which was the rate of successful follow-ups for neighbourhood controls in the cohort study.¹⁸ This gives 19,441 people who could have been evaluated at the end of the cohort under the passive TB case finding approach. Thus, the mid-time population for this group was 19,469.

Effectiveness was defined based on the number of PTB+ cases diagnosed in each strategy. It was 23 patients under smear-negative chronic coughers' follow-up approach. Number of PTB+ cases detected through TBREACH project and passive TB case finding was 30. Then, the 2010/2011 case detection rate of PTB+ in SNNPR was considered which was 48.4%.¹⁹ With this assumption, about 15 PTB+ cases could have been detected through passive TB case finding approach in the study communities. Cost-effectiveness was calculated as the average cost per number of PTB+ cases identified in each TB case finding approach. The denominator for this calculation was 23 PTB+ patients under active TB case finding approach and 15 PTB+ patients under passive TB case finding approach. For each TB case finding method, the cost-effectiveness of each phase of the follow-up was calculated as the average cost in the specified phase of the cohort per number of PTB+ cases detected in each phase of the follow-up. In both strategies, the average cost of each phase of the follow-up was calculated from the total cost (total cost of the strategy/10 months * 4 months or total cost of the strategy/10 months * 7 months). Number of PTB+ cases for each phase of the follow-up was obtained from the main study¹⁸ for active TB case finding approach and calculated from the 30 PTB+ patients detected for the passive TB case finding approach. A cost-effectiveness ratio was calculated as the net cost divided by the number of TB cases detected in each strategy.

A one way sensitivity analysis of cost-effectiveness was performed to investigate how cost-effectiveness was sensitive to variations in the costs per TB case finding. The uncertainty analyses were based on the minimum and maximum values of selected characteristics. We varied one cost variable at a time. We considered an input value of 3% discount rate and the lower and upper limits of 95% confidence interval of the case detection rate of an active TB case finding approach in the sensitivity analysis.

Ethical Clearance

Ethical approval was granted by the Ethical Review Committee for the Health Research of Southern Nations Nationalities and Peoples' Regional State Health Bureau in Ethiopia (ethical clearance number 902-6-19/13). The study was conducted in accordance with the Declaration of Helsinki. Participants' information was anonymized and informed consent was obtained from all respondents.

Results

Socio-Demographic Characteristics

The mean (standard deviation [SD]) of age was 45.5 (18.4) years for people involved in an active TB case finding approach, and it was 31.0 (12.1) years for patients detected through a passive TB case finding approach. More women were enrolled under an active TB case finding approach (61.7%; 37 of 60 patients) than under a passive TB case finding approach (48.3%; 29/60). Regarding literacy, 71.7% (43/60) of the smear-negative chronic coughers and 50% (30/60) of the TB patients were illiterate. The majority of study participants (88.3%; 53/60) of the smear-negative chronic coughers and 75% (45/60) of the TB patients were married. Characteristics like marital status, education, occupation, type of health facility visited showed variation among the two groups (Table 1).

Cost

The mean (SD) of patients' health facility travel times was 4.4 (1.2) days for peoples involved under active TB case finding approach and 4.4 (1.0) days for patients involved under passive TB case finding modality. Smear-negative chronic coughers frequently travelled to health posts 52/99 visits (52.5); while patients under the passive TB case finding modality frequently travelled to health centers 60/135 visits (44.4% of the total visit). Total patient cost (direct and indirect cost) was higher under an active TB case finding approach (USD 19.7) than under a passive TB case finding approach (USD 18.8). Total caretakers cost under active TB case finding approach was less costly (USD 7.7 vs. 8.0). Overall patient and caretaker costs under an active TB case finding approach was lower than under a passive TB case finding approach (USD 27.4 Vs 27.6). Program costs, which includes costs such as salaries, running costs and capital investment costs, for active case finding approach was lower (USD 582 vs. 681) Table 2.

Effectiveness

Under the active TB case finding scheme, 713 smear-negative chronic coughers were successfully followed for 10 months and 23 (3.1%) developed PTB+, while under passive TB case finding modality, 19,469 people were followed for the same duration and 15 PTB+ cases could have been detected. Community-based follow-up of smear-negative chronic coughers was effective in detecting more PTB+ cases than the routine facility-based passive TB case finding.

