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Research Article

# Assessment of farmers' knowledge, attitudes and practices toward brucellosis in Sibu Sire District, East Wallaga Zone of Western Oromiya, Ethiopia

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## Abstract

Brucellosis is a contagious zoonotic disease transferred from sick animals to humans and endemic in Eastern Africa and other countries. The objective of this study was to assess the extent of the knowledge and attitudes relating to brucellosis at the human-animal interface and identify practice at the farm and household level that poses a risk for human infection at the study site. By cross-sectional study design, a total of 120 participants were involved in assessing Knowledge, Attitude, and practice (KAP) toward the disease. From the study, about 20% of respondents knew the disease, out of which 75% heard about it from a veterinary service. Nearly, 79% and 75% understood that the disease can be transmitted between cattle and from cattle to humans respectively. About 54.2% handle placental membranes and aborted fetuses with bare hands. Of the total respondents, 5.8% and 38.3% have had good knowledge and good practice scores respectively. Educational level, with illiterate less, knew, highly influences both knowledge ($p$ = 0.01) and practice ($p$ = 0.018) of the respondents. Males ($p$ = 0.006) had a good practice, which was statistically significant. This indicates that an awareness creation campaign is important so as to equip the farmers in the study areas with knowledge of the disease and to change their malpractice in order to protect themselves from brucellosis.

## Introduction

Brucellosis is the second most zoonotic disease with more than 500,000 human cases every year globally [1,2]. According to the Food and Agriculture Organization (FAO), World Health Organization (WHO), and World Organization for Animal Health (WOAH), brucellosis is considered one of the most pervasive diseases in the world [3,4]. Historically, it has been called by many names, comprising Malta fever, Mediterranean fever, undulant fever, and crop disease in humans or Bang's disease in cattle [2,5]. Brucellosis is caused by different species of Gram-negative bacteria of the genus *Brucella*. The major species of *Brucella* and their principal hosts are *B. abortus* (cattle), *B. melitensis* (goats), *B. suis* (pigs), and *B. ovis* (sheep). *Brucella melitensis, B. abortus, B. suis, and B. canis are* among six classical species which are predominantly pathogenic for human beings respectively [6,7]. These pathogens are intracellular and persist within an individual animal, resulting in the lifetime carriage of the organism [2,8]. Brucellosis is a severe contagious disease that causes reproductive failure and zoonotic potential with profound public health importance [9]. The pathogen can cause pathological changes with the involvement of multiple organs. Portals of entry may include mucosal surfaces, ingestion, or droplets [10,11].

In animals, it mainly affects sexually mature animals and causes late-trimester abortions, weak calves, and infertility characterized by placentitis in infected females, epididymitis and Orchitis in males, and appetite loss [12]. Infected animals with this disease can transmit the pathogen to other animals through uterine and vaginal discharge and contaminated milk [2] and these bacteria can spread within the herd through



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ingestion of contaminated material [13]. Human brucellosis can occur through the consumption of raw milk and milk products from infected animals and via direct handling of contaminated materials from infected animals, specifically in aborted fetuses, fetal membranes, and vaginal secretions. Inhalation of pathogens and direct entrance via skin abrasions are other routes of human infection (Dasari, et al. 2013). It is noted that professionals and other individuals who handled infected animals and their products are also at risk of contracting the disease (Madut, et al. 2019).

It is of major economic and public health importance in most developing countries, which have not had a national brucellosis control and eradication program [5]. In most developing countries like Ethiopia, the resource is short falling to control brucellosis. The absence of rigorous zoonotic disease prevention and control programs poses a high risk to vulnerable poor rural livestock producers and livestock product consumers along the value chain. This disease and other zoonotic lack of awareness accompanied by poverty mean that risky behavior related to animal management and abortion material handling and disposal persists [14]. In Ethiopia, several serological surveys have shown that it is endemic and widespread [15-25].

In Ethiopia, and more specifically in the current study area, information on awareness of brucellosis and its zoonotic importance is not well established as compared to the high degree of the risks of the disease. Lack of knowledge and poor practice is very risky for private as well as government farmers who have a great tendency to expand high-producing exotic dairy farms to satisfy the ever-increasing milk demand of the urban population in the country. In the country, almost all animal owners or attendants have daily direct contact with animals and are involved in different stages of the animal production cycle (Kinati, et al. 2018). Close interaction between livestock and humans also occurs due to the close proximity of livestock to living accommodations or even shared housing during severe weather conditions [26]. In such situations, lack of awareness, poor practice that makes one contact with this infectious disease, and a negative attitude can be risky. Having basic knowledge, attitude, and application of the right practice in the community is highly privileged in the prevention and control of brucellosis, and researchers [14,25] recommend it. Raising public awareness regarding traditional practices that could potentially cause exposure to *Brucella* infection and prevention methods is a clear need. Thus, assessing the community's/livestock owners' KAP towards bovine brucellosis and risk factors for human infection is very required in the country as a whole and specifically in Sibu Sire districts. Therefore, the objective of this study is to assess the extent of the knowledge and attitudes relating to brucellosis at the human-animal interface and identify practice at the farm and household level that poses a risk for human infection in Sibu Sire districts.

