Intestinal helminth co-infection and associated factors among tuberculosis patients in Arba Minch, Ethiopia

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Abstract

Background: Helminths affect the outcome of tuberculosis by shifting cell mediated immune response to humoral and by total suppression of the host immune system. On the reverse, Mycobacterium infection favors immune escape of helminths. Therefore assessing helminth co-infection rate and predisposing factors in tuberculosis patients is mandatory to set strategies for better case management.

Methods: Facility based cross-sectional study was conducted in Arba Minch to assess the prevalence and associated factors of intestinal helminths among pulmonary tuberculosis patients from January to August, 2016. A structured questionnaire was used to capture data about socio-demographic characteristics, clinical history and possible risk factors for intestinal helminth infections. Height and weight were measured to calculate body-mass index. Appropriate amount of stool was collected and processed by direct saline and formol-ether concentration techniques following standard protocols. All the data were analyzed using SPSS version 20.0.

Results: A total of 213 (57.3% male and 42.7% female) pulmonary tuberculosis patients were participated in the study. The overall co-infection rate of intestinal parasites was 26.3%. The infection rate of intestinal helminths account 24.4% and that of intestinal protozoa was 6.1%. Ascaris lumbricoides accounted the highest frequency of 11.3%. Living in rural residence (AOR = 3.175, 95% CI: 1.102–9.153, p = 0.032), Eating vegetables/fruits without washing or peeling off (AOR = 2.208, 95% CI: 1.030–4.733, p = 0.042) and having body-mass index <18.5 (AOR = 3.511, 95% CI: 1.646–7.489, p = 0.001) were associated with intestinal helminth infection.

Conclusion: The infection rate by intestinal helminths was 24.4%. Ascaris lumbricoides was the most prevalent helminth. Residence, habit of washing vegetables/fruits before use and body-mass index were associated factors with intestinal helminthiasis. Therefore health care providers should screen and treat TB patients for intestinal helminthiasis in order to ensure good prognosis.

Keywords: Helminth, Tuberculosis, Co-infection

Background

Tuberculosis (TB) remains one of the world’s major public health problems [1, 2]. Even if TB is slowly declining each year since 2000, death from the disease is still unacceptably high [1]. According to World Health Organization (WHO) report, about 10.4 million people developed TB and 1.4 million died from all forms of TB in 2015 globally. One quarter of the cases were in the African Region. Ethiopia is ranked 8th and 2nd among 22 TB-high burden countries of the World and Africa respectively. The incidence and mortality (excluding HIV related deaths) because of all forms of TB were 192 and 26/100,000 population, respectively in 2015. It remains one of the leading causes of mortality due to communicable diseases in Ethiopia [1].

Control of Mycobacterium tuberculosis (M. tuberculosis) infection is mainly dependent on the success of the interaction between innate and adaptive immune responses of the host. The cell mediated immunity mainly determines the disease outcome [3, 4]. In most immuno-competent
individuals, infected macrophages interact with both CD4+ and CD8+ T cells and control the infection mainly via T helper (Th) -1 type inflammatory response [4, 5]. Individuals whose immunity is suppressed or shifted to Th2 type are more susceptible to develop active infection and more acute morbidity. Malnutrition, diabetes mellitus, HIV, helminth infection, different forms of cancer and prolonged use of steroid drugs are among the factors which suppress/shift the immune response [4–6]. Helminths induce a strong Th2-type immune response characterized by production of cytokines like interleukin (IL) -4, IL-5, IL-9, and IL-13 and increased levels of circulating IgE antibodies and eosinophils [4]. Prolonged Th2 response is followed by activation and expansion of both natural and inducible regulatory T cells [6, 7]. All these immune-modulations favor survival, multiplication and dissemination of M. tuberculosis to develop active TB and the associated sequelae [8, 9]. Such independent immune-modulation by both helminths and M. tuberculosis determines the pathogenesis and outcome of both infections [10].

