

## Research Article

# Knowledge, Attitude, and Practices of Population towards Brucellosis in Ethiopia: A Systemic Review and Meta-Analysis

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## Abstract

**Background:** Brucellosis is one of the zoonotic pathogen in the world which is a challenging issues for health and responsible for enormous economic losses in many developing countries such as/ like Ethiopia. Considering the high prevalence and economic importance of brucellosis, the aim of this study was systematically review published data to explore the distributions of the pooled knowledge, the awareness, attitude and practice of level of the disease in Ethiopia.

**Methodology:** A comprehensive literature search was conducted through search engine includes Web of Science, Google Scholar, Scopus, Scirus, Science Direct, HINARI databases, PubMed and reference lists of previous studies. Published articles were included based on inclusion and exclusion criteria. Overall knowledge, awareness levels, attitude and practices of study participants regarding the mode of brucellosis transmission, zoonotic nature, and symptoms of brucellosis in animals and humans. Results were presented in funnel plot, the forest plot, figures, and tables with a 95% Confidence Interval (CI). To assess heterogeneity we used inconsistency index (I<sup>2</sup>) test statistics. And also we used random effect model and R studio (4.2.0) statistical software to compute the analysis of the data. The analysis was conducted and reported in accordance with Meta-analyses guidelines and the Preferred Reporting Items for Systematic Review.

**Results:** After excluded articles which did not fulfill the inclusion criteria, a total of 28 original articles that reporting the brucellosis awareness levels of communities in Ethiopia were included in the analysis. 16.98% of the studies population had overall knowledge of brucellosis, and the pooled awareness levels regarding the zoonotic nature and mode of transmission of brucellosis were 22.75% with 95% CL (0.1337; 0.3373). And also 18.5% of study participants had awareness about clinical sign of signs of human and animal brucellosis. From the study participants, 74.3% of them had poor practice regarding transmission of brucellosis includes consumption of raw milk and meat, unsafely contact their animals. Sub-group analyses showed that there were differences in brucellosis awareness levels among regions. In Oromia region 20.4% of respondents had knowledge with 95% CL (0.0999; 0.2524), I<sup>2</sup> = 94.8%, p-value < 0.0001 where as in Amhara region 69.8% of respondents had knowledge about brucellosis. Regarding attitudes in Amhara region the studies participants had lowest attitudes (22%) towards brucellosis as compared with others region.

**Conclusion:** In general, the result of the present study showed that the population had less clear understanding about brucellosis as it affects their animals, cause abortion and its zoonotic importance. This result implies that it is necessary to create awareness of the zoonotic and its economic effect of brucellosis through a various methods, including the public media, veterinary professionals, community health extension, and local leaders.

**Keywords:** Knowledge; Attitude; Practices; Brucellosis; Meta-analysis; Ethiopia

## Introduction

The life of human being is closely associated with livestock products in the different livestock production systems particularly in pastoral communities [1]. Because of this interaction the threat of zoonotic diseases for human is high. Brucellosis is one of the most important neglected zoonotic bacterial disease in the world which is caused by *Brucella* and more than 500,000 human cases occurring globally per year [1,2]. Some important *Brucella* strains including *B. melitensis* and *B. abortus* can affect both livestock and human [3]. World Health Organization (WHO) [4] and World Organization for Animal Health (OIE) [5] reports indicated that brucellosis is rarely prioritized by health systems and is considered a neglected zoonosis. In both agropastoral and pastoral livestock production systems, people live closely with livestock making contact with different animal discharge and consumption of raw animal product lead to have a high incidence of brucellosis and thus, are at higher risk of acquiring the infection [4,5]. Brucellosis is the major reproductive problems causes abortions, and infertility in livestock [3,6].

Human brucellosis is characterized by muscular pain, lumbar pain, weight loss, fatigue, fever, sweating, joint pain, headache, and arthritis [7,8]. Humans become infected through ingestion of raw milk or milk products, handling of infected animals, contact with animal discharges such as vaginal fluids, placenta especially during parturition [9]. Veterinary health workers, farmers, pastoral communities, abattoir workers and laboratory personnel are highly exposed for brucellosis and are considered the highest occupational risk- groups [10-12]. Generally, due to prevalence of the disease in animals and poor hygiene practices of humans that expose to infected animals or their products can significantly increase the risk of the occurrence of the disease in humans. As its clinical manifestation resembles other febrile illnesses such as tularaemia, malaria, typhoid fever and tuberculosis, and lacking resources and laboratory diagnostics, the disease is difficult to accurately diagnose based solely on clinical sign [13-15]. The prevalence of brucellosis in Ethiopia is ranging between 1.3% and 22.8% with depending on husbandry systems and livestock species [2,16]. Dairy cattle owners, consumers, institutions promoting dairy industry, public health professionals, veterinarians and policy makers require baseline information about the health of dairy cattle, the public health implication and the safety of dairy products. Control and eradication of brucellosis cannot be achieved through test-and-slaughter, vaccination and treatment only; the cooperation of relevant occupational groups is an important component in achieving this goal [17]. Knowledge and attitude are promotes people to take protective measures at work and actively participate in disease control programs, thus greatly assisting the development of brucellosis control strategies. So far, in Ethiopia, different studies have been done on the prevalence, knowledge, attitude, and practice about brucellosis among the public.

However, the findings of these different studies show that there is a high variability in the level of the knowledge, attitude, and practice across the regions of the country and unclear. The aim of this systemic and meta-analysis was to explore the knowledge, attitude and practice of peoples towards brucellosis in Ethiopia.

