



Bovine tuberculosis in Ethiopia: A systematic review and meta-analysis[☆]



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ABSTRACT

Bovine tuberculosis (bTB) is a known endemic disease of cattle in Ethiopia; however, there is lack of a comprehensive information on the status and distribution of the disease in the country. The objectives of this systematic review and meta-analysis were to provide a pooled prevalence estimate of bTB at a national level, assess the level of in-between variance among study reports and illustrate the spatial distribution pattern in the country. Articles published on bTB from January 2000 to December, 2016 in English language were included in the review. Pubmed, CAB direct, AJOL and Web of Science were the databases used in electronic search. A total of 127 articles were retrieved from online sources, of which 56 articles were selected for data extraction based on the specified inclusion criteria. From these selected published articles, 114 animal level data were extracted for quantitative analysis. A pooled prevalence estimate of bovine tuberculosis in Ethiopia was found to be 5.8% (95% CI: 4.5, 7.5). In a multivariable meta-regression analysis, breed and production system explained 40.9% of the explainable proportion of the in-between study variance computed. The prevalence of bovine tuberculosis in Holstein-Friesians, 21.6% (95% CI: 14.7–30.7), was higher than the prevalence in local zebu 4.1 (95% CI: 3.4–4.9). Cattle kept under intensive and semi-intensive production systems had higher prevalence, 16.6% (95% CI: 12.4–21.6), of bTB than those kept in extensive livestock production system, 4.6 (95% CI: 3.4–6.2). Bovine tuberculosis is widely distributed across major livestock producing regions of Ethiopia. However, no valid data could be retrieved from Benishanul-Gumuz, Harari and Dire Dawa. Data obtained on bTB from Somali and Gambella regional states are also few and further studies are suggested in these regions. In conclusion, this review showed that bTB in cattle in Ethiopia is widespread with high prevalence in intensive and semi-intensive management systems that keep exotic breeds and their crosses in urban and peri-urban areas. Thus, it is suggested that the design and implementation of bTB control strategies in Ethiopia should prioritize these hotspots in order to reduce the impact of the disease on the growing dairy sector.

1. Introduction

Bovine tuberculosis (bTB) is a chronic granulomatous disease of cattle caused predominantly by *Mycobacterium bovis* (*M. bovis*). The disease is transmitted between animals primarily by inhalation although transmission through ingestion is also common in cattle grazing on pasture contaminated with *M. bovis*. The disease causes significant animal health-induced economic loss, and its impacts include reduction in productivity, movement restrictions, screening costs, culling of

affected animals, and trade restrictions (OIE, 2016). On top of its economic impacts, bTB is transmitted to humans, and prior to mandatory pasteurization about one-fourth of TB cases in children was caused by *M. bovis* in developed countries while 15% of human TB up until the end of 1990's was believed to be caused by *M. bovis* in developing countries (Ashford et al., 2001). A more recent study however, reported a much lower figure of 2.8% of human TB to be attributed to *M. bovis* in Africa (Muller et al., 2013).

Bovine TB has been eliminated or eradication programs are in

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progress in several developed countries (CFSPH, 2009). Nonetheless, significant pockets of infection remain in wildlife in Canada, the United Kingdom, the United States and New Zealand (OIE, 2016). Globally, the prevalence of the disease is estimated to be 9% based on the results of skin tests (Vordermeier et al., 2016). Although there is still scarcity of data on the prevalence of bTB in developing countries, the disease is widespread in African and Asian countries (OIE, 2016). According to the review made by Cosivi et al. (1998), approximately 85% of the cattle and 82% of the human population of Africa are living in areas where bTB is endemic and partly controlled or not controlled at all. In Asia, 94% of the cattle and 94% of the human population live in countries where bTB is not controlled or where limited control strategy is applied (Cosivi et al., 1998).

Global economic assessment of loss associated with bTB and cost-benefits analysis from its control were multifaceted and figures obtained from different countries provide variable results because of differences in epidemiological situations, livestock systems, natural reservoirs, time horizons, and absence of commonly agreed analytical frameworks (Zinsstag et al., 2006). In Ethiopia, Tschopp et al. (2012) estimated the economic cost of bTB to be in the range of 75.2 million to 385 million US\$ in the rural extensive livestock production and from 500,000 – 4.9 million US\$ in the urban livestock production systems between the years 2005–2011. These figures demonstrated losses lower than 1% of the net present value of livestock in the rural and 3.9–6.2% in urban livestock production systems per year. In both cases the costs associated with bTB were within the margin of error (i.e. the losses may not be different from zero). In their conclusion, Tschopp et al. (2012), emphasized on the urgent need for control of the disease in the urban production system in Ethiopia for non-economic reasons; including concerns over spread of bTB through dairy cattle trade from high prevalence urban system to low prevalence sedentary rural system and for public health reasons.