The geographical distribution of intestinal helminth infections and TB overlap substantially that co-infection in humans has been a major emerging public health problem in poorest regions of the world [3, 4, 11]. Strong association between active pulmonary TB (PTB) and helminthiasis has been shown from previous studies [3, 11, 12]. However the helminth species and rate of co-infection with PTB vary from place to place. Climate conditions, socio-demographic characteristics and living standards of the population are believed to determine the type of helminths existing in various TB endemic areas. This necessitates sufficient data to be collected about the co-infection rate and common co-infecting helminth species at different geographical settings; because the data will be an input for policy makers to modify TB case management protocols at local level based on the existing conditions. However very limited data is available in Ethiopia that is generated only from Gondar, Northwest Ethiopia [2–4, 13]. As to the best of our knowledge, no similar study has been conducted in southern Ethiopia so far.

On the other hand, the clinical significance and associated risk factors of helminths is more related to, and extensively studied in children. This is because of considering asymptomatic or sub-clinical level of morbidity in adults. However in adults with concurrent chronic diseases, helminthes behave aggressively to result in severe morbidity and even death [2]. Despite this, data about the infection rate and associated risk factors among adults is lacking in the study area. Therefore in this study, we have assessed intestinal helminth co-infection rate and associated factors among PTB patients in Southwest Ethiopia.

### Methods

#### Study design and area

Facility based cross-sectional study was conducted in selected TB clinics of Arba Minch town and Arba Minch Zuria district from January to August, 2016. Arba Minch is located 454 kms south of Addis Ababa. It is found at an altitude of 1200–1300 m above sea level with an average annual temperature of 29.7 °C and rain fall of 900 mm [14]. In the town, there is one hospital and two health centers. All the three institutions have TB diagnostic laboratories and treatment clinics. Arba Minch Zuria woreda is situated at average of 1285 m above sea level surrounding Arba Minch town [14]. There are seven health centers in the woreda giving routine health services including TB diagnosis and treatment.

#### Selection of study participants

Information about PTB patient flow at each governmental health institutions of Arba Minch town and surrounding rural district was collected first. Relatively, Arba Minch Hospital, two health centers in the town (Arba Minch health center and Shecha health center) and one health center in Arba Minch Zuria district (Shelle health center) were found to be with high PTB patient flow. Therefore, TB clinics in the above mentioned health facilities were purposively selected for data collection. Consecutive newly diagnosed and on treatment PTB patients who attended TB clinics during the study period and have given informed written consent were included in the study. Only PTB patients diagnosed based on the national diagnosis guideline and 15–65 years of age were recruited. Cases are diagnosed to be PTB patients if there is persistent (for ≥2 weeks) cough two sputum examinations reveal positive result for acid fast bacilli or one sputum examination is positive and chest x-ray result is suggestive for PTB.

Pregnant mothers, patients who have taken anti-helminth drug within three months before data collection and severely ill patients who are unable to respond to research questions were excluded from the study. Patients with other immunosuppressive chronic diseases were excluded by referring to their medical records. Under 15 age groups were also excluded aiming to assess intestinal helminth prevalence and associated factors among adolescents and adults. Patients above 65 years of age were not involved in the study as their immune response is expected to be weakened naturally.

#### Data collection

**Socio-demographic characteristics**

Nurses who are fluent speakers in the local language (Gamo) were trained for data collection. A pretested structured questionnaire administered through face to face interview was used to collect data about socio-
demographic characteristics and associated factors for intestinal helminth infection after translating to the local language. Clinical data was also collected by interview and from the patients’ log book.

**Anthropometric measures**
Body-mass index (BMI) is considered as the most suitable, objective anthropometric indicator of nutritional status of adults. To calculate BMI, measurements of height and weight were under taken by trained nurses following a standard procedure explained elsewhere [15]. According to the WHO definition, individuals with BMI < 18.5 are malnourished and those with BMI < 16 are severely malnourished [16].