## Materials and Methods

### Data Bases, Literature Search and Selection

Typically, the published papers were reported based on the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guideline [18]. The published papers and abstracts were identified by a computerized literature search of electronic databases include PubMed ([www.ncbi.nlm.nih.gov/entrez/](http://www.ncbi.nlm.nih.gov/entrez/)), Science Direct ([www.sciencedirect.com](http://www.sciencedirect.com)), Scirus ([www.scirus.com/srsapp](http://www.scirus.com/srsapp)), ISI Web of Knowledge (<http://www.isiwebofknowledge.com>), Google Scholar (<http://scholar.google.com>) and HINARI databases. The search was performed from May to July 2022. The search queries were set based on Medical Subject Headlines (MESH) and Boolean logic. Relevant MeSH terms and keywords were used to retrieve all relevant articles from the databases listed above. The keywords and MeSH terms used were “brucellosis AND knowledge OR awareness AND perception OR KAP) OR attitude AND Ethiopia:” [Publication Date]). (“Knowledge” [Mesh] OR “Knowledge, Attitudes, Practice” [Mesh])OR(“Attitude”[Mesh] OR “Attitude” [Mesh] OR “Attitude to brucellosis ”[Mesh ] ) ) OR “Awareness” [Mesh] AND (“Ethiopia”[Mesh].To identify additional relevant citations search was conducted on the previous studies of reference lists as well as “cited by” and “related information” tools in PubMed and Google scholars were searched. Only those articles which fulfill the selection criteria and written by English language were used to analyses the information.

### Inclusion and Exclusion Criteria

Studies were chosen for this systemic review and meta-analysis based on inclusion criteria includes randomized subjects in all studies, trial procedures, provide complete data, the study design, method of assessing the outcome, and handling of protocol deviations whereas, secondary reports, no original research, comments, editorials and reviews were directly excluded. Research conducted on knowledge, attitude and practices towards brucellosis in Ethiopia and full-length published articles in the English language were included in the analysis. The papers that were conducted to assess only the prevalence of brucellosis in Ethiopia not included. The studies were included cross-sectional observational studies and conducted in Ethiopia only.

### Selection of the Identified Publications

All the retrieved studies were imported and duplicates were

removed by using the software of EndNote version 8. The two investigators (GEK and YD) independently selected the research titles and abstracts which were followed by a full-text review to determine the eligibility of each study. If there was any disagreement between the two investigators the gap was solved by consensus with the presence of the third investigator (DW). The screening and selection of studies were promoted by the creation of appropriately labeled sub-groups in EndNote.

### Data Extraction

The selected articles were coded and the data were extracted from selected articles using a format prepared in Microsoft Excel. The format consist of the following basic information: author name, study period, publication year, geographic region, study design, study population, sampling method, number of participants (sampling size), sample type, gender distribution and the number of participants for the assessment of brucellosis awareness, knowledge, and acceptance, or the rate percentage proportions for these studied factors. The number of studied cases (n) and sample size (N) were the two necessary parameters for the calculation of the pooled level of awareness, knowledge, and practices of brucellosis in the meta-analysis. In particular, the number of participants who answered positively (n) was obtained directly from these studies or by multiplying the sample sizes (N) with the proportions (%) associated with the investigated items reported in the studies.

### Quality Control

The quality of each search study was evaluated by using different criteria based on Joanna Briggs Institute (JBI) [19]. Quality appraisal criteria adapted for studies including appropriateness of the research design to address the target population, quality of paper, completeness of the information, adequate sample size and appropriateness of methods for isolation of the bacteria and appropriate statistical analysis [20]. The eligibility of selected research articles was also assessed and approved by experts in the discipline.

### Publication Bias and Heterogeneity

Part of the strategy in conducting a meta-analysis is to identify factors that may be significant determinants of sub-population analysis or covariates that may be appropriate to explore in all studies. Variation among different trials is usually assessed using Cochran's Q statistic, a chi-squared ( $\chi^2$ ) test of heterogeneity with k-1 degrees of freedom. Variability in the participants, interventions, and outcomes studied has been described. Meta-analysis was conducted sufficiently homogeneous studies

in terms of subjects involved, interventions, and outcomes. To check publication bias we used funnel plot and asymmetry detected using Egger's linear regression test, and Begg's rank correlation test [21]. Heterogeneity of results among trials was quantified using the inconsistency index I<sup>2</sup>, which describes the percentage of total variation across studies [22]. Therefore, the value of I<sup>2</sup>, 25%, 50%, and 75% represented low, moderate, and high heterogeneity, respectively. Negative values of I<sup>2</sup> are put equal to zero, consequently I<sup>2</sup> lies between 0 and 100%. In the same way, a p-value less than 0.05 were used to declare heterogeneity. A random effect model was used to reduce the heterogeneity of studies [23].

### Data Analyses

The data were compiled in Microsoft Excel 2016 spreadsheet and summarized by descriptive statistics. A random-effect model was used to estimate the overall status of knowledge, attitude, and practice with the 95% Confidence Interval (CI). All statistical analysis was done by using R statistical software (Version 4.2.0). The presence of publication bias was assessed by funnel plot; in addition the Begg and Egger's weighted regression method was used to detect evidence of publication bias. Hence, a p-value of < 0.05 was considered as indicating the presence of significant publication bias. All available data were pooled in the present meta-analysis [24]. The sub-groups and categories considered included region, study population, education, and occupation. The data were described using forest plots, figures, and tables. Statistical heterogeneity was evaluated by Cochran's chi-square (Q-test) and the inconsistency index (I<sup>2</sup>). A funnel plot was constructed to visually examine the publication bias [21].