## Materials and methods

### Description of the study area

This study was conducted in the Sibu Sire district of the East Wallaga zone of the Western Oromia Regional administration. The study sites are purposively selected based on the serological presence of bovine brucellosis [19] and the abundance of livestock owners in the district and then, to know whether the communities of the district understand the how of the disease prevention and their awareness. The district is found in the East direction from Nekemte town, the capital of East Wallaga zone, having a distance of 58 km from the town and 273 km from Finfinne (Addis Ababa), the capital of Oromia regional administration, Ethiopia, and the center of African Union. Geographically, the district is located at 8°9'41"- 9°3'79"N latitude and 36°7'82" - 36°9'25"E longitude with an elevation of 1300 to 3020 Masl. The climate alternates with long summer rainfall (June - September) and winter dry season (October-May) with a mean annual rainfall of 1950 mm - 1100 mm, with a daily temperature of 18.5 °C - 27.5 °C. The district consists of 23 villages and a total human population of 73,970 of which 37,810 are male and 36,160 are female (CSA, 2007). The total livestock population of the area is 603,110 of which 323954 are cattle, 45723 sheep, 32528 goats, 14690 equines, and 186215 are poultry (CSA, 2020). The study was done between the period December 2021 and May 2022 by selecting five villages from the district namely Fallamo Yubdo, J/wama, Lalisa, Bujura, and Chari (Figure 1).

### Study design and sampling technique

A cross-sectional study design, using an interview-based survey, was executed to collect data from December 2021 to May 2022 in the Sibu Sire district of the East Wallaga zone, Oromia regional state. A convenient sampling technique was used to select the district based on the ease of sample collection. However, simple random sampling was employed to select study villages and households involved in this study.

### Study population (study participant)

The study populations considered for this study were farmers of different ages, sex, and educational background having exposure to diseases of animal origin because of direct or indirect contact with livestock and their products.

**Study unit selection criteria:** Farmers of less than 18 years of age and those who did not own at least one cattle or sheep or goat were excluded from the study since human-animal interaction and contact is the dominant transmission method of the disease from animals to humans.

### Sample size determination

The number of participants to be included in the study population was determined based on the sample size calculation recommended by Arsham, (2007) which is N = 0.25/SE where SE stands for standard error as well as Whitley and Ball [27] formula (which is N" = N/1-q, where N" is the final sample size to be collected, N = the first sample size calculated by Arsham, (2007) and q = proportion of attrition) was used to increase the accuracy of the result and to compensate respondents that were expected to refuse to participate or to drop out before the study ends. Hence by considering a standard error of 5%, precision



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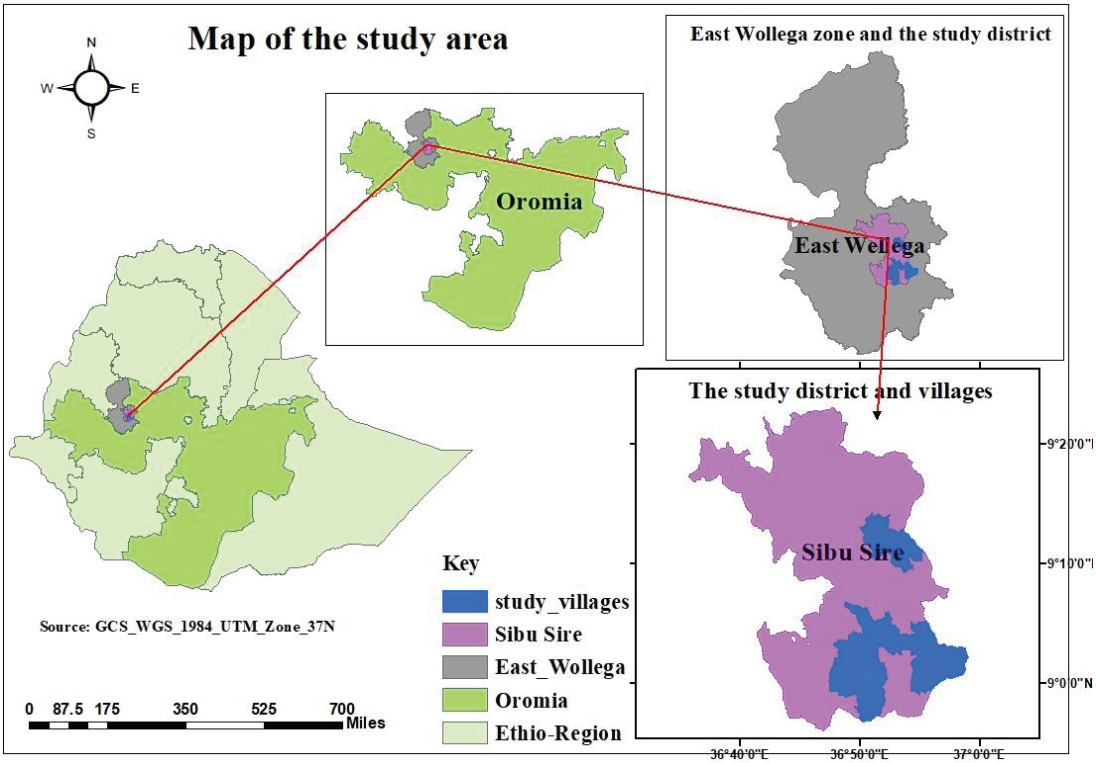


**Figure 1:** Map of the study area.

level of 5%, confidence level of 95%, and 17% of proportion of attrition, a total of 120 samples were collected.

