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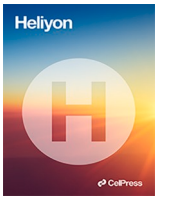

Research article

Assessment of knowledge, attitude and practices (KAP) of farmers about transmission of zoonotic diseases in Ada'a district, Oromia, Ethiopia

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ABSTRACT

In developing countries like Ethiopia, zoonotic diseases pose a significant health and economic burden, with high exposure of farmers to zoonotic infection given the prevailing traditional husbandry practices. A cross-sectional survey involving 388 farmers in the Ada'a district central Ethiopia was conducted to investigate their knowledge, attitudes, and practices (KAP) regarding the transmission of zoonotic diseases. The respondents' mean age was 41.0 ± 10.0 SD years. The majority of respondents (39.4%) were between the ages of 41 and 50, and 90.0% were married. Farmers claimed that conversations with family, colleagues, and friends were the primary sources of zoonoses information. Farmers stated that the primary sources of information on zoonotic diseases as community. They had a relatively low level (66.8%) of knowledge on zoonotic diseases and half of them (54.9%) did not have good information on zoonoses. Three-quarters (75.2%) of the farmers reported that they neither consume meat and milk nor use offal and hide/skin from sick or dead animals. Similarly, 71.1% of them stated that they do not eat meat from regularly aborting sheep/goats, and never consume raw meat and milk. Most of the respondents correctly answered that raw meat (82.7%) and raw milk (79.9%) are means of disease transmission from animals to humans. However, considerable proportions of them were unaware of zoonotic transmission of bovine tuberculosis (61.3%) and brucellosis (74.7%) transmission through raw milk intakes, and risk of taeniasis (71%) due to raw meat consumption. But, considerable proportions had never dewormed (48.7%), or tested their animals for brucellosis (82.7%) and bovine tuberculosis (83.3%), and more than three quarters (77.3%) did not used personal protective equipment when handling sick animals. Farmers who had a secondary education or above (OR = 6.8, CI = 2.4–18.0, p = 0.004), aged between 41 and 50 years (OR = 3.0, 95% CI: 1.2–7.2, p = 0.015), and those having good knowledge (OR = 2.1, CI = 1.3–3.5, p = 0.002), and positive attitude related to zoonotic diseases (OR = 7.8, CI = 4.7–12.9, p < 0.001) had better practices that reduce the risk of exposure to zoonotic infections than their counterparts. This study revealed a knowledge gaps, a low level of the desired attitude, and high-risk behavioral practices which call for awareness creation about zoonotic disease transmission.

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1. Introduction

Human-animal interactions in the environment are exacerbating the ongoing transmission of zoonoses from cattle to humans and vice versa [1]. Zoonoses have a significant impact on both animal and human health, especially in developing countries. Zoonotic diseases place a double burden on people's well-being by jeopardizing the health and productivity of their livestock; however, they are frequently overlooked by health-care managers and policymakers in both the developed and developing world [2]. Almost 60% of currently known infectious diseases are of zoonotic origin, and up to 75% of emerging infectious agents are as well [3]. Many zoonoses are considered occupational health hazards [4]. Livestock farmers are at risk because various types and intensities of contact can result in zoonotic infections [5]. Ethiopia has Africa's second-largest human population and the continent's largest livestock population [6]. Ethiopia is especially vulnerable to the effects of zoonotic diseases because its economy is heavily reliant on agriculture [7], and roughly 80% of households have direct contact with domestic animals, creating opportunities for infection and disease spread [8].

Surveys of knowledge, attitudes, and practices (KAP) provide critical information for investigating risk factors and potential intervention strategies for disease management. As a result, farmers' behavior is heavily influenced by their knowledge and attitude [9]. Poor disease knowledge correlates with disease prevalence and can set off a vicious cycle of under-diagnosis/underreporting and awareness deficit [10]. Different countries have highlighted the importance of zoonotic disease education and KAP surveys in understanding country-specific circumstances [11,12].

Ethiopia had the second-highest zoonotic disease burden in Africa [11]. Rabies, brucellosis, bovine tuberculosis, food borne illnesses and poisoning, echinococcosis, and other zoonotic diseases continue to have an impact on human and animal health in many countries, particularly in developing countries [12]. Different researchers have reported the KAP study towards zoonosis in Ethiopia [13–18].

According to the severity of each disease in the nation, 43 zoonotic diseases were ranked in order of priority by Ref. [19] and identified as severe disease burdens requiring proper treatment. The development of an efficient plan for zoonotic disease control and prevention depends on consumers' awareness of the risk that zoonotic illnesses associated with the use of animal products represent as well as the protective measures available. Information on the public's beliefs of zoonotic disease risk and preventative strategies, however, is scarce in Ethiopia. As a result, the objective of this study was to assess the level of knowledge, attitudes, and practices about the transmission of zoonotic diseases among farmers in central Ethiopia.