## Results

### Characteristics of the Included Studies

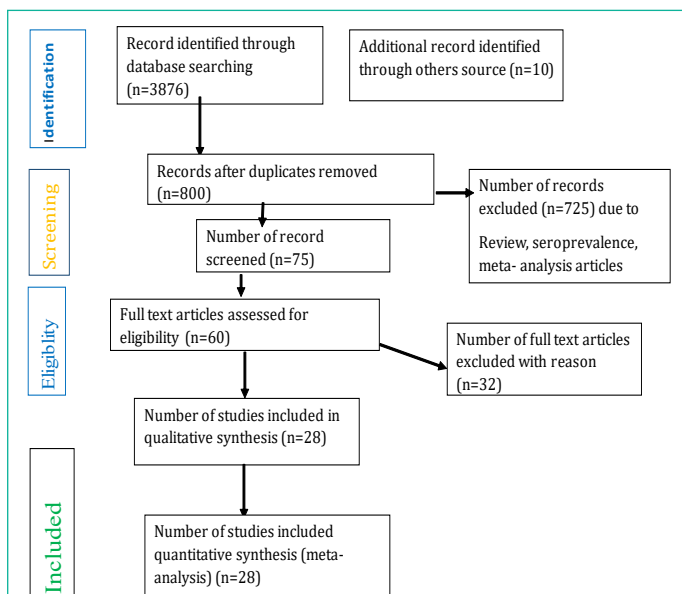
The selection process of different studies for this systematic review was presented through a flow diagram shown in (Figure 1). Of 3886 identified studies, 3086 articles were removed due to duplication then after 725 articles were excluded upon reviewing the titles, abstracts and full articles because they were irrelevant (were not focusing on KAP of brucellosis) or were done outside Ethiopia and review, sero-prevalence and meta-analysis articles. 75 studies were screened and from these screened studies 60 studies were assessed for eligibility, of these 60 studies, 32 articles were excluded because they were not meeting the inclusion criteria. Finally, 28 studies meeting the inclusion criteria were included in the qualitative synthesis and quantitative synthesis (meta-analysis) as presented (Table 1).

**Table 1:** Characteristics of the included studies regarding brucellosis awareness, attitude and practice in the meta-analysis.

Reference	publication year	Stud. period	Region (study area)	Study population	Gender distribution	Age categories	Occupation	Sample type (data collection methods)	Study design	sampling method	Sample size
[25]	2017	Nov, 2016 and May, 2017	Amhara(north shewa)	smallholder dairy farmer, milk collectors, retailers	all	young, adult	dairy farmers, retailers	full structured questionnaire	cross sectional	random	230
[1]	2020	Dec, 2017 to May, 2018	Oromia (adama town)	dairy farmers	all	adult	farmers	semistructured questionnaire	cross sectional	random	384
[26]	2018	Dec, 2015 to April, 2016	oromia (bishoftu)	dairy farmers	all	adult	farmers	full structured questionnaire	cross sectional	random	400
[27]	2017	March to April, 2017	Amhara(laygayint)	Rural communities	all	adult	farmer, merchant, employer	semistructured questionnaire	cross sectional	random	579
[28]	2022	Nov, 2020 to April, 2021	Oromia(borana zone)	pastoral community	all	-	pastoralist	semistructured questionnaire	cross sectional	random	45

[29]	2021	Nov, 2018 to Nov, 2019	Oromia(Bale Zone)	small ruminant owners and attendants	All	–	farmers	full structured questionnaire	cross sectional	random	80
[30]	2015	Nov, 2013 to May, 2014	Afar (Mille, Dubti and Chifra)	pastoral community, animal and human health professionals	all	–	pastoralist, employers	semi and full structured questionnaire	cross sectional	Stratified sampling method	168
[31]	2020	Oct, 2017 to Feb, 2018	Oromia(borena zone)	Animal owners and attendants	all	young, adult	pastoralist	structured questionnaire and interview	cross sectional	multistage and convenient sampling	341
[32]	2018	Oct to Dec, 2016	Afar(amibara district)	pastoral community	All	adult	pastoralist, agro-pastoralist	structured and open-ended questions, interview	cross sectional	multistage (simple random and stratified)	475
[33]	2021	Nov, 2017 and June, 2018	Afar(awash,afambo, chifra,mille) and Somali afdem, erer, aysha,mieso, hadegale)	all community (pastoralist, attendant, keeping animals for their livelihood)	all	adult	pastoralist, employer	A semi-structured questionnaire	cross sectional	random (multistage cluster sampling)	647
[34]	2021	–	Central highland of Ethiopia	farm owners, farm managers	all	adult	farmers, employers	interview	cross sectional	random	284
[35]	2021	Oct, 2016 and Oct, 2017	Oromia(Jimma zone)	livestock owners	all	adult	farmers and others	structured and semi-structured questionnaire	cross sectional	random	180
[2]	2011	Oct, 2007 to March, 2008	Southern and Eastern Ethiopia	livestock owners	All	adult	farmers		cross sectional	random	90
[36]	2005	Oct, 2003 to April, 2004.	Oromia (Jimma zone)	abattoir workers, butchers, farmers and animal health workers	ALL	young, adult	abattoir workers, butchers, farmers and animal health workers	structured questionnaire and interview	cross sectional	Multi stage sampling	126
[37]	2008	Sep, 2005 and March, 2006	Oromia (walmara district, lume and adami tulu)	households which keep cattle,	all		not specify	structured questionnaire	cross sectional	random (one-stage, cluster sampling method)	176
[38]	2021	Feb, 2017 to Jan, 2019	Afar (Dubti, Asaita, and Chifra.)	pastoral community	all	young, adult	pastoralist	Semistructured questionnaire	cross sectional	randomized and purposive sampling techniques	384
[39]	2019	Nov, 2016 to April, 2017.	Somali (Fafan Zone)	pastoral community	all	young, adult	livestock owners and tendants	Questionnaire interview	cross sectional	random	211
[40]	2016	Nov, 2013 to April, 2014	Afar Region(Chifra and Ewa)	livestock owners/herders	all	adult	farmers	structured questionnaire and interview	cross sectional	random	45
[41]	2013	Oct, 2011 and April, 2012	tigray(Southern Zone)	livestock owner	all	adult	farmer	semi-structured questionnaire	cross sectional	Multistage random sampling	100
[42]	2012	Nov, 2010 and April, 2011	Diredawa region eastern Ethiopia	small ruminant owners and attendants	all	adult	farmers	questionnaire and interview	cross sectional	random	49
[27]	2017	Feb to Sep, 2010	Harari region	semi-intensive and intensive farms owners	all	adult	farmers	semi-structured questionnaire	cross sectional	random	307
[43]	2018	May to June, 2013	SNNP (Nechisar National Park)	all community who have contact with animals	all	young, adult	livestock owners and tendants	structured questionnaire and interview	cross sectional	random and systematic	50
[44]	2022	–	Oromia (Borena zone)	pastoral communities	all	young, adult	pastoralist	interview and questionnaire	cross sectional	random sampling methods.	60
[45]	2016	Nov 2013 to May 2014	Oromia (in and around Asella)	all communities	all		–	interview and questionnaire	cross sectional	random	500
[46]	2018	Oct 2016 and April 2017	Oromia (Yabello districts)	pastoral community	all	young, adult	pastoralist	questionnaire	cross sectional	random	120
[47]	2013	Nov, 2011 to April, 2012	Oromia (jimma zone)	public	all		farmers	semi-structured questionnaire	cross sectional	simple random sampling method	175

