Magnitude and determinants of delay in diagnosis of tuberculosis patients in Ethiopia: a systematic review and meta-analysis: 2020

Getahun Fetensa1,2*, Desalegn Wirtu3, Belachew Etana3, Tadesse Tolossa3 and Bizuneh Wakuma1

Abstract

Background: Tuberculosis (TB) remains a major public health concern in the world resulting in significant morbidity and mortality as well as in Ethiopia. In Ethiopia, there are various primary studies with inconsistent findings. Delay in the diagnosis of TB is determined by different factors like the type of TB, marital status, TB-HIV co-infection, employment status, place of residence, educational status, type of first visited a health facility, and gender of the patient. This review will produce pooled evidence on delay in diagnosis and associated factors among TB that might have huge public health impacts, like unfavorable treatment outcomes, increase transmission of the disease in the community for better intervention.

Methods: The presence of systematic reviews and meta-analysis on similar topics was checked and the topic was registered on PROSPERO to prevent duplication with the registration number of (CRD42020158963). Both published and unpublished studies conducted in Ethiopia from 2002 to April 1 2020 were searched thoroughly using electronic databases. Data were analyzed using STATA version 14. Heterogeneity was checked by using I² and Cochrane Q test. In the presence of heterogeneity, a random effect model was employed to estimate the pooled magnitude and determinants of diagnosis delay of TB. Publication bias was checked by using the graphical funnel plot and Egger’s statistical test.

Result: The Pooled magnitude of tuberculosis diagnosis delay in Ethiopia was 45.42% [95%CI 34.44, 56.40]. Residing in urban, having educational status and patients with positive serostatus were protective against TB diagnostic delay while having extra-pulmonary TB and not being married were risk factors for delaying TB diagnosis.

Conclusion: TB diagnosis delays in Ethiopia are significantly high. Sociodemographic and institutional factors were significantly contributing to the delay. Therefore, national TB control programs need to identify and address gaps, barriers, and weaknesses along the entire patient care cascade, to improve appropriately.

Keywords: Tuberculosis, Delay in diagnosis, Ethiopia

Background

Tuberculosis is a major public health problem worldwide [1–3]. Globally, 7.0 million new cases of TB notified in 2018 an increase from a number of the case reported 6.4 million in 2017. It is a large increase in the number of cases notified from the years 2009 to 2012 [4]. Although due to improved disease prevention and management, and service delivery; nevertheless, up to 10 million people continue to fall ill with TB every year. In 2017, a significant number of new TB cases were reported globally [1–3, 5]. Due to this, it remains a main public health concern in the world resulting in significant morbidity and mortality [1, 6–10]. As it can spread through the air as
well as by personal contact with individuals affected with the disease [11]. There is success related to the incidence and mortality related to TB, its incidence was falling by 20% between 2000 and 2015. However, death-related TB remains high, with 1.8 million deaths in 2015 alone [12]. Forty percent of TB cases in Africa are under-diagnosed or under-reported [13]. Ethiopia accounts for 3% of the annually 3 million missed people with TB by the global health system, which was estimated to be 35%(56,164) of incident TB cases were missed in 2016 [6]. Tuberculosis is the main reason for illness, the third cause of hospital admission (after deliveries and malaria), and the second cause of death in Ethiopia, after malaria [10].

Ethiopia could not achieve an on-time diagnosis. The problem is contributed from different factors like inadequacy of resources for TB case finding such as a shortage of healthcare providers, inadequate basic infrastructure, and inadequate diagnostic equipment and supplies [13, 14].

It is important that healthcare providers have to be sufficiently familiar with the basic principles of TB diagnosis and care, to ensure early case identification and prompt referral to specialized centers for treatment initiation and follow-up [15].

Delays in diagnosis of tuberculosis patients have several public health impacts in the patients as well as in the community and country as a whole [1, 16]. It is significantly higher within extra-pulmonary than among those with pulmonary TB [17].

In Ethiopia evidence indicates that the proportion of tuberculosis patients who had delayed diagnosis was 59.9% [16, 18]. Delays in diagnosis were significantly longer for patients who attended a non-TB facility first, and even longer for those who failed to follow the physician’s recommendation to seek care at a TB facility [1, 19]. Delays in tuberculosis (TB) diagnosis is the main barrier to the effective management of the disease [20]. World Health Organization had made different efforts

---

**Fig. 1** PRISMA flow diagram of included studies in the systematic review and meta-analysis of determinants of delay in diagnosis and treatments of tuberculosis patients in Ethiopia, 2020: systematic review and Meta-analysis
to narrow gaps in TB detection and treatment, in 2018 through an initiative called to find to achieve estimates that at least 30 million people will be eligible for TB preventive treatment between 2018 and 2022 [21].