2. Methods

2.1. Description of study area

The research was carried out in the Ada'a district (Fig. 1), which is located about 47 km southeast of Addis Ababa. Geographically,

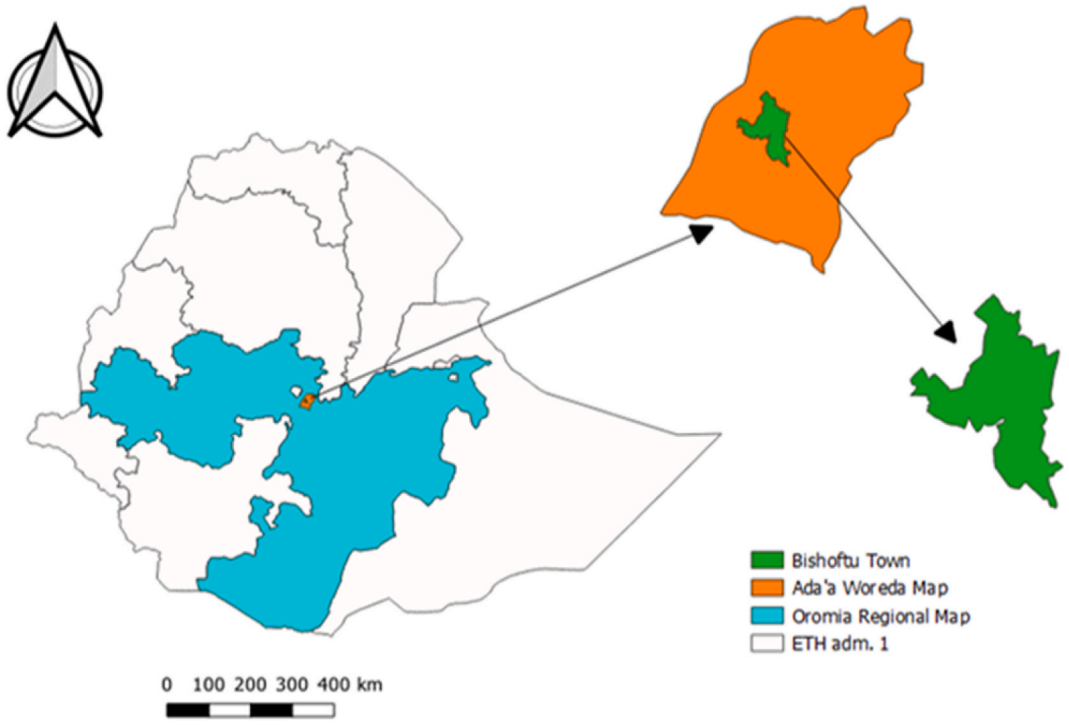

Fig. 1. Study area for KAP of transmission of Zoonoses among farmers.

it is located on the east side of Addis Ababa at 38°51′ to 39°04′ East and latitudes 8°46′ to 8°59′ North, covering a land area of 1750 km^2. The vast majority of the land (90%) is plain highland ranging from 1600 to 2000 m above sea level. The district's receives average annual rainfall of 851 mm, and has minimum and maximum average temperatures of 11 °C, and 29 °C, respectively. In 2022, the district's total population is expected to be 182,162 (CSA, 2022 [20].

2.2. Study design, sample size, and data collection

A cross-sectional survey was conducted among farmers in Ada'a district, central Ethiopia. A semi-structured pretested questionnaire was used to collect information on farmers' knowledge, attitudes, and practices related to zoonotic diseases. The questionnaire was adapted from previously published research articles [21–23] and translated into local language (Afan Oromo). The sample size was determined by the formula [23]; since there was no previous study in the area, the prevalence of poor knowledge about the transmission of zoonoses was expected to be 50%.

The sample size for this study is determined by the following formula given by Thrusfield (2007). $n = n = [1.96^2 P_{exp} (1\text{-}P_{exp})]/d^2$, Where: n = sample size, P_{exp} = minimum expected prevalence, 1.96 = the value of Z at 95% confidence interval d = desired accuracy level at 95% confidence interval.

Therefore, using the 50% expected prevalence, 95% confidence interval, and 5% marginal error, the number of farmers to be included in this study was estimated to be 384. However, for the purpose of this study we have interviewed 388 farmers. *Ganda* or villages were selected using purposive sampling methods based on their accessibility by vehicle. Farmers were then chosen using simple random sampling.

The questionnaire was divided into four sections, the first part dealt with respondents' demographic characteristics such as gender, age, level of education, marital status, and toilet type. The second section of the questionnaire focused on zoonoses knowledge, including questions about the routes of zoonosis transmission from animals to humans, the significance of uncooked meat and milk in transmitting diseases from animals to humans, diseases that humans can contract through raw milk and meat consumption, and so on. This part consisted of 23 questions. The third section of the questionnaire addressed farmers' attitudes toward zoonoses. It included 13 questions such as whether farmers think consuming or using meat, milk, offal, hide/skin from sick or dead animals, whether they consume milk from regularly aborting sheep/goats, whether they consume raw or undercooked meat, and so on. The fourth section also focused on farmer zoonoses practices. It included eight questions about raw milk and meat consumption practices, whether farmers wash their hands after having contact with animals, whether they have tested their animals for common zoonotic diseases in the area, and so on. The majority of the questions were closed-ended, requiring participants to respond with "Yes" or "No."

The aims of the research, willingness to communicate results after the end of the study and anonymity of the respondents and confidentiality of their information were explained to the livestock farmers prior to the start of the interviews, and an informed consent document was filled outlined. An interviewer read the questionnaire aloud and recorded the results on paper. The respondents were interviewed face-to-face in the early morning and late afternoon without interfering with their farming activities and without prior notice of the interview. Individual interviews typically took 10–15 min to complete. Because the study was conducted during the COVID-19 pandemic, preventive measures such as wearing facemasks, keeping social distance (at least 2 m), washing hands, using alcohol-based hand sanitizer, and conducting interviews were used.

2.3. Statistical analysis

The data were extracted using a standardized data extraction format created in Microsoft Excel, and the analysis was performed using Stata-14 statistical software. Because the interviews were conducted face-to-face by a trained veterinarian, there were a few missing responses, which were identified as missing data in the analysis.