[48]	2013	Oct 2011 and Mar 12	Oromia (Arsi zone)	livestock owners	all	adult	farmers	open and closed end question	cross sectional	stratified cluster sampling	130
[49]	2020	Feb 2019 to Nov 2019	Gambella (Gambella and Itang districts)	livestock owners	all	adult	farmers	interview and questionnaire	cross sectional	random	80



**Figure 1:** Flow diagram of study selection for systematic review and meta-analysis of KAP towards brucellosis in Ethiopia, 2022.

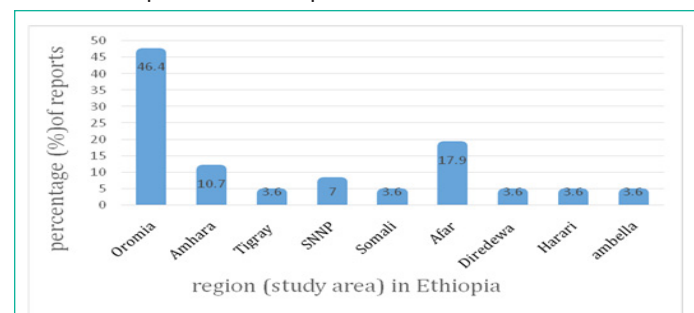
Among the included Publications, 3 (10.7%) studies from Amhara, 13 (46.4%) studies from Oromia, 5 (17.9%) studies from Afar, 2 (7%) studies from South Nation and Nationalities People (SNNP), 1 (3.6%) studies from Harari region, 1 (3.6%) Tigray, 1 (3.6%) studies from Direedewa administration, 1 (3.6%) studies from Somali region and 1 (3.6%) studies from Gambella region. However, we did not found published articles in Benishangul Gumuz regions of the country) (Figure 1). All selected studies were published in English and all the studies enrolled in this systematic review were cross-sectional studies. The study populations of the studies included pastoral community, animal and human health professionals, farmers, animal owners, abattoir workers, butchers, and farm managers. A questionnaire survey was conducted for all the studies included in the analysis, which were interview-administered and self-administered questionnaires. The main animals reared by the respondents were cattle, sheep and goats and camels.

All cross-sectional studies were conducted from 2003 to 2021 and published online from 2005 to 2022. The knowledge was assessed based on the overall knowledge of the respondents includes mode of transmission, clinical signs, symptoms, treatment and vaccine availability and mechanisms of prevention. Knowledge was defined as good if the respondents scored above the mean level. Attitude was assessed the way the community views and behaves on brucellosis preventive measures, fear of acquiring the disease and interest. Practice was assessed about protective measures for brucellosis during assisting abortion, including the use of gloves when handling an aborted fetus, washing after contact with animals and animal products, and methods of disposing of aborted fetuses and placenta and the respondent was categorized as good and poor practice based on the mean score of practice.

The sample size of all studies which were included ranged from 45 to 647 and all studies were used random sampling methods. The highest level of good knowledge (56.3%) was re-

corded in a study from Oromia region and the lowest (19%) was recorded in a study. A conducted in Tigray. There was a high level of poor practice recorded in a study done in Tigray region which was 93.2%.

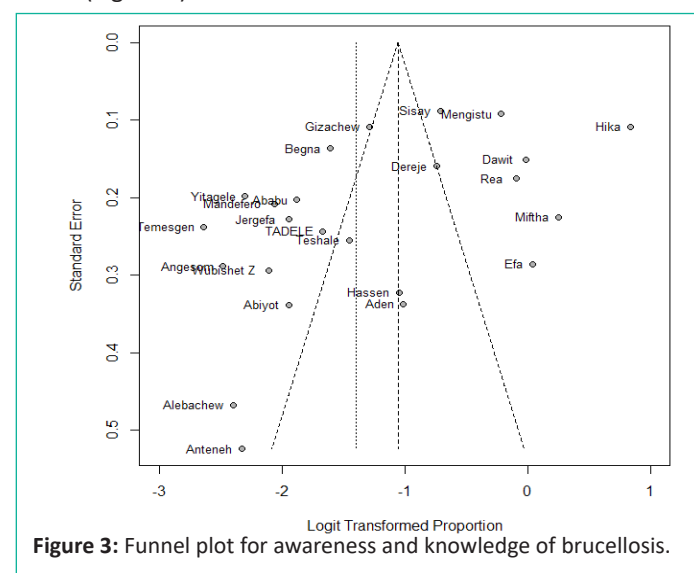
As the (Figure 2) showed below, currently the country has 11 regions and two city administrations. Reports were from 9 of them which are indicated in the figure. Reports were not found from Sidama, South-west Ethiopia and Benishangul Gumuz regions during the period of data. The results of the meta-analysis were presented separately for over all knowledge, awareness on zoonoticity and means of transmission, awareness of respondents on clinical signs of brucellosis, awareness on the source of information, awareness on disease control and prevention strategies, over all attitudes respondents for brucellosis and over all practices of respondents on brucellosis.



**Figure 2:** Percent of published studies in different regions of Ethiopia.

**Publication Bias**

The presence of publication bias for knowledge, attitude, and practice towards brucellosis was assessed using Egger regression test at  $P < 0.05$  and funnel plot. There was statistical evidence that there was no publication bias for a good level of knowledge of respondents with  $P$ -values = 0.663. For knowledge, each article's effective size was visual inspection of the funnel plot suggests asymmetry and allocated against the standard error. Since eight studies lay on the right side and fifteen studies on the left side of the line representing the estimated status (Figure 3).