Table 1 Characteristics of Study Participants

Characteristics	Active Case Finding N° (%)	Passive Case Finding N° (%)	P-value
Age, mean (SD)	45.5 (18.4)	31.0 (12.1)	
Sex			0.14
Male	23 (38.3)	31 (51.7)	
Female	37 (61.7)	29 (48.3)	
Marrital status			0.02
Single	5 (8.3)	15 (25.0)	
Married	53 (88.3)	45 (75.0)	
Widowed	2 (3.3)	0 (0)	
Education			0.05
No education	43 (71.7)	30 (50.0)	
Primary education	14 (23.3)	25 (41.7)	
Secondary education	3 (5.0)	5 (8.3)	
Occupation			0.03
Farmer	19 (31.7)	19 (31.7)	
House wife	35 (58.3)	24 (40.0)	
Student	6 (10.0)	12 (20.0)	
Merchant		5 (8.3)	
Type of health facility visited			< 0.00
Health post	52 (52.5)	33 (24.4)	
Health center	33 (33.3)	60 (44.4)	
Traditional healer	0 (0)	21 (15.6)	
Hospital	10 (10.1)	4 (3)	
Other	4 (4)	17 (12.6)	
Total	99 (100)	135 (100)	
Patients health facility visit times, mean (SD)	4.4 (1.2)	4.4 (1.0)	
Patient transport time, mean (SD)*	176.1 (106.9)	177.3 (47.7)	
Caretaker accompanied patient times, mean (SD)*	1.7 (0.9)	2.3 (0.8)	
Caretaker transport time spent, mean (SD)*	83.9 (77.6)	91.4 (34.0)	

Note: *Time in minutes.

Abbreviation: SD, standard deviation.

Cost-Effectiveness

Program costs per successfully detected TB cases was USD25.3 under an active TB case finding approach and USD 45.5 under passive TB case finding approach. Patient and caretaker costs per successfully detected TB cases were lower under active TB case finding approach than

Table 2 Average Cost per Patient in USD for TB Case Finding Modalities

Characteristics	Active Case Finding		Passive Case Finding	
	Quantity	Mean Unit Price	Quantity	Mean Unit Price
Running cost	60	222.8	60	248.0
Salaries	60	330.1	60	389.1
Capital investment	60	29.6	60	44.6
Total program cost	60	582.5	60	681.8
Patient direct cost	45	12.4	60	10.8
Patient indirect cost	60	7.3	60	8.0
Total patient cost	60	19.7	60	18.8
Caretaker direct cost	22	4.9	21	3.9
Caretaker indirect cost	27	2.8	21	4.1
Total caretaker cost	27	7.7	21	8.0
Total patient and caretaker cost	60	27.4	60	27.6
Research cost	713	3.7	60	0.0
Total cost	60	613.6	60	708.6

Abbreviation: USD, United States Dollar.

under passive TB case finding approach (USD 0.9 vs. 1.3) and (USD 0.3 vs. 0.5), respectively (Table 3). Total cost per successfully detected TB cases for the whole duration was USD 26.7 under active TB case finding approach and USD 47.2 under passive TB case finding approach. In a short term follow up (4 months or 7 months), the cost per successfully detected TB cases under passive TB case

Table 3 Cost-Effectiveness of Community-Based Follow-Up of Chronic Coughers

Expenditure	Active Case Finding	Passive Case Finding
Program cost	25.3	45.5
Patient cost	0.9	1.3
Caretakers cost	0.3	0.5
Research cost	0.2	0.0
Overall CER	26.7	47.2

Abbreviation: CER, cost effectiveness ratio.

Table 4 Cost-Effectiveness of Community-Based Follow-Up of Chronic Coughers in Different Phases of the Cohort

Time	Active Case Finding				Passive Case Finding			
	PTB+ Cases	Cost	CER	CCER	PTB+ Cases	Cost	CER	CCER
4 months	8	245.44	30.7	30.7	3.5	283.4	81.0	81.0
7 months	8	184.08	23.0	15.3	2.5	212.6	85.0	82.7
10 months	7	184.08	26.3	26.7	9	212.6	23.6	47.2
Total	23	613.6	26.7	26.7	15	708.6	47.2	47.2

Abbreviations: CER, cost effectiveness ratio; CCER, cumulative cost-effectiveness ratio.

finding modality was about three times higher than the cost per successfully detected TB cases under active TB case finding approach (see Table 4).

Sensitivity Analysis

The sensitivity analysis showed that an active TB case finding approach was found to be cost-effective compared to the passive approach on varying estimates of different cost items (Table 5).

Discussion

According to the cost-effectiveness analysis, the strategy community-based follow-up of smear-negative chronic coughers, could be classified as a less costly and highly cost-effective approach of TB case finding. This was true particularly from the perspectives of care takers cost and program cost. Compared to passive TB case finding, community-based follow-up of smear-negative chronic coughers was cost-effective approach of TB case finding by 23.7% from the perspective of program cost, by 46.2% from the perspective of patient cost and by 40% from the perspective of caretaker cost.

Moreover, the new approach was highly cost-effective when the duration of follow-up is minimized to 7 months or less. This could be due to more TB cases being detected in the early phase of the follow-up than in the later phases. The number of patients diagnosed with TB reduces as time goes. Therefore, persistency of cough among majority of chronic coughers, as the follow-up duration increases is most likely related to other chronic disease than TB. This finding suggests us follow-up of chronic coughers for 7 months or less is a relatively better duration in terms of the cost and the cost-effectiveness.