To total the farmer's knowledge on specific questions, a knowledge score (range 0–23) was created. If the participant chose the correct answer, he or she received a score of 1.0; otherwise, no score was given. The same scoring system was used for the attitude score (range 0–13) and the practice score (range 0–8). For the attitude part the median score is used instead of the mean score since the data is not normally distributed. The participants were divided into two groups—good and poor—based on their mean scores. Respondents who scored above the mean on the knowledge, attitude, and practice items were deemed to have good knowledge, attitudes, and practices, while those who scored below the mean were deemed to have poor knowledge, attitudes, and practices [21]. A series of univariable linear regression analyses were used to investigate the unconditional relationship between each explanatory variable and knowledge score. Following the preliminary analysis with knowledge score as the outcome variable, the same series of univariable analyses with attitude score as the outcome variable was performed. Finally, the same univariable analyses were performed with the practice score as the outcome variable and knowledge and attitude scores as independent variables, along with the previously mentioned explanatory variables. Explanatory variables with p-values less than 0.25 were chosen for inclusion in the multivariable model construction. P-values were obtained from logistic regression models and are rounded to three decimal places.

For each of the three scores, a forward stepwise multivariable logistic regression analysis was performed, beginning with the variable with the lowest p-value in the univariable analyses. Explanatory variables with p-values less than 0.05 were kept in the final model. Model goodness of fit-test was assessed by Hosmer and Lemeshow test. The Cronbach's alpha coefficient was used to determine the questionnaire's internal consistency (The Cronbach's alpha as reliability of questionnaire was 0.75 for knowledge, 0.78 for attitude and 7.0 for practice).

3. Results

3.1. Demographic characteristics of participants

During the survey period, 388 farmers who were approached completed the questionnaires; with 80.4% of them were men and 68.0% having never attended formal education. The respondents' mean age was 41.0 ± 10.0 SD years. The majority of respondents were (90.0%) married, and 54.4% used an open field toilet (Table 1).

Farmers claimed that conversations with community 226/388 (58.4%) were the primary sources of zoonoses information followed by radio 135/388 (34.8%), newspaper 38/388 (9.8%) and social media and celeberities 10/388 (2.6%) (Fig. 2).

3.2. Knowledge about zoonoses

Nearly 61.8% of farmers responded correctly to questions about knowledge about zoonoses. As shown in Table 2, more than half of respondents (54.7%) were not aware of diseases transmitted between animals and humans (zoonoses). The total mean score for correctly answered knowledge questions were (13.15 ± 4.8).

Two hundred thirty nine farmers (61.6%) scored mean and above the mean were considered to be knowledgeable while 149 (38.4%) scored below the mean and considered as not knowledge-able.

Respondents were asked if eating raw meat and milk could spread diseases from animals to humans. As a result, 82.7% and 79.9% of respondents correctly answered that raw meat and raw milk can transmit diseases from animals to humans, respectively. The majority of respondents (61.3%) and 74.7%) did not know that drinking raw milk can cause bovine tuberculosis and brucellosis. Furthermore, 71.1 percent of respondents had low awareness about taeniasis transmission or the risk of bovine cysticercosis due to raw meat consumption.

3.3. Attitude about the transmission of zoonoses

The mean score of farmers' attitude was 3.89 ± 3.7. Farmers who scored below the mean score were 220 (56.7% which was considered negative attitude) and above the mean score 168 (43.3% which was considered positive attitude).

Farmers generally have negative attitude toward the transmission of zoonoses (43.3%). Almost three-quarters (75.2%) of respondents stated that they do not consume or use sick or dead animals' meat, milk, offal, hide/skin, or wool products. Additionally, a large proportion of farmers (71.1%) replied that they don't have the habit of consumption of meat from a regularly aborting sheep/goat, consumption of raw or undercooked meat, raw milk consumption, and touching stray dogs (Table 3).

3.4. Practices about the transmission of zoonoses

The mean score of the farmers' practice towards zoonoses was 2.8 ± 2.0. Farmers who scored below the mean score were 195 (50.3% which was considered poor practice) and above the mean score 193 (49.7% which was considered good practice). Table 4 summarizes farmers' practices concerning the transmission of zoonosis. About 265 (68.3%) and 287 (74.0%) of the respondents claimed they consume raw milk and raw meat, respectively. A large proportion of farmers walk at home in bare feet (66.2%) and in the farm or garden (68.3%). Furthermore, (48.7%), (82.7%), and (83.3%) have never been dewormed their animals or tested for brucellosis or bovine tuberculosis. More than three quarters (77.3%) respondents stated they had never used personal protective equipment when dealing with sick animals.

Table 1
Socio-demographic characteristics of randomly selected farmers in Ada'aa district, Ethiopia (n = 388).

Variable	Category	n (%)
Age (years)	Mean (SD)	41.0 (10.0)
	Range	20–72
	20–30	59 (15.2)
	31–40	146 (37.6)
	41–50	153 (39.4)
	≥51	30 (7.7)
Marital status	Single	39 (10.1)
	Married	349 (89.9)
Gender	Female	76 (19.6)
	Male	312 (80.4)
Educational level	Informal education	264 (68.0)
	Primary education	95 (24.5)
	Secondary and above	29 (7.5)
Type of toilet used	Open field	211 (54.4)
	Ordinary with septic tank	177 (45.6)

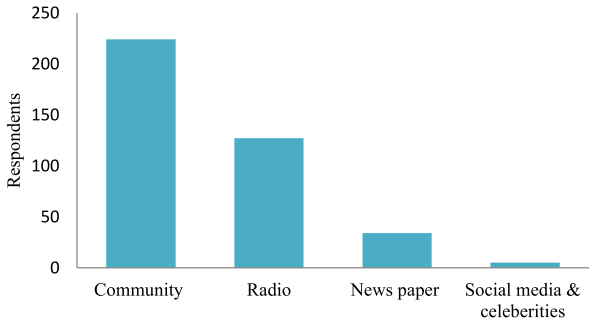

Fig. 2. Farmers' sources of information about zoonoses (n = 388).