**Figure 3:** Funnel plot for awareness and knowledge of brucellosis.

### The Overall Knowledge of Study Participants toward Brucellosis

The overall awareness about brucellosis was reported in 28 studies, with a pooled awareness level of 22% with 95% CI (0.1021; 0.2683) by using random-effects model. These result shows significant heterogeneity among studies ( $I^2=96.7\%$ ,  $p \leq 0.0001$ ). Participants' knowledge and perceptions further demonstrated that brucellosis might be passed from animals to people by ingesting raw milk. The estimated overall level of good knowledge, practice in Ethiopians presented in a forest plot (Figure 4).

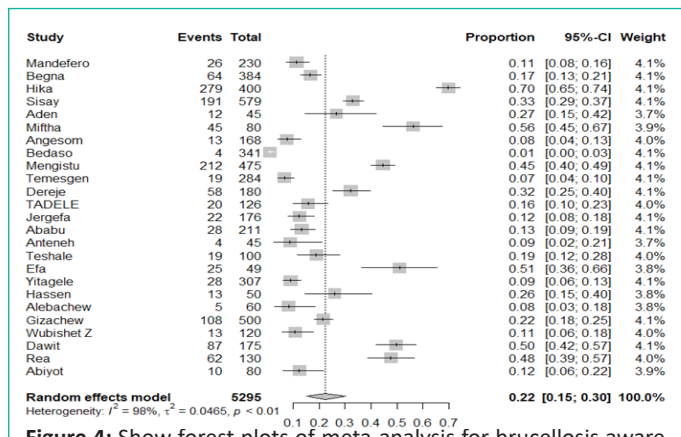


Figure 4: Show forest plots of meta-analysis for brucellosis awareness and knowledge of population in Ethiopia. At the bottom of the plot, a diamond shape represents the average effect. The length of the diamond symbolizes the confidence interval of the pooled result on the x-axis.

### Awareness of Study Participants on Zoonoticity and Means of Transmission

From included studies fifteen studies were explored the awareness of the respondents about the zoonotic importance and the means of transmission of brucellosis from infected animals to humans. Pooled awareness level of respondent which have awareness on zoonoticity and transmission of brucellosis was 22.75% with 95% CL (0.1337; 0.3373) as presented in a forest plot (Figure 5). These result shows significant heterogeneity among studies ( $I^2=98.1\%$ ,  $p \leq 0.0001$ ). The pooled awareness levels of raw milk consumption and the consumption of infected meat as risk factors for brucellosis were 5% and 6%, respectively.

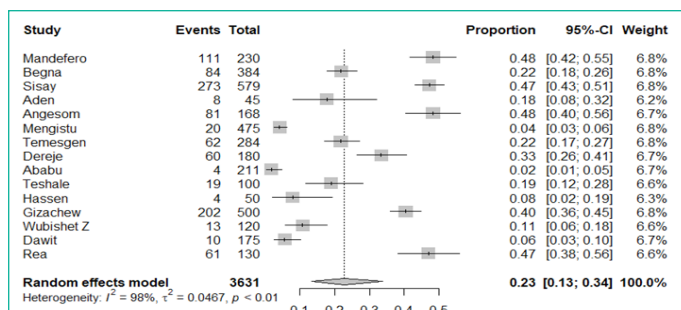


Figure 5: Show forest plots of meta-analysis for awareness population about zoonoticity and transmission towards brucellosis in Ethiopia. At the bottom of the plot, a diamond shape represents the average effect. The length of the diamond symbolizes the confidence interval of the pooled result on the x-axis.

### Awareness of Study Participants on Clinical Signs of Brucellosis

From included studies nine studies were explored the awareness of the respondents about clinical signs of brucellosis. Pooled awareness level of respondent which have awareness on clinical signs of brucellosis was 18.5% with 95% CL (0.0639; 0.34930) as presented in a forest plot (Figure 6). We explored the distribution of brucellosis symptoms in human that were mentioned in the included studies. Fever, fatigue, joint pain, sweating and abortion were the most commonly mentioned symptom of animal brucellosis.

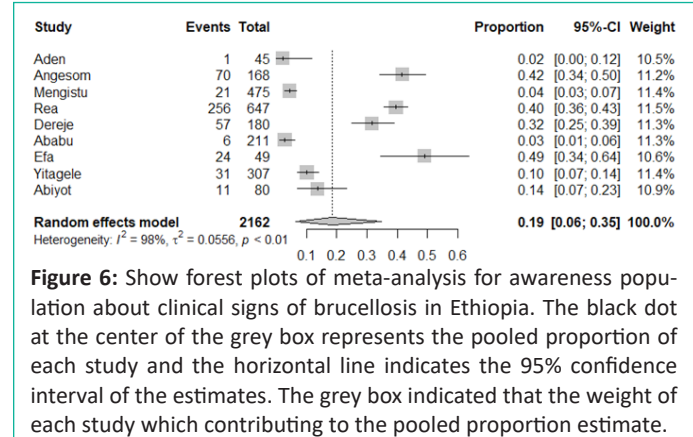


Figure 6: Show forest plots of meta-analysis for awareness population about clinical signs of brucellosis in Ethiopia. The black dot at the center of the grey box represents the pooled proportion of each study and the horizontal line indicates the 95% confidence interval of the estimates. The grey box indicated that the weight of each study which contributing to the pooled proportion estimate.