**Laboratory methods**
An appropriate amount of stool sample was collected and delivered to Parasitology laboratories of Arba Minch hospital or Arba Minch University, college of medicine and health sciences teaching laboratory following standard collection and transportation protocols [17]. About 50 mg of stool was processed immediately after collection using direct saline method in order to identify mobile trophozoites of intestinal protozoa and larvae of *S. stercoralis*. One or two drops of normal saline were mixed with an approximate of 50 mg stool on a clean slide. A uniform suspension was made using an applicator stick and covered with a clean cover slip. The entire preparation was systematically screened using the 10× and 40× objective lenses for detection of protozoal trophozoites and cysts as well as helminth ova and larvae. The remaining stool was processed by the formol-ether concentration technique, which is considered as the most sensitive for most intestinal helminths and protozoan cysts. About 1 gm of stool was added to a clean 15 ml conical test tube containing 7 ml of 10% formal saline. The stool was gently suspended with the formal saline using applicator stick. The suspension was filtered through a sieve in to a second centrifuge tube. After adding 3 ml of diethyl ether, contents in the second tube were centrifuged at medium speed (2500 rpm) for 5 min. The supernatant was poured off and smear on a clean slide was prepared from the sediment and covered with clean cover slip. The preparation was examined in the same way as that of the direct saline method. Negative results were reported after assessing the whole smear under 10 x objective. Investigators supervised all aspects of data collection and laboratory procedures.

**Statistical analysis**
Data was edited, cleaned, entered and analysed using SPSS version 20.0. Descriptive statistics are calculated to describe the study population characteristics. Bivariate logistic regression is used to assess associations between categorical variables. Multivariate regression model then followed for variables with \( p \leq 0.25 \) in the bivariate analysis. Association between variables was considered statistically significant only if \( P \)-value <0.05 at 95% confidence level.

**Results**

**Socio-demographic and clinical data**
A total of 213 PTB patients participated in the study. Eighty six of them were from Arba Minch hospital while 69, 22 and 36 participants were recruited from Arba Minch, shecha and shelle health centres respectively. One hundred twenty-two (57.3%) were male and 91 (42.7%) were female participants. The highest number of participants, 136 (31%), belong to the age group 15–34 years old while the lowest number, 7 (3.3%), belongs to ≥55 years of age. Majority (92.0%) of the study participants commonly cook their food at home. Among those having frequent habit of eating raw vegetables/fruits, 136 (66.3%) wash or peel off before use. Most respondents, 204 (95.8%) and 210 (98.6%), often wash hands before meal and defecation respectively (Table 1).

Out of 213 participants, 24 (11.3%) had self-reported diarrhea within the last 3 months before this data was collected. Ten of them contracted the last diarrheal episode within the last two weeks. Two hundred nine (98.1%) were tested for HIV of whom 20 (9.6%) were positive. About one third (33.3%) were with BMI <18.5. During the time of interview, 200 (93.9%) of the participants have already started anti-TB treatment while the rest 13 (6.1%) were contacted as soon as diagnosed before the start of treatment (Table 2).

**Prevalence of parasites**
The overall co-infection rate of intestinal parasites was 26.3%. The prevalence of intestinal helminths account 24.4% and that of intestinal protozoans was 6.1%. Totally six helminths were detected among which *Ascaris lumbricoides* (*A. lumbricoides*) was with the highest frequency (24, 11.3%) followed by hook worms (18, 8.5%). *Giardia lamblia* (*G. lamblia*) and *Entamoeba histolytica* (*E. histolytica*) were the only intestinal protozoans detected from 10 (4.7%) and 4 (1.9%) participants respectively (Table 3).