Table 2
Summary of knowledge among farmers of Ada'a districts about the transmission of zoonosis in Ethiopia (n = 388).

Zoonosis knowledge questions	Response, n (%)	
	No	Yes
Do you know what zoonosis is?	213 (54.9)	175 (45.1)
Many animal diseases can be transmitted from animals to humans	154 (39.7)	234 (60.3)
Animal disease can be transmitted via different routes to humans	95 (24.5)	293 (75.5)
Eating uncooked meat can transmit diseases from animals to human	67 (17.3)	321 (82.7)
Drinking raw milk can transmit diseases from animals to human	78 (20.1)	310 (79.9)
Close contact with sick/dead animal can transmit diseases to human	87 (22.4)	301 (77.6)
You can get infection from environment contaminated from secretions of sick animal	79 (20.4)	309 (79.6)
Insect bite can transmit animal diseases to human	123 (31.7)	265 (68.3)
Being bitten by animal can transmit diseases to human	56 (14.4)	332 (85.6)
Abortion in animals can cause a serious economic and public health problem	66 (17.0)	322 (83.0)
Infections can be transmitted to humans through:		
Raw milk consumption	146 (37.6)	242 (62.4)
Raw meat consumption	183 (47.2)	205 (52.8)
Unpasteurized yoghurt consumption	172 (44.3)	216 (55.7)
Unpasteurized cheese consumption	227 (58.5)	161 (41.5)
Being in close contact with sick animals	238 (61.3)	150 (38.7)
Being bitten by an animal	163 (42.0)	225 (60.0)
Humans can contract which of the following diseases via raw milk consumption		
Bovine tuberculosis	238 (61.3)	150 (38.7)
Anthrax	109 (28.1)	279 (71.9)
Brucellosis	290 (74.7)	98 (25.3)
Humans can contract which of the following diseases via raw meat consumption?		
Bovine tuberculosis	237 (61.1)	151 (38.9)
Anthrax	109 (28.1)	279 (71.9)
Cystycercosis/taeniasis	276 (71.1)	112 (28.9)
Brucellosis	276 (71.1)	112 (28.9)

Table 3
Summary of attitude of farmers of Ada'a district about the transmission of zoonoses in Ethiopia (n = 388).

Attitude questions on transmission of zoonoses	Response, n (%)	
	Yes	No
Do you mind consuming or using the following products from sick or dead animals?		
Meat	282 (72.7)	106 (27.3)
Milk	280 (72.2)	108 (27.8)
Yoghurt products	108 (27.8)	280 (72.2)
Cheese products	124 (32.0)	264 (68.0)
Offal	323 (83.3)	65 (16.8)
Hide/skin	255 (65.7)	133 (34.3)
Wool	319 (82.2)	69 (17. 8)
Do you mind consumption of the following activities?		
Consumption of meat from a regularly aborting sheep/goat	313 (80. 7)	75 9 (19.3)
Consumption of raw or undercooked meat	276 (71.1)	112 (28.9)
Raw milk consumption	230 (59.3)	158 (40.7)
Raw yoghurt	162 (41.8)	226 (58.3)
Raw cheese	182 (46.9)	206 (53.1)
Touching stray dogs	285 (73.5)	103 (26.6)

Table 4
Summary of practices among farmers of Ada'a districts about the transmission of zoonosis in Ethiopia (n = 388).

Transmission of zoonosis knowledge questions	Response, n (%)	
	No	Yes
Do you drink raw milk?	123 (31.7)	265 (68.3)
Do you eat raw meat?	101 (26.0)	287 (74.0)
Do you wash your hands after having contact with animals?	267 (68.8)	121 (31.2)
Do you walk bare feet at home?	257 (66.2)	131 (33.8)
Do you walk bare feet at farm or garden?	265 (68.3)	123 (31.7)
Have you ever done deworming of your animals	189 (48.7)	199 (51.3)
Have you ever tested your animals for Brucellosis?	321 (82.7)	67 (17.3)
Have you ever tested your animals for B.T.B*.?	323 (83.3)	65 (16.8)
Do you use personal protective equipment when dealing with sick animals	300 (77.3)	88 (22.7)

• Bovine tuberculosis.

3.5. Logistic regression analysis

The association between the demographic variables and the knowledge, attitude, and practices of farmers were determined using logistic regression analysis. Tables 5 and 6 shows the results Univariable and multivariable logistic regression analyses of the farmers' demographic variables with their knowledge, attitudes, and practices towards the transmission of zoonotic diseases, respectively. Individuals with good knowledge of transmission of zoonotic diseases were found to engaged in good practices that minimize risk of exposure to zoonotic infections (OR = 2.1, 95% CI = 1.3–3.5, p = 0.001). Male individuals and those possessed toilet with septic tank were 2.2 and 1.7 times more likely to have positive attitude towards transmission zoonotic diseases compared to their counterparts. Good knowledge on transmission zoonoses was significantly associated with good practices towards zoonotic diseases transmission. Farmers who had a secondary education or above (OR = 6.8, CI = 2.4–18.0, p = 0.004), aged between 41 and 50 years (OR = 3.0, 95% CI: 1.2–7.2, p = 0.015), possessed toilet with septic tank (OR = 0.5, CI = 0.3–0.8, p = 0.008), and those having good knowledge (OR = 2.1, CI = 1.3–3.5, p = 0.002), and a positive attitude related to the transmission of zoonotic diseases (OR = 7.8, CI = 4.7–12.9, p < 0.001) had better practices of transmission of zoonosis that reduce the risk of exposure to zoonotic infections than their counterparts.