Since the report of Hailemariam (1975), several fragmented studies ascertain the presence of bTB in Ethiopia. The estimated animal level prevalence ranges from less than one to 47% at study level, (Ameni et al., 2007a,b, 2010a,b; Berg et al., 2009; Tschopp et al., 2010b; Tsegaye et al., 2010; Gumi et al., 2011; Firdessa et al., 2012) and from no detection of infection (0%) (Tschopp et al., 2015) to 90% (Firdessa et al., 2012) at specific localities level depending on the prevailing production systems and breeds of cattle kept. Most of these studies were carried out based on tuberculin skin testing and postmortem inspection, although few of the studies were supported by isolation and molecular typing of the causative agents. In the former case, bovine purified protein derivative (PPD) alone or together with avian PPD has been used to determine exposure status in live animals (Asseged et al., 2000; Ameni and Regasa, 2001; Fikru et al., 2005; Ameni and Erkihun, 2007).

Regardless of the diagnostic test types used, several reports were available since the early 2000's, in various parts of the Ethiopia. Many of these reports however, were conducted by graduate and undergraduate students to fulfill their research requirements in the academic programs to which they were enrolled, therefore these studies were noted to have limitations in producing country level picture for one or the other reasons including, the scope of study objectives, methodology used, target population and geographic coverage. Besides, to our knowledge there has never been national level survey or surveillance report that can demonstrate the magnitude of the diseases. There are few compiled qualitative reviews on bTB in animals and humans in Ethiopia (Shitaye et al., 2007; Tschopp and Aseffa, 2016), yet, no single review is available based on quantitative analysis of study results conforming to Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA). In a situation where such a gap is noted, producing a review based on data integration from selected articles with objectively defined criteria is worthwhile (Bornstein et al., 2009; Dohoo et al., 2009). Such qualitative analysis would give complimentary picture on the level and scopes of studies made so far from which fellow researchers visualize the existing research gap. Besides, the

information will provide policy input for appropriate strategy on the way forward. The current systematic review and meta-analysis is conducted with the aim of providing a pooled prevalence estimate of bTB in Ethiopia. This review also attempts to assess the level of in-between study variance and quantify the true heterogeneity attributed to the hypothesized predictors captured in the final model. The review also illustrated the spatial distribution pattern of bTB in the country based on the available study reports.

2. Material and methods

2.1. Literature search strategy

Search for published articles on bTB in Ethiopia was conducted from January 2, 2017 to February 21, 2017. PubMed, CAB direct, African Journals OnLine and Web of Science were the databases used. Key strings were: bovine, cattle, large ruminants, livestock, TB, wasting diseases, mycobacteriosis, zoonotic mycobacteria, *M. bovis* and Ethiopia. The strings were rearranged to phrases as close as “*bovine tuberculosis in Ethiopia*” and literature searches were limited to articles published both in English and Amharic (Federal working language) since 2000. Reference lists of reviews and all retrieved articles were also manually searched during the same period to maximize article recovery.

2.2. Inclusion and exclusion criteria

A preliminary screening was made based on the title and abstract content of the manuscripts. Those articles thought to have reasonable reflection on the review question were fully scanned and rated using an evaluation form with a rating scales for the following criteria: i) TB in cattle or bovine species (yes/no), ii) clarity of objective/s (estimation of prevalence or otherwise), iii) appropriateness of methodology including the study design and diagnostic details, iv) clarity of result presentation and v) the study period. The study designs considered were cross-sectional and cohort. With regards to the diagnostic techniques, detailed meat inspection (DMI) for abattoir based studies, and single intradermal tuberculin (SIDT) and comparative intradermal tuberculin (CIDT) tests at cut-off values of 4 mm and above for skin test based studies were valid for the review. Sampling strategies reported in the original studies were either random or purposive. In line with pre-defined criteria, manuscripts that were rated to be of moderate quality and above were included in the review while abstracts, proceedings, review articles, case and outbreak reports, articles published before the year 2000 and those articles rated of low quality due to poorly executed or poorly described methodology or lack of usable data due to vague result presentation were excluded from the review.

2.3. Data extraction

Data extraction template was developed on biologically plausible predictors which were consistently reported in most of the selected published articles. The template was further reviewed and enriched by all co-authors and pilot tested before use. Two authors were engaged fully in literature search and data extraction independently based on agreed milestones. Finally, the selected articles and the dataset generated were crosschecked by third author and ambiguities were ruled out by group discussions or through telephone conversations. The dataset constituted authors' name, year of publication, web-link, manuscript title, journal name and volume in addition to hypothesized biologically meaningful predictors, i.e. breed, production systems, type of study population (study set-up), agro-ecology, study design, sampling technique, diagnostic technique, housing type, herd composition and herd contacts. Sample size, number positive, number negative, prevalence and respective confidence intervals were also generated along each predictor.

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