**Factors associated with intestinal helminth co-infection**
Residence had significant association with intestinal helminth infection (\( p = 0.032 \)) that rural residents were 3 times more likely (AOR = 3.175, 95% CI: 1.102–9.153) to be infected than urban dwellers. According to the bivariate analysis model, respondents who commonly cook their food at home were 3 times more affected (95% CI: 1.119–8.429, \( p = 0.029 \)) than those who commonly get their food from hotel; but in the multi-variate analysis,
| Variables                                      | Frequency                   | Total no. of respondents |
|-----------------------------------------------|-----------------------------|--------------------------|
| Sex                                          |                             |                          |
| Male                                          | 122                         | 213                      |
| Female                                        | 91                          | 42.7                     |
| Age group                                     |                             |                          |
| 15–34                                        | 136                         | 63.8                     |
| 35–54                                        | 70                          | 32.9                     |
| 55–65                                        | 7                           | 3.3                      |
| Marital status                                |                             |                          |
| Single                                        | 115                         | 54                       |
| Married                                       | 98                          | 46                       |
| Educational level                             |                             |                          |
| Illiterate                                    | 60                          | 28.2                     |
| Primary and above                             | 153                         | 71.8                     |
| Residence                                     |                             |                          |
| Urban                                         | 166                         | 77.9                     |
| Rural                                         | 47                          | 22.1                     |
| Have/use latrine                              |                             |                          |
| Yes                                           | 182                         | 85.4                     |
| No                                            | 31                          | 14.6                     |
| <14 children live in the house                |                             |                          |
| Yes                                           | 64                          | 30                       |
| No                                            | 149                         | 70                       |
| Common food source                            |                             |                          |
| Cooked at home                                | 196                         | 92.0                     |
| Hotel                                         | 17                          | 8.0                      |
| Wash raw vegetables/fruit before use          |                             |                          |
| Often or always                               | 136                         | 66.3                     |
| Never or occasionally                         | 69                          | 33.7                     |
| Habit of eating raw meat                      |                             |                          |
| Often or always                               | 176                         | 82.6                     |
| Never or occasionally                         | 37                          | 17.4                     |
| Hand washing habit before meal                |                             |                          |
| Often or always                               | 204                         | 95.8                     |
| Never or occasionally                         | 9                           | 4.2                      |
| Hand washing habit after defecation           |                             |                          |
| Often or always                               | 210                         | 98.6                     |
| Never or occasionally                         | 3                           | 1.4                      |
| Water source for washing utensils             |                             |                          |
| Pipe                                          | 171                         | 80.3                     |
| River/lake/stream                             | 42                          | 19.7                     |
| Water source for bathing                      |                             |                          |
| Pipe                                          | 166                         | 77.9                     |
| River/lake/stream                             | 47                          | 22.1                     |
| Water source for drinking                     |                             |                          |
| Pipe                                          | 199                         | 93.4                     |
| River/lake/stream                             | 14                          | 6.5                      |
| Swimming habit                                |                             |                          |
| Yes                                           | 37                          | 17.5                     |
| No                                            | 175                         | 82.5                     |
| Shoe wearing habit                            |                             |                          |
| Yes                                           | 202                         | 94.8                     |
| No                                            | 11                          | 5.2                      |
| Raise cattle                                  |                             |                          |
| Yes                                           | 63                          | 29.6                     |
| No                                            | 150                         | 70.4                     |
| Raise pets (cat/dog)                          |                             |                          |
| Yes                                           | 73                          | 34.3                     |
| No                                            | 140                         | 65.7                     |
| Use night soil for farming                    |                             |                          |
| Yes                                           | 32                          | 15.0                     |
| No                                            | 181                         | 85.0                     |
food source was not associated with intestinal helminthiasis. Eating vegetables/fruits without washing or peeling off was also significantly associated with helminthiasis ($p = 0.042$). The odds of infection were 2 times higher (AOR = 2.208, 95% CI: 1.030–4.733) for those eating vegetables/fruits without washing or peeling off as compared to participants who wash or peel off before eating fruits/vegetables. Participants who often walk bare foot were at higher risk to helminth infection (COR = 2.27, 95% CI: 1.168–4.413, $p = 0.016$) but this association was not significant when adjusted for confounding factors. Nutritional status had significant association with intestinal helminthiasis ($p = 0.001$) that participants with BMI <18.5 were 3.5 times at higher risk to helminth infection (COR = 3.511, 95% CI: 1.646–7.489) of acquiring helminth infection as compared to those with $\geq 18.5$. The other considered socio-demographic and clinical factors didn’t show significant level of association with intestinal helminth infection (Tables 4 and 5).