Table 5
Univariable logistic regression of factors associated with good knowledge, positive attitude and good practices about the transmission of zoonotic diseases among farmers in Ada'a district in Ethiopia (n = 388).

Variable	Good knowledge (n = 259)			Positive attitude (n = 168)		Good practices (n = 193)	
	Freq. (%)	Univariable		Univariable		Univariable	
		OR (95% CI)	*p* -value	OR (95% CI)	*p* -value	OR (95% CI)	*p* -value
Gender							
Female	49 (64.5)	Ref.	na.	Ref.	na.	Ref.	na.
Male	210 (67.3)	1.13 (0.7–1.9)	0.64	1.86 (1.1–3.2)	0.023	1.20 (0.7–2.0)	0.473
Age							
20–30	39 (66.1)	Ref.	na.	Ref.	na.	Ref.	na.
31–40	92 (63.0)	0.87 (0.46–1.65)	0.68	1.9 (1.0–3.7)	0.041	1.22 (0.7–2.3)	0.525
41–50	103 (67.3)	1.06 (0.6–2.0)	0.87	1.8 (1.0–3.4)	0.063	2.30 (1.2–4.3)	0.008
≥51	25 (83.3)	2.6 (0.9–7.7)	0.09	0.77 (0.3–2.0)	0.592	1.6 (0.6–3.8)	0.322
Marital status							
Single	112 (86.8)	Ref.	na.	Ref.	na.	Ref.	na.
Married	237 (91.5)	1.64 (0.8–3.2)	0.151	1.4 (0.7–2.8)	0.327	1.32 (0.7–2.6)	0.419
Education							
Informal	173 (65.5)	Ref.	na.	Ref.	na.	Ref.	na.
Elementary	63 (66.3)	1.04 (0.6–1.7)	0.890	0.8 (0.5–1.3)	0.343	0.91 (0.6–1.5)	0.680
Secondary & above	23 (79.3)	2.0 (0.8–5.1)	0.141	3.6 (1.5–8.3)	0.003	5.27 (2.0–14.2)	0.001
Type of toilet used							
Open field	141 (66.8)	Ref.	na	Ref.	na	Ref.	na.
Ordinary with septic tank	118 (66.7)	1.00 (0.8–1.9)	0.371	1.2 (0.8–1.9)	0.270	0.75 (0.5–1.1)	0.151
Knowledge							
Poor	na.	na.	na.	na.	na.	Ref.	na.
Good	na.	na.	na.	na.	na.	2.15 (1.4–3.3)	0.001
Attitude							
Negative	140 (63.6)	Ref.	na.	na.	na.		
Positive	119 (70.8)	1.39 (0.9–2.1)	0.137	na	na	6.85 (4.4–10.8)	0.000
Practice							
Poor	48 (37.2)	Ref.	na	Ref.	na.	na	na
Good	145 (60.0)	2.15 (1.4–3.3)	0.001	6.9 (4.4–10.8)	0.000	na	na

Table 6
Multivariable logistic regression of factors associated with good knowledge, positive attitude and good practices about the transmission of zoonotic diseases among farmers in Ada'a district in Ethiopia (n = 388).

Variable	Good knowledge		Positive attitude		Good practices	
	AOR (95% CI)	p -value	AOR (95% CI)	p -value	AOR (95% CI)	p - value
Gender						
Female	Ref.	–	Ref.	–	Ref.	–
Male	1.1 (0.6–1.9)	0.873	2.22 (1.2–4.3)	$p < 0.05$	0.7 (0.4–1.3)	0.271
Age						
20–30	Ref.	–	Ref.	–	Ref.	–
31–40	0.70 (0.31–1.55)	0.377	1.38 (0.6–3.2)	0.452	1.2 (0.5–2.9)	0.629
41–50	0.75 (0.33–1.72)	0.503	0.85 (0.4–2.0)	0.718	3.0 (1.2–7.2)	<0.05
≥51	2.00 (0.6–7.0)	0.276	0.34 (0.1–1.2)	0.097	2.43 (0.8–7.7)	0.131
Marital status						
Single	Ref.	–	Ref.	–	Ref.	–
Married	1.82 (0.8–4.0)	0.134	1.0 (0.4–2.3)	0.983	1.1 (0.4–2.6)	0.884
Education						
Informal	Ref.	–	Ref.	–	Ref.	–
Elementary	1.1 (0.6–2.0)	0.769	0.7 (0.4–1.4)	0.305	1.63 (0.9–3.1)	0.131
Secondary & above	1.7 (0.6–4.6)	0.287	1.92 (0.7–5.0)	0.181	6.76 (2.4–18.0)	<0.05
Type of toilet used						
Open field	Ref.	–	Ref.	–	Ref.	–
Toilet with septic tank	1.0 (0.7–1.7)	0.907	1.7 (1.0–2.8)	0.032	0.51 (0.3–0.84)	0.05
Good knowledge	–	–	1.4 (0.9–2.1)	0.137	2.09 (1.3–3.5)	<0.001
Positive Attitude	1.4 (0.9–2.1)	0.137	–	–	7.8 (4.7–12.9)	<0.001
Good Practice	2.1 (1.3–3.5)	<0.001	7.8 (4.7–12.9)	<0.001	–	–
Goodness of fit-test	(Chi2 (73) = 83.9, p = 0179)		(Chi2 (73) = 84.0, p = 177)		(Chi2 (106) = 113.6, p = 0.290)	

4. Discussion

This study provides information on the transmission of zoonoses KAP of Ethiopian farmers in the Ada'a district. It revealed that farmers had a good level of transmission of zoonotic disease knowledge, a negative attitude and poor practices regarding zoonotic disease transmission risk, and common risk behaviors. In this study, over half of the respondents (54.90%) didn't know about transmission zoonosis. The observed proportion of farmers with poor knowledge on transmission zoonosis is lower than another Ethiopian study finding [18] in which the majority of their study participants (91.2%) had heard of transmission zoonosis. Farmers' levels of knowledge may vary with diseases prevalence, time and place due to differences in access to information and educational level.