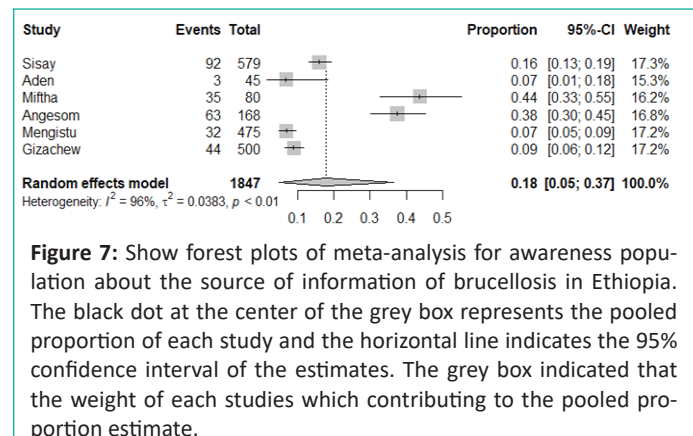


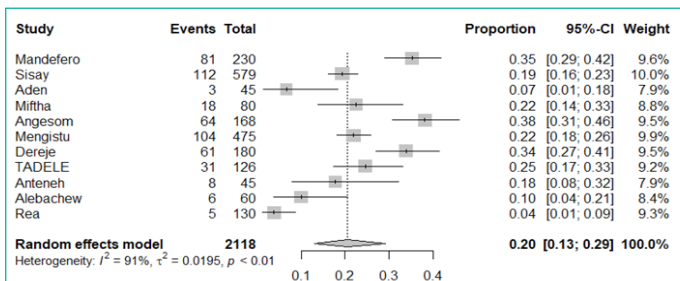
Figure 7: Show forest plots of meta-analysis for awareness population about the source of information of brucellosis in Ethiopia. The black dot at the center of the grey box represents the pooled proportion of each study and the horizontal line indicates the 95% confidence interval of the estimates. The grey box indicated that the weight of each studies which contributing to the pooled proportion estimate.

### Source of Information about Brucellosis in the Study Participants

Six studies were explored the awareness regarding the source of information about brucellosis. The pooled awareness level of respondent which have awareness on source of information about brucellosis was 17.83% with 95% CI (0.0476; 0.3657). These six studies were analyzed the information sources of those respondents who had heard about brucellosis. The respondents mainly acquired knowledge of brucellosis from neighbors, friends, mass media, and health workers and from different training. The estimated overall level of good knowledge, practice in Ethiopia is presented in a forest plot (Figure 7).

### Awareness of Study Participants on Disease Control and Prevention Strategies

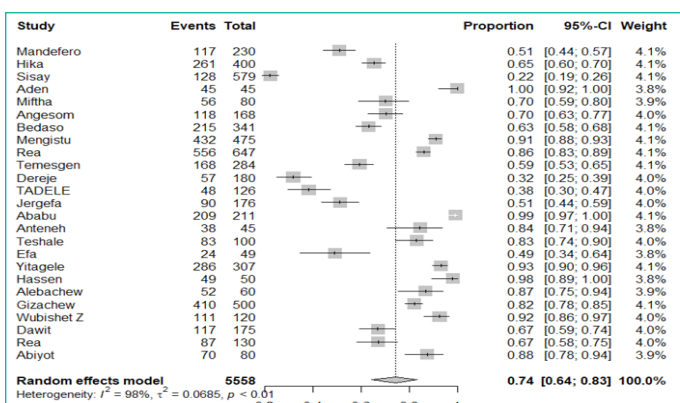
The overall awareness of respondent about control and prevention strategies of brucellosis was reported in 11 studies, with a pooled awareness level of 20% with 95% CI (0.1300; 0.2915) by using random-effects model as presented in a forest plot (Figure 8). The others 79.51% of the respondent have not awareness about control and prevention of the brucellosis. These result shows significant heterogeneity among studies ( $I^2= 91.1\%$ ,  $p \leq 0.0001$ ).



**Figure 8:** Show forest plots of meta-analysis for awareness of population about brucellosis control and prevention strategies in Ethiopia. At the bottom of the plot, a diamond shape represents the average effect. The length of the diamond symbolizes the confidence interval of the pooled result on the x-axis.

**Practices of Study Participants toward Brucellosis**

From included studies 25 articles were explored the overall practice of respondents on Brucellosis. The overall poor practices of the respondents were 74.3%, with 95%-CI (0.6411; 0.8333) while the remaining 26% of the respondents had good practice about Brucellosis presented in a forest plot (Figure 6). These result shows significant heterogeneity among studies ( $I^2=98.5\%$ ,  $p \leq 0.0001$ ). Most of the respondents practiced unsafely contact with their animals; used meat slaughtered from backyard slaughter system, consumed raw milk and had a habit of eating raw meat.



**Figure 9:** Show forest plots of meta-analysis for overall practice of population about Brucellosis control and prevention strategies in Ethiopia. The black dot at the center of the grey box represents the pooled proportion of each study and the horizontal line indicates the 95% confidence interval of the estimates. The grey box indicated that the weight of each studies which contributing to the pooled proportion estimate.

**Sub-Group Analysis for Knowledge Based on Occupation and Region**

Sub-group analysis was done for overall knowledge of respondent based on region, occupation, sampling method, and

**Table 2:** Sub-group analysis of knowledge of brucellosis.

Subgroups	Categories	Numbers of studies	Pooled Proportion	Level (95%CI)	I <sup>2</sup>	P-Value
Region	Oromia	14	20.4%	0.0999; 0.2524	95%	< 0.0001
	Amhara	1	69.8%	0.2941; 0.9730	—	—
	Afar	5	21.4%	0.0077; 0.5784	99.1%	< 0.0001
	Tigray	1	51%	0.1174; 0.8957	—	—
	Somali	1	8.9%	0.0000; 0.4677	—	—
Occupation	Livestock owners (farmers)	14	22.6%	(0.1425; 0.3217)	95.5%	<0.0001
	Pastoralist and agro-pastoralist	7	20%	0.0314; 0.4574	98.8%	<0.0001
	Employers	2	26.5%	0.0001; 1.0000	98.7%	<0.0001
	Others	2	10.4%	0.0000; 0.4694	51.2%	<0.0001

animal species and we checked the possible heterogeneity among studies. In Oromia region, 20.4% of respondents have knowledge with 95% CL (0.0999; 0.2524),  $I^2=94.8\%$ ,  $p$ -value < 0.0001 where as in Amhara region 69.8% of respondents had knowledge about brucellosis. Furthermore, we have done a sub-group analysis by way of occupation, since there is heterogeneity. Hence, three was the highest estimated status of the knowledge for pastoralist, and agro-pastoralist sub-group which was 20% (0.0314; 0.4574) while dairy farmers and retailers had 22.6% (0.1425; 0.3217) (Table 2). Again, the heterogeneity still existed. So, for the last, we performed sub-group analysis based on the study area but there is no evidence of heterogeneity.