Diagnosis of Tuberculosis employs the use of various diagnostic methods. Under certain circumstances this may not be achieved due to either lack of literate workforce or facility in 2016, an estimated 35% of incident TB cases were missed in Ethiopia [6, 22]. On another way, most of the laboratory tests employed in Ethiopia are based on direct smear microscopy, which is insensitive and can only detect 36% of tuberculosis
cases which can contribute to delay of TB to some extent [23].

Delay in the diagnosis of TB, which leads to under-reporting of detected cases, and under-diagnosis. This can mislead policymakers and clinicians in managing tuberculosis [1, 3]. In another way, fear of stigma towards TB can also lead to delay in health care seeking [24, 25]. In-country like Ethiopia, the effect is very high as the point prevalence estimate (per 100,000) of undiagnosed smear-positive Pulmonary Tuberculosis (PTB) included was 79.7% [26]. TB prevalence is not only the factor to cause to cavitation of the lung tissue, but also delays in health-care-seeking can do so. Ninety percent of lung degradation occurs with a delay of more than 30 days [27, 28].

Studies have indicated different factors associated with a diagnosis of TB. Even if some evidence indicates, the burden of TB is higher in men than in women [29]. However another result reveals that the female gender is one of independent predictors for not seeking diagnosis and treatment for tuberculosis as a mixed-method study from India indicates [19, 21, 30–32]. Rural areas patients were more likely to have experienced delayed diagnosis [33].

Furthermore, characteristics of TB patient and characteristics of the diseases also associated with timely diagnosis of TB. Study indicated that family and patient knowledge about the disease decreases a delay in diagnosis [24, 34]. In another way, new patients were about three times more likely to come late for TB diagnosis as compared with those who had the previous history of treatment [16]. The result from England also reveals that extra-pulmonary TB disease is significantly associated with longer diagnostic delays [32]. Smear-positive patients experienced longer delays in seeking care but shorter diagnostic delays [19].

There are primary studies in Ethiopia that show the level of diagnosis delay with inconsistent results and factors. However, there is a need to pool the finding of these studies for decision-makers and health care programs to indicate the over level of delay in the country. Therefore, this study was done to review existing evidence through systemic review and pool the delay in magnitude using systemic review and meta-analysis.

Methods

Search strategy

This systemic review and meta-analysis were conducted to assess delays in the diagnosis of tuberculosis patients and determinant factors in Ethiopia. We checked the presence of systematic reviews and meta-analysis on this topic and the topic was registered on PROSPERO.
Table 1  Abstraction of studies included in determining the prevalence of diagnostic Delay among Tuberculosis patients in Ethiopia, 2020: systematic review and Meta-analysis

| no | Author            | Year of publication | study design     | Region      | Study Area                                | sample size | Prevalence | Delayed diagnosis cases | Median delay in days | NOS |
|----|-------------------|---------------------|------------------|-------------|-------------------------------------------|-------------|------------|------------------------|---------------------|-----|
| 1  | Abdulbasit H. et al. [52] | 2015               | Cross-sectional | Oromia      | Asella, Robe and Abomsa of Arsi zone     | 362         | 48.9(43.75,54.01)   | 177                    | 40                  | 10  |
| 2  | Mengiste M. et al. [53] | 2010               | Cross-sectional | Tigray      | Ten districts of Tigray region            | 924         | 11.69(9.62,13.76)   | 108                    | 30                  | 9   |
| 3  | Melashu B. et al. [54] | 2019               | Cross-sectional | Amhara      | North shoa                               | 162         | 59.88(52.33,67.42)  | 97                     | 53.2                | 9   |
| 4  | Fentabil G. et al. [31] | 2019               | Cross-sectional | Somali      | Four Hospitals in Somali                  | 434         | 56.68(52.02,61.34)  | 246                    | 49                  | 9   |
| 5  | Senedu B. et al. [55] | 2016               | Cross-sectional | Amhara      | West Gojam                                | 706         | 55.81(52.14,59.47)  | 394                    | 22                  | 10  |
| 6  | Terefe G. et al. [56] | 2018               | Cross-sectional | SNNPE       | Hadiya Zone                               | 395         | 58.23(53.36,63.09)  | 230                    | 30                  | 8   |
| 7  | Workineh B. et al. [57] | 2017               | Cross-sectional | Harar town  | Harar town                                | 280         | 50.00(44.14,55.56)  | 140                    | 21                  | 7   |
| 8  | Meaza D. et al. [51] | 2002               | Cross-sectional | AA          | Addis Ababa city                          | 700         | 9.57(7.39,11.75)    | 67                     | 60                  | 10  |
| 9  | Mihret A. et al. [58] | 2017               | Cross-sectional | Amhara      | Addis Ababa city                          | 605         | 53.39(49.41,57.36)  | 323                    | 45                  | 8   |
| 10 | Solomon A. et al. [59] | 2014               | Cross-sectional | Amhara      | Bahirdar City                             | 201         | 45.77(38.88,52.67)  | 92                     | 27                  | 10  |
| 11 | Mulugeta B. et al. [50] | 2012               | Cross-sectional | Afar        | Addis Ababa city                          | 216         | 50.00(45.33,56.67)  | 108                    | 70.5                | 8   |
| 12 | Fentabil G. et al. [28] | 2019               | Cross-sectional | Somali      | SNNPE and Amhara                          | 442         | 48.87(44.21,53.53)  | 216                    | 50                  | 9   |
| 13 | F Ambabawi et al. [60] | 2019               | Cross-sectional | SNNPE and Amhara | SNNPE and Amhara | 592 | 41.72(37.75,45.70) | 247                    | 84                  | 9   |
| 14 | Seyoum Dejen e[61] | 2002               | Cross-sectional | Somali      | SNNPE and Amhara                          | 126         | 68.84(61.83,77.85)  | 88                     | 171                 | 7   |
| 15 | Dame T. et al. [62] | 2018               | Cross-sectional | Oromia      | Mettu Town                                | 87          | 17.24(9.30,25.18)   | 15                     | NR                  | 7   |
| 16 | Robel Y. et al. [63] | 2017               | Case-control    | Oromia      | Arsi zone, Seru                          | 8716        | 50.009463(43.54,66) | 358                    | 15                  | 9   |