In this study, most of the respondents were not knowledgeable about the transmission of bovine tuberculosis (61.3%) and brucellosis (74.7%) through consumption of raw milk. This is an alarming situation that an immediate action is needed to create awareness among farmers about the danger of raw milk consumption. However, another study from Ethiopia indicated that 70% of the participants were aware that rabies is one of the pet contact-associated diseases [19]. This finding is consistent with previous reports from Mekelle [15] and Gonder [19] where rabies is considered a serious problem. This clearly demonstrates that rabies is the oldest and a well-known zoonotic disease in Ethiopia. According to Abera et al. [22], 83.4% of respondents had heard of rabies, tuberculosis (61.6%), taeniasis (33.2%), anthrax (22.2%), and brucellosis (21.6%), while very few individuals (8.8%) had not heard of zoonosis. In South West Ethiopia, rabies (83.3%), taeniasis (64.3%), bovine tuberculosis (45.6%), and brucellosis (22.1%) were also reported [21]. Another study by Tesfaye et al. [24], found that rabies was the most common disease in Southwestern Ethiopia, followed by taeniasis (83.4%), anthrax (55.4%), bovine tuberculosis (29.1%), and hydatidosis (4%). In general, zoonotic disease awareness is low to moderate among farming communities in Ethiopia. In Addis Ababa, however, it was reported that a higher level of awareness (100%) among respondents naming rabies as a zoonotic disease, followed by anthrax (94.3%), taeniasis (89.1%), bovine tuberculosis (88.5%), and brucellosis (49.5%), suggesting urban residents have higher awareness on zoonotic diseases compared to those from rural settings The overall disparity awareness among studies for common zoonotic diseases could be attributed to differences in educational status, accessibility, proximity to information sources and frequencies, lifestyle, and disease prevalence.

In this study, more than half of the farmers (57.7%) said they get information about transmission zoonoses primarily from conversations with family, colleagues, and friends, followed by radio (32.7%). This finding indicated that there is a knowledge gap among farmers. According to Abera et al. [22] 31.8% of respondents get information from family and friends, while only 4.6% get information from the media. In another study conducted in and around Addis Ababa [22] 85.4% of respondents received information in the form of advice from their family. However, electronic media such as radio and television were a major source of information among high school students in Addis Ababa, Ethiopia. According to a study done in Nairobi, evidence-based communication through the media to the general population could be helpful in reducing the dangers of zoonotic diseases [25]. The differences in the level of knowledge among farmers from place to place could be attributed to the respondents' age group, proximity to towns, and access to electronic media [26].

In this study, nearly three-quarters (75.2%) of the respondents claimed that animal diseases can be transmitted to humans through various routes. Furthermore, respondents were asked if consumption of raw meat and milk can transmit diseases from animals to

humans. As a result, 82.3% and 79.9% of respondents correctly answered that consumption of raw meat and raw milk can transmit diseases from animals to humans, respectively. The majority of respondents (61.4%) and 74.4%) did not know that drinking raw milk can cause bovine tuberculosis and brucellosis. Furthermore, 71.1% of respondents were unaware that raw meat consumption causes bovine cysticercosis. Even though eating raw meat might expose to health concerns including tapeworms, salmonella, and *E. coli*, Ethiopians continue to do so during family gatherings and festive occasions. Nearly, 93.2%, 81.6%, and 15.6% of respondents in and around Asella, Arsi Negele, and South West Ethiopia, respectively, diseases could transmit from animal to human [22,27,24]. A large proportion of farmers responded that uncooked meat (82.73%), raw milk (79.0%), close contact with sick/dead animals (77.58%), sick animal secretions from contaminated environments (79.4%), insect bite (68.0%), and animal bites (85.6%) can transmit infection from animals to humans. Another report from Ghana indicated that 88% of respondents knew about tuberculosis and 76% knew about brucellosis, which contradicts the findings of this study [28]; which might be attributed to the fact that the diseases reporting practice and the level of awareness towards zoonoses among farmers might be better in Ghana than Ethiopia. According to the findings of this study, respondents were aware of general milk-borne zoonosis but did not know the specific names of the diseases. The possible reasons for variations in the level of knowledge from place to place could be attributed to the access to information, educational background, life experience and the prevalence of the respective diseases. Only 3.5% of respondents were aware that pasteurization could be used to prevent milk-borne zoonosis [29]. Similarly, 61.3% of respondents were aware that boiling could be used to prevent milk-borne zoonosis. Unpasteurized or raw milk has been linked to milk-borne zoonotic diseases like brucellosis and bovine tuberculosis [30]. The majority of respondents were aware that diseases can be transmitted through the consumption of raw cow milk [29]. This result was due to the fact that 100% of students in high school were well aware that diseases can be acquired through the consumption of raw cow milk. A study from Punjab indicated that 69.6% of respondents drink raw milk and 55.6% are aware that diseases can be transmitted through the consumption of contaminated milk [31]. Only 61.3% of the respondents are aware that boiling milk can prevent milk-borne zoonosis [29]. The disparity in milk-borne zoonosis awareness is due to the study area's unique circumstances. Remoteness, a lack of health facilities, poor extension services, a lack of training in animal rearing and handling, and a low literacy rate as major contributors to a lack of awareness among smallholder dairy farmers as major contributors to a lack of awareness [32]. Furthermore, many African communities associate diseases shared by livestock and humans with misbehavior or witchcraft [33], and all of these practices are the result of a lack of information or knowledge about milk quality at the farm level and about various aspects of dairy husbandry issues [33]. A higher proportion of respondents (94.3%) believe dog bites are the cause of rabies, and consumption of raw milk and meat is a transmission route of bovine tuberculosis from cattle to humans [28]. 15.0% of respondents identified contact with sick animals as a mode of zoonotic disease transmission [27]. Contact and ingestion of animal products as modes of zoonotic disease transmission [26]. The variations in these findings indicate the presence of a knowledge gap between cities and rural residents. This variation could be attributed to differences in participants' educational levels, access to media and other public health information services, and the prevalence of diseases in the specific area.