Sub-group analysis also done for practices respondents towards brucellosis based on occupation and region. Of the 25 studies, the highest estimated status of poor practice respondents towards brucellosis was 98% (0.6650; 1.0000) in Dire dawa city administration. While Amhara region respondents had the lowest poor practice with 22.11% 95% CI (0.0027; 0.6343). Finally, we have carried out a sub-group analysis based on occupation. Hence, the highest estimated prevalence of the poor practice among pastoralist and, agro-pastoralist with 85.9% 95% CI (0.4062; 1.0000) but farmers and employers had less poor practice with 59% 95% CI (0.1369; 0.9631).

Sub-group analysis for attitude towards brucellosis using methods of a region, and occupation was done. Of the 12 studies, the highest estimated status of attitude towards brucellosis studied in Harari region, 98% the respondents had positive attitudes with (0.6650; 1.0000) whereas, the lowest one was in Amhara region which was 22% of the respondents had positive attitudes towards brucellosis with 95% CI (0.0027; 0.6343). Furthermore, we have done a sub-group analysis based on occupation since heterogeneity existed. Hence, 90% of employer and agro-pastoralist had positive attitudes towards about brucellosis with 95% CI (0.4062; 1.0000) but, 50% dairy farmers and retailers had less attitudes towards brucellosis with 95% CI (0.0839; 0.9256).

The pooled awareness level of the zoonotic nature of brucellosis had higher in pastoralist (16%) than farmer (14%). The Livestock owners (farmers) (24%) showed relatively higher awareness of the zoonotic nature of brucellosis than dairy farmers (11%), pastoralist (15.8%) and abattoir workers, butchers (12.5%). Regarding the mode of transmission from infected animal to human, a low awareness level was found in the occupationally exposed population, whereas a relatively higher awareness level was found in human health care providers and animal health workers. However, abattoir workers and dairy farmers had extremely low awareness levels. With regards to awareness of the symptoms of brucellosis in human and animals, higher awareness levels were found in employers and pastoralists.

**Table 3:** Sub-group analysis of poor practices of study participants toward brucellosis.

Subgroups	Categories	Numbers of studies	Pooled Proportion	Level (95%CI)	I <sup>2</sup>	P-Value
Region	Oromia	14	68%	0.5453;0.8018	96.5%	< 0.0001
	Amhara	1	22.11%	0.0027; 0.6343		-
	Afar	5	87.71%	0.7052; 0.9809	95.7%	< 0.0001
	Tigray	1	48.98%	0.0936; 0.8938	-	-
	Somali	1	84.44%	0.4155; 1.000	-	-
	Harari	1	98%	0.6650; 1.0000	-	-
	SNNP	1	86.67%	0.4551; 1.0000	-	-
Occupation	Livestock owners (farmers)	15	70.7%	0.5461; 0.8452	98.6%	<0.0001
	Pastoralist and agro-pastoralist	6	85.9%	0.7051; 0.9246	91.2%	<0.0001
	Employers	2	64.95%	0.4018; 0.8608		-
	Others	2	81.97%	0.0001; 1.0000	99.4%	<0.0001

## Discussion

Occupation based training regarding raising of the awareness of brucellosis is an important for the effective control of brucellosis [19]. Raising the awareness of brucellosis and brucellosis-related knowledge in occupation-related groups is an important aspect for the effective control of brucellosis [50]. The overall result of this study revealed that from the total study participants 16.96% had awareness and knowledge about brucellosis, while the remaining 83% had no awareness about brucellosis. This finding is nearly similar with study in India (region of Puducherry) revealed 16.4% in brucellosis [51]. But, it is lower than another study (30.8 %) which was done in Punjab region of India [52]. Brucellosis is neglected zoonotic disease that causes a considerable animal and human morbidity in many areas of the world especially poor countries like Africa [53,54]. However, the results of this study revealed that the study participants had no information on the zoonotic importance of brucellosis with 22.75%. The result is also in agreement with the study reports from Tajikistan in which the majority (85%) of the study participants had no awareness about brucellosis [55].

The awareness of the participants in this study about the zoonotic importance of brucellosis was lower than others studies which have done at Jimma in Oromia region with reported 46.0% [56]. On the other hand, similar studies done in Jimma reported 22.1%, while 0% in another case for brucellosis respectively [57,58]. There were similar findings in Afar Region in which only (7.7%) study participants had knowledge about a disease called brucellosis. This variation could be due in the variation of socio-economic, socio-demographic, training access and residence factors.

This study revealed that study participants were consumed raw milk (54%), raw meat (50%) and contact of sick animal product without protective. This study in agreement with other studies in Jimma and 66.8% responded by consumption of both raw milk and meat [47], while in Cape Town which is reported 67% and 56% of raw milk and meat, respectively [59]. The result of this study indicated that the study respondents had poor level of knowledge on transmission of brucellosis through milk and meat. This could be due to the respondent had not training access about means of transmission of brucellosis.

Only 20% the pastoral and agro-pastoralist community had concern about brucellosis which causes abortion in their animals. This is similar to the findings of a study by Kothalawala et al. [60] in Sri Lanka where farmers identified this disease as a cause of abortion in their cattle, but they had no adequate

information regarding brucellosis as a cause of abortion in animals.

On the other hand, 28.5% of the present study participants mentioned brucellosis (hahayita) as a disease which causes abortion in animals. However, the finding of this study contrasts the findings of studies which showed that most of the study participants mentioned abortion as the major clinical sign of brucellosis in animals from elsewhere [61]. The present study indicated that in Ethiopia there was lack of well-organized extension system communities to create awareness to the community members about diseases which cause abortion in their animals like elsewhere [62].