NOS Newcastle-Ottawa Scale
to prevent duplication (CRD42020158963). Both published and unpublished studies conducted from 2002 to April 1, 2020 were searched thoroughly using electronic databases such as Medline, Embase, Hinari, Pub Med, Cochrane library, the Web of Science, and Google Scholar using the key terms “Tuberculosis” “magnitude of TB” prevalence of TB” TB treatment delay” “delay in TB diagnosis” “associated factors”, determinants”, Ethiopia”. To find unpublished papers, some research centers, including the Digital Library of universities in Ethiopia were searched. All articles published and unpublished until April 1, 2020, were as included.

Pre-defined search terms were used to enable a comprehensive search strategy that included all the relevant studies. All fields within records and Medical Subject Headings (MeSH terms) were used to expand the search in advanced Pub Med search. The search strategy was prepared and modified for the various databases using important Boolean operators with initial keywords “(((prevalence, TB treatment/diagnosis delay) OR magnitude, TB treatment/diagnosis delay) AND associated factors, TB treatment/diagnosis delay) OR determinants, TB treatment/diagnosis delay) AND TB treatment/diagnosis delay) AND Ethiopia”.

The meta-analysis was reported using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline [35]. Literature were downloaded to Endnote (version X7.2,) to maintain and manage citation and facilitate the review process.

### Selection and eligibility criteria

This systematic review and meta-analysis included studies that were conducted on the delay in the diagnosis of tuberculosis patients and determinant factors. This review considered all observational study designs, which reported the delayed diagnosis and associated factors of tuberculosis that were written in the English language. This review included studies conducted only in Ethiopia and a master’s thesis from grey literature. There were no limits on the studies by sample size. We had excluded articles, with studies with low-quality assessment scale due to methodological problems. Studies with multi-drug resistant TB were excluded. Studies conducted before 2002 were excluded due to the fear of result distortion of finding (Fig. 1).

### Outcome measurement

This systematic review and meta-analysis have four main outcomes. The primary outcome of review was the delay in diagnosis of tuberculosis, which was estimated as the total number of patients with delay in TB diagnosis cases divided by the total number of TB patients multiplied by 100%. The other outcomes was determinant factors of delay diagnosis among tuberculosis patients, which was determined in the form of odds ratio and calculated, based on the binary outcome from the included primary studies. The major factors were identified after reviewing all primary articles.

![Sensitivity analysis on TB diagnosis delay in Ethiopia 2020: systematic review and Meta-analysis](image_url)

**Fig. 5** Sensitivity analysis on TB diagnosis delay in Ethiopia 2020: systematic review and Meta-analysis. Legend: X-axis indicates the estimated contribution of individual papers and within the region. Y-Authors of the primary studies and years of publication.
Quality assessment and data extraction
The citation management software (Endnote version X7.2) was used to combine database search results and to remove duplicate articles manually. Newcastle-Ottawa Scale (NOS) adapted for cross-sectional studies was used for quality assessment. Data were extracted by GF and checked by TT using standardized data extraction checklists on Microsoft excel. For the first outcomes (delay in diagnosis), the data extraction checklist included the title, author name, year of publication, region, study design, sample size, number of the subject with the outcome. For the third and fourth outcomes (determinant factors), data were extracted in a format of two-by-two tables, and then the log odds ratio for each factor was calculated based on the findings of the original studies. Discrepancies between two independent reviewers were resolved by after discussion for the consensus.