Raw milk consumption is an age-old tradition and widespread practices throughout Ethiopia. As a result, in this study, 59.3% of respondents consumed raw milk. 50.0% of milk produced by smallholder farmers in the Ethiopian Rift Valley areas was consumed fresh at home, without being boiled or pasteurized [25]. Approximately, 35.0% of dairy farmers drank raw milk, and only 13.0% of these farmers were aware of foodborne diseases that can be transmitted through drinking raw milk [34]. In most parts of Ethiopia, the consumption of pasteurized milk is low and is most likely due to underdeveloped milk pasteurization practice. The vast majority (95%) of all milk produced in the country being sold through informal marketing systems rather than pasteurization plants [35]. As many as 67.0% of farmers in North Western Ethiopia drank raw milk [36]. In the Jimma zone of western Ethiopia, 57.0% of adults drank fermented milk on occasion and 14.0% of interviewees did not boil milk for their children [37]. As a result, these findings imply that a sizable portion of Ethiopian society consumes raw milk, either fresh or fermented, on a regular or sporadic basis. This clearly indicates that farmers lack knowledge about the zoonotic risks associated with drinking raw milk.

In this study, nearly three-quarters (75.1%) of farmers stated that they didn't consume or used animal products such as meat, milk, offal, hide/skin, and wool products from sick or dead animals. Cooking animal products such as meat (33.7%) and meat products (64.3%) is also practiced by respondents in fear of disease transmission [27]. In contrast to this finding, it was reported that in Africa and Southeast Asian countries, socio-cultural practices such as slaughtering sick animals, eating or handling meat from infected animals, and dumping carcasses in the open have been linked to anthrax transmission [38].

Furthermore, a large proportion of farmers (77.3%) responded that they had never used personal protective equipment when dealing with sick animals. It is stated that due to the scarcity of personal protective equipment in their areas; farmers and pastoralists do not use it when dealing with animal abortion [39]. Approximately, 60.0% of respondents were exposed to the risk of zoonotic diseases due to their frequent consumption of raw meat [40]. This was despite the fact that over 90% of the respondents were aware of possible zoonotic risks of raw meat consumption. Location, gender and age of the household head, household size, meat type preference, per-capita meat consumption, knowledge about disease transmission risks, and training on zoonoses were all associated with raw meat consumption behaviors. It was also reported that in the Arsi-Negele district of Ethiopia, 58.2% and 57.1% of respondents consumed raw meat and milk, respectively [27]. Moreover, it was reported that 56.8% of respondents in Mana and Limmu-Kosa districts of Jimma Zone, South West Ethiopia, consumed raw food of animal origin [24]. A large proportion of respondents (69.1%) in Jimma, Southwestern Ethiopia also consume raw meat [41]. In Ethiopia, meat consumption is a deep-rooted cultural behavior. Meat is often consumed as part of the staple diet of the people and also during special occasions of festivity. Its cultural symbolism is more significant than that of any other cuisine. Eating raw meat or half cooked meat is very common and although Ethiopians from various cultures enjoy eating meat, they are generally very selective, in that only poultry, beef, mutton, goat and fish (not including shell-fish) are culturally and religiously acceptable. Eating other kinds of meat, such as pork, is a cultural taboo among most Ethiopians [42]. Consumption of raw meat is practiced in some parts of the world as a cultural heritage passed down through

many generations. Raw and/or undercooked meat is known to be consumed in countries such as Russia, Cuba, and many social groups on the African continent [43]. To safeguard the public health, it needs an intensive awareness programs about the dangers of raw meat consumption. Because raw meat consumption may not only predisposes to taeniasis but also to other extremely dangerous foodborne pathogens such as anthrax and bovine tuberculosis. In one study conducted in Ethiopia's Arsi-Negele district, respondents revealed that butchery (15.3%), slaughtering at home (59.2%), and backyard slaughtering (94.9%) were the sources of meat for home consumption [27]. There is no discernible trend in the sources of meat and meat products purchased. It may be determined by consumer needs, festivals, or everyday use, as well as the availability of markets in urban and rural areas. This is due to the fact that there is a weak regulatory body to implement the zero tolerance for backyard slaughtering.