## Survey instrument

A semi-structured questionnaire was developed to measure participants' knowledge about zoonotic disease, attitudinal barriers related to brucellosis risk and exposure prevention from livestock birth products, and practices used to prevent the disease risks from livestock birth products. The demographic questionnaire included information on gender, age, education, primary livelihood activity, ethnicity, marital status, intervention status, and residential area, as well as on animal abortion history in the farm/herds.

A thorough review of the literature was done to generate items for the KAP survey. Then, to confirm the content validity of the survey tool, veterinary experts, public health specialists, and epidemiologists were requested to evaluate the questionnaire in terms of wording, grammar, relevance, and coverage. A pilot study was attempted on 10 farmers who were not included in the study population to assess the face validity of the items and to understand the meaningfulness of the concepts in the studied population. The survey tool was updated based on the feedback gained during the pre-test. The questions related to farmers, farming systems, and their prevailing knowledge and practices towards disease management with a focus on brucellosis. Knowledge about brucellosis was assessed by asking the farmers if they had heard of the disease called 'brucellosis' (there is the local term for the disease, the word 'Gatachisa' in Afan Oromo). The questions highly focus on the knowledge and awareness related to the transmission of brucellosis from livestock to humans. Accordingly, 34 semi-structured questionnaire surveys were presented to the respondents

## Data analysis

The data collected from the field were entered into Microsoft Excel spreadsheet version 2010 and checked for errors. Then the data was imported and analyzed by using statistical software called Statistical Package for Social Sciences and currently named Statistical Product for Service Solutions (SPSS) version 20 (SPSS Inc., Chicago, Illinois, USA). Descriptive statistics such as proportion and frequency were utilized to present the results of demographic features of the respondents, knowledge, attitudes, and practice questions. Knowledge, attitude, and practice scores were calculated according to Kothalawal, et al. [28]. Accordingly,

$$\text{Knowledge score}_k = \frac{CA_k}{QE_k}$$

Where $QE_k$ is the number of questions against farmers and $CA_k$ is the number of individual correct answers. Then, after calculating the mean for all respondents, it was multiplied by 100 to be converted into proportion and if the proportion of the individual farmer was found below 50%, it was concluded that the KAP score of the farmer was poor, but if found 50% - 75% it was taken as a good and >75% considered as very good knowledge and practice score. Attitude score analysis was categorized into two categories (negative and positive) in which attitude score <50% was regarded as negative and >50% proportion was taken as positive attitude score. The



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Fishery exact test was used for the analysis of the association between the KAP score and demographic profiles of the study participants and the Knowledge score with practices of the respondents. The statistical significance level was set at a 95% confidence level and a 5% level of precision so that a p-value ≤ 0.05 was considered significant.

## Results

The majority of this study's participants were male (65%) and found between the age category of 26 - 40 years old (57.5%) with an educational background of basic education (52.5%) (Table 1).

Descriptive analysis of knowledge of this study respondents indicated that 24 (20.0%) of them knew about the disease from which 18 (75.0%) of them heard from veterinarians. Nineteen (79.2%) and 18 (75.0%) of the participants knew that the disease can transmit between animals and from animals to humans respectively (Table 2).

Attitude analysis of this study respondents revealed that 107 (89.2%) need to know more information about the disease. More than half 73 (60.8%) did not believe that personnel working mostly with cows exposed to the *Brucella* infection are at high risk of infection (Table 3).

Regarding the practice of the respondents, this finding indicated that 65 (54.2%) handle aborted fetuses and placental membranes bare hand and, at the same time, they provide/ give aborted fetuses/ afterbirth to dogs. Similarly, 67 (55.8%) of this study participants throw away or dump aborted fetuses into the environment (Table 4).

Evaluation of the association between knowledge score and demographic characteristics of the respondents showed that educational level was found statistically significant association ($p$ - value = 0.001). On the other side, 96 (80.0%), 7 (5.8%), and 17 (14.2%) of the participants had poor, good, and very good knowledge scores respectively (Table 5).

Univariable analysis of demographic features of the respondents and practice score of this study showed that practice score was significantly associated with gender and educational status. Besides this, 46 (38.3%) and 7 (5.8%) were practicing in a good and very good manner respectively (Table 6).

A three-dimensional analysis of the association between knowledge, attitude, and practice score revealed that the majority of the respondents (23.3%) had poor knowledge and practice scores but positive attitude scores. However, only 0.8% had very good scores for both knowledge and practice with positive attitude scores. Of the total respondents 16.7% exercise good practice and has a positive attitude even though they do have poor knowledge about *Brucella*.