In contrast to present studies, studies done in other countries such as Kenya [61,58,63] indicated that a large proportion of the study participants knew the disease by the name brucellosis. 74.3% of present study participants not wearing protective glove when assisting of animal during abortion, calving, and removing retention placenta. 80% of respondent in study area was had no about prevention and control method of brucellosis in animal and human. The main practices for management of aborted material and fetus in the present studies were giving to dogs, and throw on the ground without disposing properly.

17.83% of study participants mentioned they had information about brucellosis from different sources includes mass media (radio/TV), friends and training; this fact may suggest that dissemination of knowledge about brucellosis by using of television or radio was the main way to reach the communities. This should be considered in the development of education programs regarding brucellosis control. And also the study participants heard information about the zoonoticity of brucellosis was from health education, training, and families. Generally, most of present study participants had not information sources [27].

The results of 14 studies in Oromia region showed that the estimated practice towards brucellosis (poor practice) was 68% (95% CI (0.5453; 0.8018)) as well as Amhara region had less poor practice as compared to other regions as shown in (Table 3). Based on the occupation of study participants, 85.9% of pastoralist and agro-pastoralists had poor practice as compared to different occupation.

Due to the low knowledge of brucellosis, public food safety need and highly exposed population in the government sectors more attention. This knowledge gap could lead to delay in seeking medical support diagnosis and treatment of the disease



[64,65]. This could result long-term complications and disabilities [66]. In addition, the low brucellosis awareness and knowledge level of people involved in the livestock value chain could lead to a neglect in disease prevention and incorrect practices in handling, cooking and preserving animal-based food, which poses a great threat to public food safety [67]. So knowing the high-risk behaviors associated with brucellosis infections could be important to promote individuals to take protective measures, such as avoiding the consumption of uncooked meat and raw milk, wearing gloves when delivering or handling abortion materials. Several studies in the meta-analysis have indicated

there was many factors which are related to the level of awareness of brucellosis includes education, and researches [68].

On the other hand, in Harari region 80% of study participants had information regarding the zoonotic importance and mode of transmission as presented on (Table 4). These finding contrasts with the findings of studies from the previous studies in Afar region 50% of the study participants had information about zoonotic [33]. Similar previous reports from Sri Lanka [60] and Nigeria [69] regarding the zoonotic importance and mode of transmission, most of the study participants had no a clear information.

**Table 4:** Subgroup analysis of Awareness of study participants on zoonoticity and means of transmission.

Subgroups	Categories	Numbers of studies	Pooled Proportion	Level (95%CI)	I <sup>2</sup>	P-Value
Region	Oromia	11	29.93%	0.1910; 0.4202	96.5%	< 0.0001
	Afar	3	67.3%	0.0000; 0.3841	92.6%	< 0.0001
	Harari	1	80%	0.0000; 0.3905	-	-
Occupation	Livestock owners (farmers)	8	29.34%	0.1776; 0.4244	95.3%	<0.0001
	Pastoralist and agro-pastoralist	4	17.45%	0.0004; 0.5242	97.6%	<0.0001
	Employers	2	23.42%	0.0000; 1.0000	98.9%	<0.0001
	Others	1	19%	0.0000; 0.2770	-	-

Overall, knowledge and awareness of brucellosis were insufficient in the occupation-related groups. The knowledge levels regarding mode of transmission and symptoms in humans, the zoonotic nature, and animals of brucellosis were lower than the awareness level of brucellosis, which means that people had heard of brucellosis but did not necessarily have a clear understanding of brucellosis. This could be an obstacle for brucellosis control and prevention in Ethiopia [70]. The low awareness and knowledge levels elucidated in this study are therefore of great importance, particularly considering the zoonotic nature and the public health significance of brucellosis.

Health education about brucellosis for animal owners, and health workers was essential in gaining support for a control program [71]. Therefore, exploring the knowledge, attitude and practice of communities is important for the development and implementation of more efficient health education activities and brucellosis control programs that concerned the needs and perceptions of communities [72].

In the present study, greater brucellosis awareness and knowledge were reported in the respondents involved in employers, and the awareness level of the participants involved in dairy production was higher than that pastoral and agro-pastoral communities involved in small ruminant production. Health workers play an important role in health education and disease knowledge advocacy for occupational groups. In this study, the greatest awareness was reported in health care providers, including both animal and human health workers. This can be explained by their medical background and the training and experience they receive over their career, which proves the importance of education and training to improve the awareness of brucellosis in high-risk groups [73,74]. The results showed that the main brucellosis information sources were friends and neighbors. Cooperation and communication between the human and animal health sectors, the education sectors, the agricultural sector, animal producers and other relevant occupational groups are very important to improve the awareness and control of brucellosis.

### Limitations

The limitation of this study was searching of published articles because there was no enough data or studies regarding the level of knowledge, practice and perception of the studied populations about brucellosis. The fact that each studies was used different measurements for the level of knowledge, practice and perception. So that this difference makes difficult to conclude and compare our finding with others finding. The scarcity of data in the study regions of Ethiopia. We used quantitative approach to measuring knowledge, attitude, and practice, so, we did not included qualitative work and focus group discussion which are important to gather detailed and additional information regarding study populations awareness about brucellosis.

### Conclusions

Awareness, attitude and practice of communities towards brucellosis were differing by occupation, and region. This study generally found that most of the study participants were engaged in at least one risky practice that is crucial for the transmission of brucellosis from animal to human. As a result, a large percentage of communities in Ethiopia have inadequate awareness of brucellosis. It is crucial to raise knowledge of brucellosis among livestock owners and health professionals, especially veterinarians, because perceptions of affected communities have an impact on the creation and adoption of best practices and habits as well as the implementation of disease control initiatives.

### Author Contribution Statement

Gashaw Enbiyale and Yohans Dagnaw: data extraction, analyzed and interpreted the data, wrote the paper.

Daniel working: wrote the paper and editing; Tadesse Mihret: editing and interpreted the data.

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## Declaration of Interests' Statement

The authors declare no conflict of interest.

## Data Availability

The data will available based on request.

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