Statistical analysis and synthesis
A systematic review was conducted to compare and contrast as well as to describe results from the primary studies. While the meta-analysis data were analyzed using STATA version 14. The logarithm and standard error of the odds ratio (OR) for each included study were generated using the “generate” command in STATA.

Assessment of heterogeneity
Heterogeneity was evaluated using the Q test and inverse variance index ($I^2$). The random effect model was used for analyses to estimate the pooled effect of delay in diagnosis of tuberculosis patients.

Publication bias
A funnel plot of asymmetry was used to check the presence of publication bias. Furthermore, Egger statistical test was used to check the statistical significance of publication bias, and the I-squared statistic ($I^2 = 100\% \times (Q-df)/Q$). For the Q test, a $P$-value of 0.10 or less was considered statistically significant, indicating marked heterogeneity among studies. I2 is a relative measure. It compares the variation due to heterogeneity ($r^2$) to the total amount of variation in a ‘typical’ study ($r^2 + \epsilon^2$), where $\epsilon$ is the standard error of a typical study of the review [36]. For subgroup analysis, the heterogeneity within groups was tested.
using the same statistical methods. A subgroup analysis was conducted by region (the area where studies were conducted).

**Ethical consideration**
Not applicable. Because the author used articles that were already secured ethical issues in Ethiopia.

**Operational definition and definition of terms**
Diagnostic delay: time interval between the onset of symptoms and labeling of the patient as a tuberculosis patient (tuberculosis diagnosis) [4, 37] (Fig. 2).
Patient delay will be measured using patients’ recall of first TB symptoms as the starting point, (usually described as the onset of a persistent cough) and the date of the first health facility consultation as the endpoint [4, 20, 37].
Health care system delay: time interval between the date of health-seeking behavior at a health care provider and the initiation of anti-tuberculosis treatment [4, 37].

**Result**

**Result for delayed diagnosis of tuberculosis in Ethiopia**
A systematic search of electronic databases and library catalogs identified a total of 764 published articles and four unpublished studies. A total of 16 studies with a sample size of 6948 were included to determine the pooled prevalence of diagnostic delay of tuberculosis patients in Ethiopia. Of these studies five of them were conducted in the Amhara regional state [38–42] and three of them in the Oromia regional state [43–45]. Another of two studies were conducted in SNNPE [42, 46] one in Tigray regional state [47], one in Harari Regional state [48], One in Somali regional state [49], one study in Addis Ababa city administration, one study conducted in two regions of the country and one in Afar regional state [50] (Fig. 1). Accordingly, the pooled prevalence of tuberculosis diagnosis delay in Ethiopia is 45.42% at [95% CI 34.44, 56.40] (Fig. 3. The presence of publication bias was checked and indicated the funnel plot (Fig. 4). The median diagnosis delay for the included study was 45 days. A maximum prevalence was observed in the Somali region 68.84 at [95% CI 61.83,
while the minimum prevalence was in Addis Ababa city 9.57 at [95%CI 7.39, 11.75] [51] (Table 1).

Sensitivity analysis
Sensitivity analysis was looked for variables included to identify TB diagnostic delay for identifying the presence of any outliers of a single study influence on the overall meta-analysis, it was conducted using a random-effects model, and the result reveals that there was no evidence for the effect of a single study on the overall meta-analysis result (Fig. 5).

Subgroup analysis
Subgroup analysis was conducted based on the regions in which the studies were conducted to reduce the possible random disparity between studies. The maximum prevalence was observed in SNNP 58.23 at 95% CI (53.36, 63.09), while the minimum prevalence was observed in Addis Ababa 9.57 at 95% CI (7.39, 11.75) (Fig. 6).

Determinants of delay in diagnosis
Type of TB and delay in diagnosis of TB
Patients with extra-pulmonary TB are 2.27 more likely to delay diagnosis of tuberculosis when compared with patients with pulmonary TB at (OR = 2.27, CI: 1.77, 2.91). Four studies out of 16 studies were included to look association between type of TB and delay in diagnosis [38, 39, 42, 50]. All studies were significantly associated independently (Fig. 7).

Marital status and delay in the diagnosis of TB
Four studies were included to compute the association between marital status and delay in the diagnosis of tuberculosis for the final meta-analysis [39, 41, 42, 48]. A random-effect model was used to estimate the pooled association between marital status and delay in diagnosis of tuberculosis (I² 44.1%, P = value <0.147). Among included studies, three of them have significant association with delay in diagnosis of TB [41, 42, 48] while one of the included did not have significant association [39]. The pooled result of the analysis indicates that unmarried individuals were 1.91 more likely to delay the diagnosis of tuberculosis (OR = 1.91, CI: 1.41, 2.59) (Fig. 8).