## Discussion

In the current KAP assessment; the descriptive analysis of livestock owners' knowledge regarding bovine brucellosis in

**Table 1:** Demographic Profiles of the Respondents who participated in the study.

| Parameters | Categories | Frequency (%) |
|---|---|---|
| Gender | Male | 78 (65) |
| | Female | 42 (35) |
| Age (in years ) | 18 - 25 | 27 (22.5) |
| | 26 - 40 | 69 (57.5) |
| | 41 - 60 | 23 (19.2) |
| | >60 | 1 (0.8) |
| Marital status | Single | 45 (37.5) |
| | Married | 68 (56.7) |
| | Divorced | 7 (5.8) |
| Educational Level | Illiterate | 35 (29.2) |
| | Basic Education | 63 (52.5) |
| | Elementary | 16 (13.3) |
| | High School | 4 (3.3) |
| | Diploma | 2 (1.7) |

**Table 2:** Descriptive statistics of Knowledge about the Diseases in the study area.

| Knowledge Questions | Categories | Frequency (%) |
|---|---|---|
| Do you know that diseases can transmit during the handling of delivery or abortion? | Yes | 57 (47.5) |
| | No | 63 (52.5) |
| Do you know a disease called Brucellosis? | Yes | 24 (20.0) |
| If yes, from where did you hear about it? | Vet. Services | 18 (75.0) |
| | Community gathering and/ or talk | 4 (16.7) |
| | Neighbors | 1 (4.2) |
| | At school | 1 (4.2) |
| If yes, do animals infected with Brucellosis? | Yes | 18 (75.0) |
| | No | 5 (20.8) |
| | I don't know | 1 (4.2) |
| If yes, which group of animals? | Cattle | 13 (72.2) |
| | Shoats | 2 (11.1) |
| | All animals | 3 (16.7) |
| If yes, Is brucellosis transmitted between cattle? | Yes | 19 (79.2) |
| | No | 4 (16.7) |
| | I Don't Know | 1 (4.2) |
| If yes, how does brucellosis transmit between cattle? | Abortion | 16 (66.7) |
| | Shared grazing | 5 (20.8) |
| | Shared pens | 2 (8.3) |
| | Placenta from live birth | 1 (4.2) |
| What symptoms do you know in cattle? | Abortion | 19 (79.2) |
| | Weak Calves | 3 (12.5) |
| | Infertility | 1 (4.2) |
| Do you know that brucellosis transmit from animals to humans? | Yes | 18 (75.0) |
| | No | 5 (20.8) |
| | I don't know | 1 (4.2) |
| If yes, by what mechanisms? | Drinking raw milk | 2 (11.1) |
| | Assisting with calving and or handling the placenta | 3 (16.7) |
| | Handling abortion | 6 (33.3) |
| | Slaughtering infected animal | 7 (38.9) |
| Have you ever encountered Brucella infection within your animals? | Yes | 16 (66.7) |
| | No | 7 (29.2) |
| | I don't know | 1 (4.2) |
| Is brucellosis a preventable disease? | Yes | 20 (83.3) |
| | No | 3 (12.5) |
| | I don't know | 1 (4.2) |
| If yes, how? | Avoiding drinking raw milk | 8 (40) |
| | Avoiding careless handling of aborted fetuses and or RFM | 10 (50) |
| | Avoid Consumption of raw food | 2 (10) |



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the Sibu Sire district, shows that 24 (20.0%) of respondents from the total of 120 participants knew about the disease called bovine brucellosis. This result indicated that the majority of livestock owners (80%) did not know what bovine brucellosis is and the mechanisms of its transmission (Table 2). The present result nearly concords with the finding of 21.6% by Abera, et al. (2016) in and around Asella and 18% by Deka, et al. [29] from peri-urban and rural areas of Assam and Bihar in India. It also supports the recently done systematic review and meta-analysis of 79 observational studies conducted by Guan, et al. [30] which indicated the lowest level of knowledge of brucellosis in Ethiopia (17.3%) from African countries. However, this result is far lower than the results of 79% by Obonyo and Gufu, (2015) in Pastoral Communities in Kenya; 70% by Arif, et al. [2] in smallholder dairy livestock owners in Pakistan, and 59.9% by Cloete, et al. [13] in communal cattle keeper group in South Africa.

On the other hand, the knowledge of the livestock owners in the present study is found better than the finding of Kuma, et al. [31] in which none of the respondents were aware of brucellosis in Jimma; Girma [32], which is 2.2% in Debre-Birhan Town, Lakew, et al. (2019) who reported 2.0% in the Somali region and Gichamo, et al. (2020) of 3.8% in Southern Ethiopia. Such variation across different countries and areas in terms of knowledge may be due to differences in access to formal education, previous experience with bovine brucellosis, health education programs, and extension services, communication, and cooperation between the animal and human health