**Discussion**

The co-infection rate of intestinal parasites among PTB patients in this study was 26.3% (95%CI: 20.2–32.4); higher than co-infection rate of 7.3% in China [11]. Variations in socio demographic characteristics and level of awareness about intestinal parasite transmission and prevention might be important determinants for low parasite prevalence in China as compared to the present study. Our findings show lower intestinal parasite prevalence as compared to cross-sectional study results from Gondar, Northwest Ethiopia by Alemayehu et al. (33.3%) [13] and Afework et al. (40.5%) [2]. Alemayehu et al. [13] conducted the study only among newly diagnosed PTB patients before starting treatment. Hence study population difference may be one factor for differences in intestinal parasite co-infection rate. Currently school based deworming for STH and schistosomiasis is being practiced bi-annually throughout Ethiopia which might also decrease the current transmission and prevalence of helminths.

In the present study, the total intestinal helminth co-infection rate at least with one helminth was 24.4% (95%CI: 18.8–30.5). This goes in line with findings from Brazil (27.5%) [12] and Northwest Ethiopia (29%) [4]. Lower intestinal helminth co-infection rate (7%) was

| Variables | Frequency |
|-----------|-----------|
| History of diarrheal within 3 months | Yes 24 [11.3] No 189 [88.7] |
| Time of last diarrhoea occurrence | Before a month 11 [4.7] Before 2 weeks 3 [1.4] Within 2 weeks 10 [4.7] |
| Duration of last diarrhoea occurrence | $>$ a month 2 [0.9] $<$ a month 13 [6.1] $<$ a week 9 [4.2] |
| Other GIT discomfort within 3 months | Yes 40 [18.8] No 173 [81.2] |
| Started anti-TB treatment | Yes 200 [93.9] No 13 [6.1] |
| Course of treatment | First 190 [95.0] Re-treatment 10 [5.0] |
| Duration of treatment in months | $<$2 45 [22.5] 2–4 55 [27.5] $>$4 100 [50.0] |
| Started anti-TB treatment | Yes 200 [93.9] No 13 [6.9] |
| HIV status | Positive 20 [9.6] Negative 189 [90.4] |
| BMI | $<$18.5 71 [33.3] $\geq 18.5$ 142 [66.7] |
reported from China [11]. Elias et al. (71%) [3] and Eba et al. (36.8%) [18], both from Northwest Ethiopia, have reported higher infection rate of helminthes than that of the present study. The laboratory protocol followed and differences in sample size may justify for those differences. In both previous studies, 3 stool samples were collected and examined from each participant before ruling out intestinal helminthiasis. However, in the present study, we have collected and examined a single stool specimen for the sake of logistic problems. Our sample size was 213 which is much smaller than that of Eba et al. (424) [18]. The other possible reasons for helminth infection in this study. This finding is in line with studies conducted in China and Ethiopia [11, 13]. Variable occupational exposure status at different social settings might bring differences in exposure rate by sex.

The multivariate regression model in the present study revealed that rural residence, frequent eating of raw vegetables/fruits without washing or peeling off and BMI <18.5 are risk factors for helminth infection in PTB patients. Rural residents were 3.175 times more at risk than urban residents. Alemayehu et al. also reported walking bare foot is more prevalent than Ascaris lumbricoides. Xin et al. [23] and Alemayehu et al. [13] reported walking bare foot is associated with helminth infection. May be because most respondents are urban residents, shoe wearing habit was not associated factor in the present study.