HIV status and delay in the diagnosis of TB
Four studies were utilized to analyze association between HIV Sero-status and Delay in the diagnosis of TB [39, 40, 42, 48]. The pooled indicates that the odds of not...
delaying TB diagnosis is 88% more likely for people living positively when compared with their counterparts 95% (OR = 0.12, CI: 0.09, 0.15) (Fig. 9).

**Patients employment and delay in diagnosis of TB**
Four studies were included to check the association between employment status and delay in diagnosis of TB [39–41, 48]. Two of the included were not significantly associated with a delay in diagnosis of TB [40, 48], but two of them were significantly associated [39, 41]. However, the pooled reveals that there is no significant association between delay in diagnosis of TB and employment status at (OR = 0.46, 95% CI: 0.17, 1.26) (Fig. 10).

**Place of residence and delay in diagnosis of TB**
Six studies were included to check the association between place of residency and Delay in the diagnosis of TB [39–42, 46, 48]. One of the included studies was not significantly associated [42], while the rest five of them were significantly associated. The pooled effect indicates urban residents were 68% times more likely to not delay a diagnosis of TB than Rural residents (OR = 0.32, 95% CI: 0.15, 0.67) (Fig. 11).

**Educational status and delay in diagnosis of TB**
Seven studies from all were included to check the association between educational status and Delay in the diagnosis of TB [40–42, 45, 46, 48, 50]. Three of the studies were significantly associated [41, 42, 48], while four of them were not [40, 45, 46, 50]. The pooled result of the analysis indicates that being educated lowers delay in diagnosis of TB by 35% times when compared with uneducated patients (OR = 0.65, 95% CI: 0.49, 0.87) (Fig. 12).
First visited health facility and delay in diagnosis of TB
Three studies were identified to assess the association between first visited health facilities and delay in diagnosis of TB [39, 40, 42]. Of the included studies two studies were significantly associated with a delay in diagnosis of TB [40, 42], while one of the studies [39] and the pooled included studies were not significantly associated with (OR = 0.95, 95% (0.42, 2.13) (Fig. 13).

Sex of respondents and delay in diagnosis of TB
Half of the identified studies were included to assess the association between sex and delay in diagnosis of TB [39–42, 45, 46, 48, 50]. Out of all studies, only one of them reveals significant association between delay in diagnosis and treatment of [41]. The pooled revealed there is no significant association between smear sex of respondents and delay in diagnosis of TB (OR = 0.89, 95% CI: 0.77, 1.03) (Fig. 14).

Discussion
The Pooled prevalence of tuberculosis diagnosis delay in Ethiopia was 45.42%. This result is higher than the findings from Shenzhen of China 27.8% [19] and England (34.0%) [32]. This significant prevalence of TB diagnostic delay implies as innovative diagnostic platforms for effective response in Ethiopia are needed urgently [64], As it can speed up disease prognosis at the individual level and increase communicability of disease within the society [54] However, this result is lower than the study results from Uganda [59], Kenya [55], Pakistan [58], and Brazil, Sao Paulo [60]. This is because accessibility and health care facility of this country is different.

In another way in the current study evidence suggested that the median diagnosis delay was 45 days. Which is lower than the study result from, Angola 64 days [52], While it is lower than the study result from Kenya 37.3 days [62], India 31 days [63].
Improving current diagnostic and therapeutic practices will supplement the WHO end-TB Strategy launched post-2015 [15].

In the current study, patients with extra-pulmonary TB are 2.27 more likely to delay diagnosis of tuberculosis as compared with patients with Pulmonary TB at (OR = 2.27, CI: 1.77, 2.91). This result is comparable to other similar studies that tuberculosis patients with extra-pulmonary site involvements were more likely to delay in seeking health service as compared with patients with only pulmonary site involvement [16, 53, 56]. This is consistent with study results from England [32] and Italy [17]. This implies that TB patients with extra-pulmonary TB need special attention from policymakers and clinicians because the time of delay in diagnosis increase with increases of pulmonary cavitation [16]. This finding strongly indicates that health professionals have to give special attention for patients with extrapulmonary TB to prevent further complications and transmission.

This study reveals that residing in the urban area lowers 68% risk of in delay diagnosis of TB than rural residents (OR = 0.32, 95% CI: 0.15, 0.67). This is consistent with studies conducted in Pakistan, England, and Chinese which states that patients from rural areas were more likely to have experienced delaying diagnosis [32, 33, 57]. This can be justified, as there is a difference in access to health care and awareness of early seeking health facility.

According to the current study, being educated lowers delay in diagnosis of TB by 35% when compared with
counterparts (OR = 0.65, 95% CI: 0.49, 0.87). This is consistent with the study result from Sao Paulo, Brazil [60]. This implies that educated peoples have good awareness in early diagnosis seeking and play a pivotal role in the prevention of communicable disease.