The low number of times patients visit health facilities and a decreased in the distance where patients go for the diagnosis of TB under community-based follow-up of smear-negative chronic coughers approach were the main reasons for the present finding. Patients under smear-

Table 5 Variation in Cost-Effectiveness Ratio Upon Changes of Input Variables

	Input Values		CER ACF		CER PCF	
	Min	Max	Min	Max	Min	Max
Patient direct cost*	0	81.3	0.0	35.3	0.0	54.2
Patient indirect cost*	3.2	15	1.4	6.5	2.1	10.0
Caretaker direct cost*	0.5	34.3	0.2	14.9	0.3	22.9
Care take indirect cost*	1.6	8	0.7	3.5	1.1	5.3
Discount rate	0	0.03	82	84.5	168.6	173.7
Case detection rate**	28.8	57.2	12.5	24.9	19.2	38.1

Notes: Minimum and maximum costs for patients and caretakers are taken from the data. Discount rate = 3%. *CER* 10 for these variables. **Case detection rate=23/56 for CCFU and 48.4% for PCF.

Abbreviations: CER, cost effectiveness ratio; ACF, active case finding; PCF, passive TB case finding.

negative chronic coughers' follow-up approach visited health facilities 99 times while patients under passive TB case finding approach made a total of 135 facility visits. In this study majority of patients under follow-up of smear-negative chronic coughers approach went to health posts (52.5%), which is located in their community. While under passive TB case finding approach majority of patients went to the health centers (44.4%). In rural settings of southern Ethiopia, most health centers are located further away than health posts. In agreement to the current study, some studies reported that community-based approaches of TB care improved accessibility of TB care facilities to the people, thus it minimized the costs incurred on them for transport and other indirect costs.^{20,21}

In this study, the mean patient transport time was nearly the same under the two methods of TB case finding. Also, the mean caretakers transport time spent had small difference between the two approaches. The number of times smear-negative chronic coughers went to hospitals was 10 times (10.1% of the whole visits) while similar figures for patients under a passive TB case finding approach was 4 times (3% of the whole visits). The higher SD of this variable under chronic coughers' follow-up approach supports our explanation for it. This may also be the reason for the caretakers' direct cost are higher under the chronic coughers' follow-up approach. Caretakers of patients who went to these hospitals might have had higher expense.

Despite the difference in their methodology, other studies also showed the cost-effectiveness of community-based TB case findings.^{21–27} The cost-effectiveness analysis differs from previous studies done for TB in that the comparison was community-based follow-up of smear-negative chronic coughers with the conventional passive TB case findings. Follow-up visit for smear-negative chronic coughers was carried out every 3 to 4 months. This gap may be too wide and

made some PTB+ cases may be missed in the surveys and diagnosed by another project that was carried out in the study area.²⁸ Based on this, the author suggests that reducing the time of follow-up to every 2–4 weeks is better to catch all the PTB+ cases in the follow-up and limit the transmission of TB within the communities. This may improve the cost-effectiveness more than has been seen in the current study. In the TBREACH project they did follow-up visits every 2–4 weeks for each smear-negative chronic cougher they saw for the first time.²⁸

Strengths and Limitation

One of the strengths of this study is that it included both the direct and indirect costs. In economic analysis, considering both the direct and indirect costs is more informative to policymakers to plan for a wider section of the community. Another strength was that program cost data was obtained from all health facilities that patients attended and the district health office. This minimized information bias which could occur if selected facilities were included in the study. A limitation seen in this study is that the investigator did not carry out adjustment of costs collected in two different periods for the two groups of patients. However, the interval between the two data collection periods was small (only two years) and the change in costings was low between the two data collection periods. Moreover, an official exchange rate of ETB to USD for each data collection period was considered in the analysis.

Conclusion

Community-based follow-up of smear-negative chronic coughers has lower cost and higher cost-effectiveness, which could help in improving PTB+ case detection in rural communities of southern Ethiopia. This implies that

with the same level of resources, more smear-positive TB patients could be detected in a community-based follow-up of smear-negative chronic coughers. The cost benefit obtained could be even higher when the follow-up duration is reduced to 7 months or less. However, increasing the frequency of follow-up to every 2–4 weeks could help in early diagnosis of the PTB+ cases, which could limit transmission of the disease in communities. The author believes that the finding of this study could be applicable in similar settings in Ethiopia or in other high TB burden countries. In addition to the passive TB case finding approach, chronic coughers follow-up could be implemented to early detect TB cases as it is a less costly and cost-effective method. Chronic coughers' follow-up could save costs and lives.

Abbreviations

DOTS, Directly Observed Treatment Short course; HEWs, health extension workers; TB, tuberculosis; PTB+, smear-positive TB.

Data Sharing Statement

Data could be obtained from the author on request.

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Author Contributions

EMW made a significant contribution to the work reported, including the conception, study design, execution, acquisition of data, analysis and interpretation,; drafting, revising and critically reviewing the article; gave final approval of the version to be published; has decided on the journal to which the article has been submitted; and agrees to be accountable for all aspects of the work.

Disclosure

The author reports no conflicts of interest for this work.

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