**Table 3:** Descriptive Statistics of Attitude about the Diseases.

| Attitude Questions | Categories | Frequency (%) |
|---|---|---|
| Do you need to know more information about the disease? | Yes | 107 (89.2) |
| | No | 13 (10.8) |
| If yes, from which source do you want the information? | Health professionals | 42 (39.3) |
| | Family and friends | 9 (8.4) |
| | Meeting in the village | 4 (3.7) |
| | Social media | 3 (2.8) |
| | Vet. Services | 49 (45.8) |
| Do you believe that you or your family members working most with the cows exposed to the Brucella infection are at high risk of infection? | Yes | 47 (39.2) |
| | No | 73 (60.8) |
| The general hygiene of the house of your cattle | very good | 33 (27.5) |
| | Good | 68 (56.7) |
| | Satisfactory | 18 (15.0) |
| | Poor | 1 (0.8) |
| Do you think that selling cows that frequently abort is correct? | Yes | 45 (37.5) |
| | No | 75 (62.5) |
| Do you believe that putting delivered cow in separate rooms is important in disease prevention? | Yes | 76 (63.3) |
| | No | 44 (36.7) |

**Table 4**: Descriptive Statistics of Practice toward the Diseases.

| Practice Questions | Categories | Frequency (%) |
|---|---|---|
| Do you separate cows during parturition? | Yes | 70 (58.3) |
| | No | 50( 41.7) |
| Do you mix your animals (cattle) with other herds? | Yes | 67 (55.8) |
| | No | 53 (44.2) |
| How do you handle aborted fetuses and placental membranes? | bare hand | 65 (54.2) |
| | using glove | 8 (6.7) |
| | washing hands after handling | 47 (39.2) |
| Do you keep dogs with your cattle? | Yes | 71 (59.2) |
| | No | 49 (40.8) |
| Do you provide/give aborted fetuses/ afterbirth to dogs? | Yes | 65 (54.2) |
| | No | 55 (45.8) |
| Do you drink raw milk and its products? | Yes | 43 (35.8) |
| | No | 77 (64.2) |
| Do you eat raw meat? (yes=1, No=0) | Yes | 74 (61.7) |
| | No | 46 (38.3) |
| Who assists your cattle during delivery? | Veterinarians | 40 (33.3) |
| | Shepherds | 52 (43.3) |
| | Household members | 28 (23.3) |
| What do you do if a cow aborts? | Contact veterinarians | 51 (42.5) |
| | Apply home remedies | 40 (33.3) |
| | Nothing | 29 (24.2) |
| What do you do if an aborted fetus is found? | Bury in ground | 33 (27.5) |
| | Throw away or dump | 67 (55.8) |
| | Give to dogs | 20 (16.6) |

**Table 5:** Univariable analysis of knowledge score and demographic characteristics of the study participants.

| Variables | Categories | Knowledge score N (%) | | | Fishery's Exact test | p - value |
|---|---|---|---|---|---|---|
| | | Poor | Good | Very good | | |
| Gender | Male | 42 (35) | 4 (3.3) | 12 (10) | 4.377 | 0.105 |
| | Female | 54 (45) | 3 (2.5) | 5 (4.2) | | |
| Age | 18 - 25 | 24 (20) | 1 (0.8) | 2 (1.7) | 5.701 | 0.526 |
| | 26 - 40 | 54 (45) | 3 (2.5) | 12 (10) | | |
| | 41 - 60 | 17 (14.2) | 3 (2.5) | 3 (2.5) | | |
| | >60 | 1 (0.8) | 0 | 0 | | |
| Marital Status | Single | 35 (29.2) | 5 (4.2) | 5 (4.2) | 8.944 | 0.175 |
| | Married | 56 (46.7) | 1 (0.8) | 11 (9.2) | | |
| | Divorced | 5 (4.2) | 1 (0.8) | 1 (0.8) | | |
| Educational Level | Illiterate | 31 (25.8) | 0 | 4 (3.3) | 23.383 | 0.001 |
| | BE | 55 (45.8) | 3 (2.5) | 5 (4.2) | | |
| | Elementary | 8 (6.7) | 3 (2.5) | 5 (4.2) | | |
| | High School | 1 (0.8) | 1 (0.8) | 2 (1.7) | | |
| | Diploma | 1 (0.8) | 0 | 1 (0.8) | | |
| Total knowledge score | | 96 (80.0) | 7 (5.8) | 17 (14.2) | | |

BE = Basic Education, N = Frequency.

**Table 6:** Univariable analysis of practice score and demographic characteristics of the study participants.

| Variables | Categories | Practice score N (%) | | | Fishery Exact test | *p* - value |
|---|---|---|---|---|---|---|
| | | Poor | Good | Very good | | |
| Gender | Male | 27 (22.5) | 24 (20.0) | 7 (5.8) | 9.776 | 0.006 |
| | Female | 40 (33.3) | 22 (18.3) | 0 | | |
| Age | 18-25 | 21 (17.5) | 6 (5.0) | 0 | 9.732 | 1.08 |
| | 26-40 | 35 (29.2) | 29 (24.2) | 5 (4.2) | | |
| | 41-60 | 11 (9.2) | 10 (8.3) | 2 (1.7) | | |
| | >60 | 0 | 1 (0.8) | 0 | | |
| Marital Status | Single | 27 (22.5) | 16 (13.3) | 2 (1.7) | 5.044 | 0.592 |
| | Married | 38 (31.7) | 25 (20.8) | 5 (4.2) | | |
| | Divorced | 0 | 1 (0.7) | 0 | | |
| Educational Level | Illiterate | 15 (12.5) | 17 (14.2) | 3 (2.5) | 16.186 | 0.018 |
| | BE | 41 (34.2) | 21 (17.5) | 1 (0.8) | | |
| | Elementary | 8 (6.7) | 7 (5.8) | 1 (0.3) | | |
| | High School | 3 (2.5) | 0 | 1 (0.3) | | |
| | Diploma | 0 | 1 (0.7) | 1 (0.7) | | |
| Total practice score | | 67 (55.8) | 46 (38.3) | 7 (5.8) | | |

BE = Basic Education, N = Frequency.