The result of analysis indicates that unmarried individuals were 1.91 more likely to delay diagnosis of tuberculosis (OR= 1.91, 95% CI: 1.41, 2.59). This might be due to the reality that lack of social support may lead to delay in health care seeking which can lead to delay in diagnosis [11].

In the current study, people living positively were 88% less likely not to delay in diagnosis of TB when compare with their counterparts (OR = 0.12, 95% CI: 0.09, 0.15). This is due to the fact that the WHO and TB Strategy gives a framework for TB and HIV programs to unite with each other and with other sectors to attain the sustainable development goals contributes for early detection of the case among people living positively [61].

### Study strengths and limitations

The Study have considered different inconsistent data from different part of Ethiopia, to come up with pooled data. On the top if this researchers have undergone robust analysis, which can be considered as strength. As the review was based only on articles conducted in the English language, it might overlook other articles. As well there is no single study with a diagnosis from two regions of Ethiopia (Gambella National Regional state and Benishangul Gumuz national regional state) that might lead to under representation of the region within the country.
Conclusions
The pooled result indicates that delay in TB diagnosis was still significantly high in Ethiopia. Factors like urban residence, having certain education and positive HIV serostatus were protective factors for TB patients’ delay in diagnosis. While having extrapulmonary TB unmarried and unmarried marital status were a risk factor for delayed diagnosis of TB.

For health facilities
- In a communicable disease like TB control program early diagnosis important is important in the prevention and control of TB. Strengthening health facilities for diagnosis of TB for patients indicating signs and symptoms during the visit is mandatory.

- Health facilities have to include education about TB for all patients seeking service as knowledge about TB has positive influences on diagnosis, paying special attention to female patients.

For health extension workers
Health extension workers have to include health education during their house-to-house visit as a health education program as it positively influences TB diagnosis.

For private health facility
Private health facilities must undergone thoroughly examination any of any patients with signs and symptoms of TB and to timely refer on time as well link them with appropriate diagnosing governmental facilities.
For the national TB control program
National TB control programs to have to provide sufficient and basic principles of TB diagnosis for health care providers to ensure early case detection and for follow-up including the private facility to their best.

Abbreviations
JBI-MAStARI: Joanna Briggs Institute Meta-Analysis of Statistics Assessment and Review Instrument; MeSH: Medical Subject Heading; NOS: Newcastle-Ottawa Scale; OR: Odds Ratio; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses; PTB: Pulmonary Tuberculosis; SDG: Sustainable Development Goals; TB: Tuberculosis; TB-SDG: Tuberculosis Sustainable Development Goals; US$: United State Dollar; WHO: World Health Organization.

Acknowledgements
Authors thank the authors of primary studies included within current study.

Authors’ contributions
GF*, DW, BE, TT, and BW involved in the design, selection of articles, data extraction, statistical analysis, and manuscript writing. GF, TT, and BW were involved in developing the initial drafts of the manuscript revising subsequent drafts. GF*, TT, and BE prepared the final draft of the manuscript. All authors read and approved the final draft of the manuscript.

Funding
No funding was obtained for this research work.

Availability of data and materials
All data generated or analysed during this study are included in this published article.

Declarations
Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declared that they have no competing interests.

Author details
1Department of Nursing, School of Nursing and Midwifery, Institute of Health Sciences Wollega University, Nekemte, Ethiopia. 2Department of Health, Behavior and Society, Institute of Health, Jimma University, Jimma, Ethiopia. 3Department of Public Health, Institute of Health sciences, Wollega University, Nekemte, Ethiopia.
References