According to this study, 68.8% of respondents' didn't wash their hands after coming into contact with animals. A similar study from Turkey shows over 90% of cattle farmers had both positive attitudes and good practices regarding hand-washing after contact with an animal, the burial of dead animal bodies, and the separation of sick animals from the herd [44]. Incorrect perceptions and attitudes toward zoonotic disease prevention underscore the importance of culturally appropriate health education in rural communities. As a result, it is critical to change the community's attitude in order to improve their behavioral practices regarding zoonotic disease transmission prevention practices [45]. It was also reported the awareness of zoonotic disease transmission by consumption of meat (96.3%) and milk (51.3%) among the respondents in the Arsi-Negele district of Ethiopia [27]. Similar study from Ethiopia indicated that in the southwestern part of Ethiopia, 82.3% of respondents were aware of raw/undercooked meat consumption as a vehicle for the transmission of taeniasis to humans [41]. Such variation could be explained by differences in educational attainment, media access, and disease prevalence.

The majority of farmers in this study had never dewormed their animals (48.7%), had never tested for brucellosis (82.7%), and had never tested their animals for bovine tuberculosis (83.3%)., One study from India indicated that 23% of farmers consumed raw milk, while only 10% and 8% of livestock farmers had their animals tested for brucellosis and tuberculosis, respectively. A low level of education and being a cattle farmer were negatively associated with the farmer's knowledge of zoonotic diseases. The participants' attitude score was positively related to their practice score. The findings highlight the importance of educating livestock farmers, especially those with a low level of education, in order to reduce the health and economic impact of zoonotic diseases [46].

In this study, there was no significant difference in farmers' knowledge of zoonotic diseases based on their gender, marital status, or educational level ($p > 0.05$). Farmers' good practices, on the other hand, were found to be positively associated with zoonoses knowledge ($p = 0.001$). Farmers who have good zoonotic practices were found to have better knowledge than their counterparts. It was also reported that respondents' knowledge was positively associated with desired attitudes and practices [39]. Similarly, it was reported that gender and age are important demographic factors that can influence farmer knowledge, attitude, and practices [47]. The educational background of farmers have been linked to improved zoonotic disease knowledge and practices [48]. Different studies have reported different outcomes from different countries regarding the role of demographic profiles of the respondents; which might be due the fact that different countries have different level of zoonoses awareness, some countries have strict regulations regarding zoonoses, and countries have different cultural backgrounds.

Regarding attitude, those farmers who use a toilet with an ordinary septic tank ($p = 0.032$), and those who practice good hygiene ($p < 0.001$) had a more positive attitude toward zoonosis than their counterparts. This might be explained by the fact that in Ethiopia, individuals who use toilets are those who are better informed about the transmission of zoonotic diseases; however large proportion of individuals are still using open defecation. An encouraging efforts made by the government of Ethiopia is that it has set ambitious targets for water, sanitation, and hygiene (WASH). Total Sanitation to End Open Defecation and Urination (TSEDU) campaign also aims to make Ethiopia open defecation free (ODF) by 2024 (49). Finally, farmers with a secondary or higher level of education ($p = 0.004$) had better zoonoses practices than their counterparts. People will use hygienic practices if they have good knowledge [35]. Higher education, on the other hand, only significantly improves their knowledge while having no effect on their attitude or practices. It was also reported that higher education levels were associated with better knowledge and practices [48]. This might be because farmers with better levels of education are more progressive or informed than others.

Furthermore, toilet usage among farmers is found to be significantly associated ($p = 0.008$) with good zoonoses practice. This suggests that raising awareness among farmers about the use and importance of toilets in disease prevention and control is critical. Furthermore, farmers who had good knowledge ($p = 0.002$) and a positive attitude ($p < 0.001$) practiced zoonosis better than their counterparts. There is a positive relationship between correctly answering knowledge questions and a positive attitude ($p < 0.0001$) and self-reported good practice ($p < 0.0001$) [49].

5. Conclusions

The results of this study indicated that most of the farmers are not aware of the transmission, prevention and control of zoonosis in the study area. Numerous possible problems stem from farmers' attitudes and practice towards zoonoses. For instance, the consumption of raw milk from infected animals is a potential risk for the transmission of brucellosis and tuberculosis. Similar to this, barefoot walking at home and field or garden may increase the risk of contracting cutaneous larva migrans. We suggest a continuous program of occupational health and food safety education and updating farmers' understanding of significant zoonotic illnesses could benefit greatly from the efforts of all the stakeholders. Additionally, regular awareness creation of zoonotic disease prevention and control-via mass media, and education and training programs could enhance the knowledge of farmers.

5.1. Strength of this study

An important strength of this study was that it used an appropriate random sample size of farmers; therefore, there can be confident that the findings are generalizable to the whole population. Farmers were randomly sampled from their peasant associations (PA) not more than once to avoid bias. The sample size was estimated before the start of the study and considered to provide adequate predictive power. The questionnaire was adapted from published instruments and revised by experts to ensure content validity. It was accurately translated into local languages Amharic/Afaan Oromo and tested to ensure clarity of questions and respondents' ability to provide accurate answers.

5.2. Limitations of this study

As an observational and cross-sectional study, our study has several limitations. We cannot document causal relationships because of the current survey's cross-sectional nature. Because our study was questionnaire-based, there is a possibility of recall bias. Because of the use of multiple-choice answers, response bias is unavoidable, though it may have been mitigated in the construction of the knowledge score due to some stringent requirements. The attitude responses clearly do not correspond to practices, as many respondents admitted that despite knowing the proper action, they do not implement it due to cost or the amount of handwork required. This is even more understandable given the highly risky behaviors revealed by self-reported practices. However, the Cronbach's alpha results indicate that our questionnaire had good internal consistency.

Ethical approval

This research was reviewed and approved by the ethical committees of Addis Ababa University (Protocol number 031/21).

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Data availability

Data can be obtained from the corresponding author.

Additional information

No additional information is available for this paper.

CRediT authorship contribution statement

Fufa Abunna: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Bekele Megersa:** Writing – review & editing, Supervision, Resources, Funding acquisition, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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