In the present study we have shown factors associated with intestinal helminthiasis among PTB patients. The findings can help to estimate to the general adolescent/adult population of the study area as TB patients are part of the population. Xin et al. from China reported that females are 2.05 times (95% CI = 1.01–4.17) more likely to acquire intestinal parasite infections than males [23]. Females were also at higher risk according to findings in Kenya by Anderek et al. [22]. Age and sex were not significantly associated with intestinal helminth infection in this study. This finding is in line with studies conducted in China and Ethiopia [11, 13]. Variable occupational exposure status at different social settings might bring differences in exposure rate by sex.

Nutrition screening, assessment and management are integral components of TB treatment and care. Therefore WHO recommended that patients with TB should be nutritionally assessed and receive nutritional care and support [24]. In this study, 33.3% of the participants were malnourished among which 35.2% were co-infected with intestinal helminthes. Dodor reported 51% prevalence of malnutrition among PTB patients prior to treatment in Ghana [25]. Similarly Anurag et al. reported that 80% of women and 67% of men TB patients had moderate to severe under-nutrition of which 52% had stunting indicating chronic under-nutrition [26]. Both patient groups who started anti-TB drug or not were

| Parasites | Frequency |
|-----------|-----------|
| A. lumbricoides | 24 11.3 |
| Hook worm | 18 8.5 |
| T. trichiura | 9 4.2 |
| Taenia species | 5 2.3 |
| H. nana | 2 0.9 |
| S. stercoralis | 2 0.9 |
| G. lamblia | 10 4.7 |
| E. histolytica | 4 1.9 |
| Helminths | 52 24.4 |
| Protozoa | 13 6.1 |
| Parasite (helminth + protozoa) | 56 26.3 |
| Variable               | Number examined | Rate of helminth infection (%) | Crude OR (95% CI) | P value | Adjusted OR (95% CI) | P value |
|------------------------|-----------------|--------------------------------|-------------------|---------|----------------------|---------|
| **Sex**                |                 |                                |                   |         |                      |         |
| Male                   | 122             | 32 (2.6%)                      | 1.085 (0.578–2.037) | 0.800   |                      |         |
| Female                 | 91              | 24 (2.6%)                      |                   |         |                      |         |
| **Age**                |                 |                                |                   |         |                      |         |
| 15–34                  | 136             | 32 (23.5%)                     |                   | 0.700   |                      |         |
| 35–54                  | 70              | 19 (27.1%)                     | 0.826 (0.427–1.527) |         |                      |         |
| 55–65                  | 7               | 1 (14.3%)                      | 1.846 (0.214–15.909) |         |                      |         |
| **Educational status** |                 |                                |                   |         |                      |         |
| Illiterate             | 60              | 13 (21.7%)                     | 1.416 (0.684–2.633) | 0.349   |                      |         |
| Primary/above          | 153             | 43 (28.1%)                     |                   |         |                      |         |
| **Marital status**     |                 |                                |                   |         |                      |         |
| Single                 | 115             | 29 (25.2%)                     | 1.116 (0.597–2.088) | 0.731   |                      |         |
| Married                | 98              | 27 (27.6%)                     |                   |         |                      |         |
| **Residence**          |                 |                                |                   |         |                      |         |
| Urban                  | 166             | 46 (27.7%)                     | 2.619 (1.042–6.584) | 0.041   | 3.175 (1.102–9.153)  | 0.032   |
| Rural                  | 47              | 6 (12.8%)                      |                   |         |                      |         |
| **Have/use latrine**   |                 |                                |                   |         |                      |         |
| Yes                    | 182             | 41 (22.5%)                     | 0.529 (0.234–1.193) | 0.125   |                      |         |
| No                     | 31              | 11 (35.5%)                     |                   |         |                      |         |
| **Common food source** |                 |                                |                   |         |                      |         |
| Cooked at home         | 196             | 44 (22.4%)                     | 3.071 (1.119–8.429) | 0.029   | 2.866 (0.900–9.131)  | 0.075   |