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sectors (Guan, et al. 2019), the intention of the society to participate on the awareness creation meeting, accountability of health extension workers and attention of government and health professionals (both human and veterinary medical professionals) to provide health education.

About 75.0% of the respondents who knew about the disease were heard from veterinary services. In this regard, the report of Cloete, et al. [13] is nearly similar to the present result in which more than half (53.7%) of the source of information was veterinary services. This finding implies the powerful role veterinarians play in terms of relaying important health messages to the livestock owners presenting their animals for treatment and vaccination programs.

From this assessment, it is concluded that 75.0% of the respondents who knew about brucellosis understood that the disease can affect animals, from which 72.2% of them responded that the disease can infect cattle, 11.1% know as it infects shoats whereas the rest 16.7% understood that it infects all animals (Table 2). In contrast to this finding, in a study in Tajikistan by Lindahl, et al. [33] where 82% of respondents knew that cattle, sheep, and goats could be affected, and a study in Egypt by Holt, et al. [34] 98.1%, 99.1%, 86.0%, 85.0% and 0.9% of participants were very confident that cattle, buffalo, sheep, goats and poultry can have brucellosis, respectively.

About seventy-nine percent of the respondents responded that the major symptom they know in animals is abortion; whereas 12.5% and 4.2% responded as weak calves and infertility are the major clinical manifestation of the disease. In agreement with this study, abortion was the most known clinical manifestation of bovine brucellosis as reported by Musallam, et al. [12] in Jordan and Buhari, et al. [35] in Nigeria. However, a study conducted in Uganda by Kansiime, et al. [36], in Nigeria by Hezekiah, et al. (2013) and in Tajikistan by Grahn, [37] reported that 14%, 11%, and 11% of respondents perceived abortion is the major clinical manifestation in animals. This variation may be due to the different perceptions that livestock owners have concerning infertility, reduced milk production, and abortions since the perception of risk is influenced by such factors as life experience, culture [38], and inadequate knowledge of the disease in animals [36].

Seventy-five percent of the participants of this study responded that the disease could transmit from animals to humans, out of whom 38.9% responded that the disease can transmit from animals to humans through Slaughtering infected animals; 33.3% through handling of abortion and 11.1% through drinking raw milk (Table 2). This finding was in discrepancy with the report of 16.7% of Buhari, et al. [35] in Nigeria, 3.0% of Arif, et al. [2] in Pakistan, and 0.8% of Deka, et al. [29] in India, in line with the current study, the results of previous studies conducted by Holt, et al. [34] in Egypt, Adesokan, et al. [39] in Nigeria and Lindahl, et al. [33] in Tajikistan in which the results were indicated that handling abortion was the major transmission route of bovine brucellosis from animals to humans.

On the other side, in comparison with the finding of 26.2% of Buhari, et al. [35], 40% of this study participants responded that the disease is preventable mainly through avoiding drinking raw milk and careless handling of the fetus and aborted materials (50%) but, the rest (10)% claim that brucellosis can be prevented through avoiding of raw meat consumption. However, the study of Kansiime, et al. [36] in Uganda reported that 89.8% of respondents were aware of the possibility of preventing brucellosis in both humans and animals.

Regarding attitude, out of the total participants of this study, almost 90% of them need to know more about the disease of which 39.3%, 8.4%, 3.7%, 2.8%, and 45.8% want information about the disease from public health professionals, family and friends, meeting at the village, public media and veterinary professionals respectively (Table 3). Even though there is variation in the preferences of the sources of information which may be due to variations of availability and reliability of the sources, regarding the need for further knowledge, this result was found similar to the report of Obonyo and Gufu, [40] in Kenya that indicated 97% of respondents need to know more information about the disease particularly from the local FM radio stations (39%), religious leaders 25%, local community meetings 20% and community health workers and/or community animal health workers 16%. Contrary to this finding, Lindahl, et al. [33] reported that only 63% of the households wanted more information about brucellosis.

A certain proportion (39.2%) of the participants believed that personnel's working most with the cows exposed to the *Brucella* infection are at high risk of infection. On the other side, most of the respondents (60.8%) did not believe as the personnel's workings mostly with the cows exposed to the disease are highly at risk of infection (Table 3). In this regard, similar to the present result, the finding of Lindahl, et al. [33] indicated the proportion of respondents who believed that Personnel's working most with the cows exposed to the disease are highly at risk of infection was 14.7%.