1. Health, M.O., and N.I. Medicine. Weekly epidemiological report a publica-
tion of the epidemiology Unit.Ministry of health, Nutrition & Indigenous Medicine. Colombo: Ministry of Health Nutrition & Indigenous Medicine Sri Lanka, 2019.
2. WHO. WHO guideline on tuberculosis infection prevention and control. Geneva World Health Organization, 2019.
3. Organization, W.H. Global tuberculosis report. Geneva World Health Organization, 2018.
4. Diagnostic WH. treatment delay in tuberculosis. An in-depth analysis of the health-seeking behaviour of patients and health system response in seven countries of the eastern mediterranean region. Regional Officer for the Eastern mediterranean, Cairo: World Health Organization, 2006.
5. Odusanya OO, Babafemi JO. Patterns of delays amongst pulmonary tuberculosis patients in Lagos. Nigeria BMC Public Health. 2004;4(1):1–5.
6. Health, F.D.R.o.E.M.o., National Guideline for TB, DR-TB, and Leprosy in Ethiopia, F.D.R.o.E.M.o. Health, Editor. 2018. Addis Ababa, Ethiopia.
7. Visson, W. Technical guideline for tuberculosis (TB) and TB-HIV program implementation; 2017.
8. Africa, W.H.O.R.O.F. Framework for implementing the 'end TB strategy' in the African region 2016 - 2020. Geneva: World Health Organization, 2017.
9. Jiang Y, Cao B, Ohmagari N, Wu AH, Liu YX, Guo LP . Comprehensive understanding of health-seeking behaviour among pulmonary tubercu-
losis patients in China. Int J Tuberc Lung Dis. 2017;21(10):1094–9.
10. Ethiopia, F.M.o.H.o., Federal Ministry of Health Ethiopia Tuberculosis. Leprosy and TB/HIV prevention and control Programme; 2008. Ethiopia.
11. Tadesse S. Stigma against tuberculosis patients in Addis Ababa, Ethiopia. PLoS one. 2016;11(6):e0152900.
12. UK, K.P. Global economic impact of tuberculosis. UK; 2017.
13. Ereso BM, Yimer SA, Gradmann C, Sagbakken M. Barriers for tubercu-
losis case finding in Southwest Ethiopia: a qualitative study. PLoS One. 2015;10(3):e0120088.
14. Fund, T.G. Best practices on TB case finding and treatment reflections and lessons from west and Central Africa and beyond. Geneva: The Global fund, 2018.
15. Sulis G, Centis R, Sotgiu G, D'Ambrosio L, Pontali E, Spanelvano A, Mattielli A, Zumla A, Migliori GB. Recent developments in the diagnosis and management of tuberculosis. NPI primary care respiratory medi-
cine, 2016;2(6):1–18.
16. Getnet F, Demissie M, Worku A, Gobena T, Tschopp R, Girmachew M, Assefa G, Seyoum B. Delay in diagnosis of pulmonary tuberculosis increases the risk of pulmonary cavitation in pastoralist setting of Ethiopia. BMC Pulm Med. 2019;19(1):1-0.
17. Peri AM, et al. Determinants of patient and health care services delays for tuberculosis diagnosis in Italy: a cross-sectional observational study. BMC Infect Dis. 2018;18:690.
18. Getnet F, et al. Delay in diagnosis of pulmonary tuberculosis increases the risk of pulmonary cavitation in pastoralist setting of Ethiopia. BMC Pulm Med. 2019;19(1):1-0.
19. Xu X, et al. Delays in care seeking, diagnosis and treatment among pulmonary tuberculosis patients in Shenzhen, China. Int J Tuberc Lung Dis. 2013;17(5):615–20.
20. Cai J, Wang X, Ma A, Wang Q, Han X, Li Y. Factors associated with patient and provider delays for tuberculosis diagnosis and treat-
mist in Asia: a systematic review and meta-analysis. PLoS one. 2015;10(3):e0120088.
21. Storla DG, Yimer S, Bjune GA. A systematic review of delay in the diagnos-
sis and treatment of tuberculosis. BMC Public Health. 2008;8(1):1-9.
22. Gele AA, et al. Barriers to tuberculosis care: a qualitative study among Somali pastoralists in Ethiopia. BMC Res Note. 2010;3(86):1–9.
23. Dignaw AM, Tiruneh BZ. Laboratory diagnostic systems used in the diagnosis of tuberculosis in Ethiopia: a systematic review.Laboratory diagnostic systems used in the diagnosis of tuberculosis in Ethiopia: a systematic review. J Med Lab Diagn. 2014;5(2):14–21.
24. Shatil T, et al. What constitutes health care seeking pathway of TB patients: a qualitative study in rural Bangladesh. J Comput Intell S. 2019;9(4):300–8.
25. Osei E, Akweogo P, Binka F. Factors associated with DELAY in diagnosis among tuberculosis patients in Hoeho Municipality, Ghana. BMC Public Health. 2015;15(1):1-1.
26. Arega B, et al. Prevalence rate of undiagnosed tuberculosis in the community in Ethiopia from 2001 to 2014: systematic review and meta-analy-
sis. Arch Publ Health. 2019;7(33):1–7.
27. Abbara A, Collin SM, Kon OM, Buell K, Sullivan A, Barrett J, Corrah T, McGregor A, Hansel T, John L, Davidson RN. Time to diagnosis of tubercu-
losis is greater in older patients: a retrospective cohort review. ERU Open Research. 2019;5(4).