| Hotel                  | 17              | 8 (47.1%)                      |                   |         |                      |         |
| **Habit of washing vegetables/fruits** | | |                   |         |                      |         |
| Yes                    | 141             | 26 (18.4%)                     | 2.835 (1.468–5.476) | 0.002   | 2.208 (1.030–4.733)  | 0.042   |
| No                     | 64              | 25 (39.1%)                     |                   |         |                      |         |
| **Habit of eating raw meat** | | |                   |         |                      |         |
| Often or always        | 176             | 43 (24.4%)                     | 0.994 (0.435–2.271) | 0.989   |                      |         |
| Never or occasionally  | 37              | 9 (24.3%)                      |                   |         |                      |         |
| **Hand washing habit before meal** | | |                   |         |                      |         |
| Often or always        | 204             | 48 (23.5%)                     | 0.385 (0.099–1.490) | 0.167   |                      |         |
| Never or occasionally  | 9               | 4 (44.4%)                      |                   |         |                      |         |
| **Hand washing habit after defecation** | | |                   |         |                      |         |
| Often or always        | 191             | 40 (20.9%)                     | 0.642 (0.057–7.222) | 0.719   |                      |         |
| Never or occasionally  | 22              | 12 (54.5%)                     |                   |         |                      |         |
| **Water source for drinking** | | |                   |         |                      |         |
| Pipe water             | 199             | 47 (23.6%)                     | 0.433 (0.131–1.428) | 0.388   |                      |         |
| River/stream/lake      | 14              | 5 (35.7%)                      |                   |         |                      |         |
| **Swimming habit**     |                 |                                |                   |         |                      |         |
| Often or always        | 37              | 16 (43.2%)                     | 0.617 (0.285–1.338) | 0.222   |                      |         |
| Never or occasionally  | 175             | 36 (20.6%)                     |                   |         |                      |         |
| **Shoe wearing habit** |                 |                                |                   |         |                      |         |
| Often/always           | 155             | 31 (20.0%)                     | 2.27 (1.168–4.413) | 0.016   | 1.225 (0.238–6.297)  | 0.808   |
| Never/occasionally     | 58              | 21 (36.2%)                     |                   |         |                      |         |
recruited in the present study that drugs and associated health services might play a role for lower prevalence of under nutrition. Patients with BMI < 18.5 were 3.511 (95% CI = 1.646–7.489) times at higher risk of acquiring helminth co-infection. Findings from China go in line with our results [11, 23]. This is expected as helminths cause under-nutrition [27, 28]. We had got no significant association between anti-TB treatment and its duration with helminth co-infection similarly with studies from China [11, 23]. This is unexpected and needs further large scale study accompanying effects of anti-TB drugs on host immune profile. As a limitation, immunological parameters and worm load were not assessed so that their role on TB pathogenesis could be justified.

Table 4 Factors associated with intestinal helminth co-infection among TB patients attending selected health institutions of Arba Minch town and Arba Minch zuria district from January to August, 2016 (Continued)

| Variable                  | Yes   | No   | Crude OR (95% CI) | P value | Adjusted OR | P value |
|---------------------------|-------|------|-------------------|---------|-------------|---------|
| Raise cattle              |       |      |                   |         |             |         |
| Yes                       | 63    | 150  | 14 (22.2%)        | 1.187 (0.590–2.388) | 0.630 |
| No                        |       |      | 38 (25.3%)        |         |             |         |
| Raise pets (cat/dog)      |       |      |                   |         |             |         |
| Yes                       | 73    | 140  | 13 (17.8%)        | 1.782 (0.881–3.604) | 0.108 |
| No                        |       |      | 39 (27.9%)        |         |             |         |
| Use night soil for farming|       |      |                   |         |             |         |
| Yes                       | 32    | 181  | 7 (21.9%)         | 1.182 (0.479–2.916) | 0.717 |
| No                        |       |      | 45 (24.9%)        |         |             |         |