Among the total of this study respondents, 45 (37.5%) of participants considered selling cows that frequently abort as correct practice whereas 75 (62.5%) of them did not take as a correct action. Such attitudes initiate livestock owners to practice in wrong manners that facilitate the transmission of bovine brucellosis. Similar to this finding, in the endemic areas of Egypt, livestock owners may sell animals that abort to the butcher and some livestock owners may sell animals in markets if they believe they are infected with brucellosis. This may increase the transmission of brucellosis, not only between households in the same village but also between villages and even larger geographical areas as animals purchased at a market can be moved without restriction to anywhere in the country [34].

Concerning the practices of wise livestock owners toward bovine brucellosis, separation of cows during parturition is not being practiced by 58.3% of respondents (Table 4) which is unlike the report of Jilo [41], in which 21.21% of interviewed pastoralists do not separate animals during parturition. Moreover, 55.8% of current study respondents mix their cattle



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with other herds like sheep, goats, and equines (Table 4). Similarly, Desta [42], reported a high chance of mixing camel herds with other herds and/or ruminants in watering points, pasture, night resting, and market and during migration, and Arif, et al. [2] reported that most livestock owners share calving space with other animals. Moreover, Cloete, et al. [13] reported 98.2% of respondents indicated that their cattle shared grazing and/or water with other livestock, and 91.5% of respondents claimed that they could not keep their cattle separate from other livestock. Many *Brucella* organisms are shed during the 10 days after calving or at abortion, contaminating the environment, and increasing the risk of other cattle ingesting the organism (Park, et al. 2005).

In the current study, 54.2% handle aborted fetuses and placental membranes barehand; 6.7% use gloves, and the rest (39.2%) wash their hands after handling. Comparable to this finding, 90.5% of respondents in the Yabello districts of Borena Zone Oromia regional state handle aborted fetuses and retained placenta by bare hand [43] and according to Musallam, et al. [12] only 6% of livestock owners used protective clothing when handling placentas and aborted fetuses. Moreover, it was speculated that herders never wear protective clothing or masks in Egypt when assisting with parturition or while handling placentas and aborted fetuses [44]. These practices could be the major predisposing factors of human brucellosis, however; the livestock owners were practicing due to poor knowledge and lack of access to protective equipment like gloves.

In regard to the personnel assisting the cattle during delivery, less than half of the respondents (23.3%) responded that household members assist the cattle, whereas one-third (33.3%) of them contact veterinarians, and 43.3% responded that shepherds assist cattle during delivery (Table 4). Likewise, Holt, et al. [34] reported large numbers of respondents (94.4%) assisting their animals during delivery usually by pulling the calf out or removing fetal membranes. Therefore, there is a high risk of transmission of the pathogen between animals and from animals to humans through direct contact with contaminated materials such as fetal membranes and aborted fetuses [40]. The organism can enter through cuts in the skin and the mucous membranes of the eye and mouth while assisting and even the bacteria could be inhaled resulting in infection [45]. Due to a low/lack of knowledge of personnel assisting the cow, the environment may be contaminated since they do not use disinfectants.

From the current study participants, 55.8% throw away or dump aborted fetuses into the environment which may facilitate environmental contamination, but only 27.5% bury them in the ground whereas 16.6% give aborted fetuses to dogs. In line with this result, the report of Jilo [41], in the Pastoral community in Borena indicated that 87.88% of the respondents dispose of the aborted fetus in the environment. Contrary to this finding, Lindahl, et al. [33] reported 94% of Tajikistan's dairy owners bury aborted fetuses and birth materials. *Brucella* species have been shown to survive in aborted fetuses, manure, and water for periods of up to 150 to 240 days [46] and in a humid environment (manure and soil) for several months [47] hence disposing into the environment is among the major predisposing factors of human brucellosis and facilitators of transmission and maintenance of the pathogen. Therefore, such risky practices need to be avoided via an awareness creation program for the livestock owners and the whole community of the study area.

A descriptive analysis of factors affecting the knowledge, attitude, and practice scores of livestock owners indicated that from the total of the respondents, only about 14% and 5.8% have a very good and good knowledge score respectively whereas, 80.0% of them have poor knowledge score about bovine brucellosis (Table 5). In line with this study, poor knowledge scores had been reported in Tajikistan by Lindahl, et al. [33], northern Uganda by Nabirye, et al. [48], and Nigeria by Buhari, et al. [35]. However, Holt, et al. [34] in Egypt and Musallam, et al. [12] in Jordan reported good knowledge scoring of their study participants. Therefore, health education relating to zoonotic diseases including bovine brucellosis, targeting all groups of the community in general and people most exposed to livestock and livestock products should be given by the government and other concerned bodies such as NGOs, print and broadcast media communication channels. In this study, knowledge score did not significantly associated with livestock demographic characteristics' which agrees with the works of Diez and Coelho [9] and Deka, et al. [29] who did not find any significant association between knowledge about brucellosis with livestock owners' age and gender.