28. Getnet F, Demissie M, Worku A, Gobena T, Tschopp R, Girmachew M, Assefa G, Seyoum B. Delay in diagnosis of pulmonary tuberculosis increases the risk of pulmonary cavitation in pastoralist setting of Ethi-
pia. BMC Pulm Med. 2019;19(1):1-0.
29. People, U.A.F. Knowledge, evidence and learning for development end tuberculosis; 2018. UK AID from British people: Liverpool School of Tropical Medicine.
45. Yirgu R, et al. Determinants of delayed care seeking for TB suggestive symptoms in Seru district, Oromiya region, Ethiopia: a community based unmatched case-control study. BMC Infect Dis. 2017;17(292):1–7.
46. Fuge TG, et al. Patient delay in seeking tuberculosis diagnosis and associated factors in Hadliya zone, southern Ethiopia. BMC Res Notes. 2018;11(15):1–6.
47. Mesfin MM, Newell JN, Madeley RJ, Mirzoev TN, Tareke IG, Kifle YT, Gessessew A, Walley JD. Cost implications of delays to tuberculosis diagnosis among pulmonary tuberculosis patients in Ethiopia. BMC Public Health. 2010;10(1):1-9.
48. Bekana W, Sisay M, Baye Y. Evaluation of factors affecting patient delay in the diagnosis and treatment of TB among TB patients attending in Hiwot Fana Specialized University hospital, Harar, eastern Ethiopia. J Infect Dis Prev Med. 2017;5(1):1–7.
49. Dejene S. The role of the private health sector in tuberculosis control in Jijiga town, eastern Ethiopia, in Addis Ababa university: Addis Ababa University, 2002.
50. Belay M, Bjune G, Ameni G, Abebe F. Diagnostic and treatment delay among Tuberculosis patients in Afar Region, Ethiopia: a cross-sectional study. BMC Public Health. 2012;12(1):1-8.
51. Demissie M, Lindtjorn B, Berhane Y. Patient and health service delay in the diagnosis of pulmonary tuberculosis in Ethiopia. BMC Public Health. 2002;2(23):1–7.
52. Santos E, et al. Diagnosis delay of tuberculosis in the Huambo province, Angola. Pulmonology. 2018.
53. Bojovic O, Medenica M, Zivkovic D, Rakocевич B, Trajkovic G, Kisić-Tepavcević D, Grguerević D. Factors associated with patient and health system delays in diagnosis and treatment of tuberculosis in Montenegro, 2015–2016. PLoS One. 2018;13(5):e0193997.
54. Gupta K, Bansal A. Delay in diagnosis and treatment of tuberculosis - a review. NTI Bull. 2008;44(1&2):27–30.
55. Enos M, et al. Kenya tuberculosis prevalence survey 2016: challenges and opportunities of ending TB in Kenya. PLoS One. 2018;13(12):e0209098.
56. Zãoa I, et al. Why does it take so long? The reasons behind tuberculosis treatment delay in Portugal. Pulmon J. 2019;25(4):215–22.
57. Li Y, et al. Factors associated with patient, and diagnostic delays in Chinese TB patients: a systematic review and meta-analysis. BMC Med. 2013;11(56).
58. Ali U, Zubair UB, Ambreen A, Yousaf H, Kaleem F, Fatima K, et al. Delay in diagnosis of pulmonary tuberculosis: study of factors related to patients and health care system. J Microbiol Infect Dis. 2017;7:119–24.
59. Buregyeya E, Criel B, Nuwaha F, Colebunders R. Delays in diagnosis and treatment of pulmonary tuberculosis in Wakiso and Mukono districts, Uganda. BMC Public Health. 2014;14(1):1–0.
60. Sasaki NS, Santos MD, Vendramini SH, Ruffino-Netto A, Villa TC, Chillavalli-Neto F. Delays in tuberculosis suspicion and diagnosis and related factors. Revista Brasileira de Epidemiologia. 2015;18:809-23.
61. UNAIDS/PCB. Ending tuberculosis and aids a joint response in the era of the sustainable development goals. GenevaSwitzerland UNAIDS Programme Coordinating Board: UNAIDS, 2018. p. 1–44.
62. Kunjok DM, et al. Assessment of delayed tuberculosis diagnosis preceding diagnostic confirmation among tuberculosis patients attending Isiolo County level four hospital, Kenya. Pan Afr Med J. 2021;38(51).
63. Steerearmediddy CT, Qiri ZZ, Satyanarayana S, Subbaraman R, Pai M. Delays in diagnosis and treatment of pulmonary tuberculosis in India: a systematic review. Int J Tuberc Lung Dis. 2014;18(3):255-66.
64. World Health Organization. First WHO global ministerial conference: ending TB in the sustainable development era: a multisectoral response: 16–17 November 2017, Moscow, Russian Federation. InFirst WHO global ministerial conference: ending TB in the sustainable development era: a multisectoral response: 16–17 November 2017. Moscow: Russian Federation, 2017.

Publisher’s Note
Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Ready to submit your research? Choose BMC and benefit from:
• fast, convenient online submission
• thorough peer review by experienced researchers in your field
• rapid publication on acceptance
• support for research data, including large and complex data types
• gold Open Access which fosters wider collaboration and increased citations
• maximum visibility for your research: over 100M website views per year

At BMC, research is always in progress.
Learn more biomedcentral.com/submissions