Conclusion
The co-infection rate of intestinal parasitic infection among PTB patients was 26.3% and that of intestinal helminths only was 24.4% in Arba Minch. *A. lumbricoides* was the most prevalent helminth with infection rate of 11.3%. Rural residence, frequent habit of eating raw vegetables/fruits without washing or peeling off and malnutrition (BMI < 18.5) were associated factors with intestinal helminth co-infection among PTB patients. We recommend to health care providers to screen and treat TB patients for intestinal helminthiasis. Health education about transmission and prevention of intestinal parasites should also be part of TB case management to ensure good TB prognosis.

Table 5 Clinical data associated with intestinal helminth co-infection among TB patients attending health institutions of Arba Minch town and Arba Minch zuria district from January to August, 2016

| Variable                  | Number examined | Rate of helminth infection (%) | Crude OR (95% CI) | P value | Adjusted OR | P value |
|---------------------------|-----------------|-------------------------------|-------------------|---------|-------------|---------|
| BMI                       |                 |                               |                   |         |             |         |
| < 18.5                    | 71              | 25 (35.2%)                    | 2.315 (1.217–4.401) | 0.010   | 3.511 (1.646–7.489) | 0.001 |
| ≥ 18.5                    | 142             | 27 (19.0%)                    |                   |         |             |         |
| Started anti-TB treatment |                 |                               |                   |         |             |         |
| Yes                       | 200             | 50 (25.0%)                    | 1.833 (0.393–8.554) | 0.441   |             |         |
| No                        | 13              | 2 (15.4%)                     |                   |         |             |         |
| Duration of anti-TB treatment |         |                               |                   |         |             |         |
| 1–2 months                | 45              | 10 (22.2%)                    | 1.230 (0.535–2.828) | 0.885   |             |         |
| 2–4 months                | 55              | 14 (25.5%)                    | 1.029 (0.484–2.186) |        |             |         |
| > 4 months                |                 |                               |                   |         |             |         |
| Course of treatment       |                 |                               |                   |         |             |         |
| First                     | 190             | 46 (24.2%)                    | 0.479 (0.130–1.772) | 0.270   |             |         |
| Re-treatment              | 10              | 4 (40.0%)                     |                   |         |             |         |
| HIV status                |                 |                               |                   |         |             |         |
| Positive                  | 20              | 3 (15.0%)                     | 1.929 (0.546–6.871) | 0.110   |             |         |
| Negative                  | 189             | 48 (25.4%)                    |                   |         |             |         |
Abbreviations
AOR: Adjusted odds ratio; BMI: Body-mass index; CI: Confidence interval; HIV: Human immunodeficiency virus; IL: Interleukin; PTB: Pulmonary tuberculosis; STH: Soil transmitted helminths; TB: Tuberculosis; Th: T helper; WHO: World Health Organization

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Availability of data and materials
The original data for this study is available from the corresponding author.

Authors’ contributions
GA conceived and designed the project. GA and MM performed the experiment, analyzed the data and wrote the manuscript. Both authors read and approved the final manuscript.

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

Consent for publication
Not applicable.

Ethics approval and consent to participate
Ethical approval for the research was granted by review boards of Arba Minch University with a project code of Gov/AMH/5-2/CMHS/MLS/01/08. Official permission letter was also obtained from Arba Minch Hospital and health offices of Arba Minch town and Arba Minch Zuria district. Informed verbal consent was obtained from all participating study subjects. All laboratory results were communicated to study participants promptly so that positive patients could be treated in the TB clinics.

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