Moreover, 38.3% of respondents in this study participants had good practice scores relating to bovine brucellosis but, 55.8% were in the manner of risky practices that may expose them to the disease (Table 6). According to the report of Cloete, et al. [13] in South Africa, the overall practice scores of respondents were poor to average, with several high-risk behaviors identified in the community. Studies conducted in Egypt by Holt, et al. [34], in Tajikistan by Lindahl, et al. [33], in Jordan by Musallam, et al. [12], in Nigeria by Buhari, et al. [35], and in northern Uganda by Nabirye, et al. [48-51] also revealed high-risk activities, including the handling of abortion and placental membranes without protection as well as consumption of raw milk and its products resulting in low practice score. The practice score of the respondents showed that from the caretakers of animals, males were found better than the female and hence there is a statistically significant difference between the two ($p$ - value = 0.006) (Table 6).

A three-dimensional analysis of the association between knowledge, attitude, and practice score revealed that the majority of the respondents (23.3%) had poor knowledge and practice scores but positive attitude scores (Figure 2). This indicates that several respondents have a good perception of the disease even though they do not have a good practice score, which could be due to a lack of awareness about the disease. Such occurrence indicates the requirements of public health education.

## Conclusion and recommendations

Findings from this study demonstrate a poor understanding of brucellosis and a high level of risky practices being undertaken,



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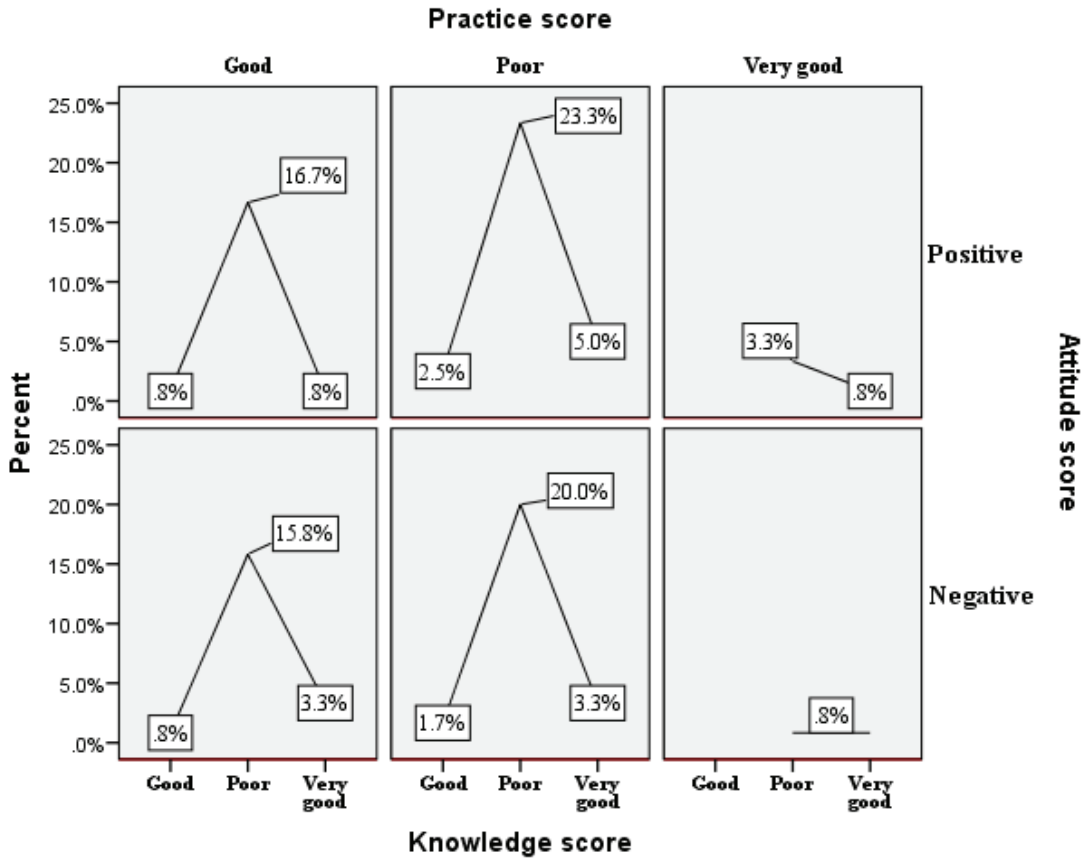


**Figure 2:** Three-dimensional Association among Knowledge, Attitude, and Practice toward Brucellosis.

all contributing to the risk of humans contracting brucellosis. Even though several respondents had positive attitude scores on bovine brucellosis, due to poor knowledge scores, most of this study participants were in malpractices such as handling fetal membranes bare hand and throwing away aborted materials and fetal membranes into the environment, which worsen contamination of the environment and facilitate maintenance as well as transmission of the pathogen. Therefore, depending on this conclusion, the following remarks are forwarded

Education is the feasible preventive measure to enhance the knowledge of this zoonotic disease, hence public health education campaigns on situations like zoonotic transmission of bovine brucellosis need to be undertaken by the government and other responsible bodies.

A synergistic "one health" approach to this type of education in rural communities would be ideal in order to ensure the uptake of recommendations and practice change on a farm and household level.

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### Data availability

The data used to support the findings of this study are available from the corresponding author upon request.

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