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BRUCELLOSIS KNOWLEDGE, AWARENESS AND PRACTICES AMONG MILITARY DAIRY FARM WORKERS IN BANGLADESH

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ABSTRACT

Background: Brucellosis is an ancient re-emerging bacterial zoonotic disease caused by species of the *Brucella genus*, affects a wide range of domesticated and adult wildlife, and plays a significant economic impact on the public health and the livestock sector. Improvement of knowledge, attitudes and practices among dairy farm workers could have a significant impact on reduction of zoonotic brucellosis in daily farming.

Objectives: This study aimed at assessing workers' knowledge about brucellosis and practices relevant to its transmission on military dairy farms in Bangladesh.

Materials and Methods: From March to August 2020 a cross-sectional study was conducted among the dairy workers (n = 715) in eight military dairy farms from different regions in Bangladesh. A standardized questionnaire was used to collect information of participants' knowledge, awareness and practices on brucellosis. Multivariable logistic regression analysis was used to identify factors associated with knowledge, awareness and practices.

Results: All participants were male and 33.4% of them were in the age group 25 to 34 years. Only 0.3% of the participants knew that brucellosis is a zoonosis and was familiar with its symptoms. Among them, 61% of the participants stated that fever is the most noticeable clinical sign of brucellosis. None of the workers and their families consumed raw milk and products there. While handling fetal membranes and dead fetuses 74.8% of the workers used hand gloves, 94% of participants washed hands after contact with animals and 95.5% also washed hands before and after milking. Dairy farm workers aged between 18 to 24 years and > 44 years were 9.9% (95% CI: 2.9; 33.6) and 5.8 times (95% CI: 1.6; 20.5) more likely to have adequate knowledge of brucellosis than 25 and 44 years old. The odds awareness were 1.8 times (95% CI: 1.1; 2.8) higher among dairy farm workers aged between 18 to 24 years than those aged between 25 to 34 years. Dairy farm workers aged between 18 to 24 years and > 44 years were 2.1 (95% CI: 1.3; 3.4) and 2.9 times (95% CI: 1.8; 4.9) more likely to perform appropriate practice than those aged between 25 to 34 years. In addition, animal attendant performed 8.9 times (95% CI: 2.2; 36.1) more appropriate practices than milkmen.

Conclusions: The knowledge of the workers about brucellosis in these eight military dairy farms was considered moderate. Awareness programs are necessary to improve and foster preventive practices.

Keywords: Knowledge, Awareness, Practices, Military dairy farm workers, Brucellosis, Bangladesh

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INTRODUCTION

Brucellosis is a bacterial zoonosis caused by *Brucella* species primarily in domestic animals e.g. cattle, buffaloes, sheep, and goats.[1] The disease remains a serious public health concern in many African, Middle-Eastern, Mediterranean, South American, and Asian countries, however, Australia, Canada, Japan, New Zealand, and many countries of Europe are considered free of brucellosis at least in domestic animals.[2,3] Diseased animals shed brucellae via utero-vaginal secretions into the environment and milk which acts as a direct source of transmission to humans.[4] It remains an economically important disease due to losses in fetuses, milk production, treatment costs, infertility, and even culling of the infected animals. Treatment and vaccination of animals are not 100% safe for human health.[5] Diagnosis mainly relies on serology whereas isolation of the etiology remains the gold standard. However, the latter should be followed only under strict biosafety conditions e.g. Biosafety level (BSL) 3 due to the high risk of biohazard.[6] In the Indian subcontinent (nowadays India, Pakistan, and Bangladesh), brucellosis was first investigated as "contiguous abortion" in 1918.[7] Since then, brucellosis has remained a persistent problem in the domestic livestock e.g. cattle, buffaloes, sheep and goats, camels, and dogs of the subcontinent.[8,9] There exists a strong animal-human bond in this region where animals act as an important instant-income source to the farmers. In this scenario, brucellosis poses not only a significant threat to livestock but also to farmer health and economics. Moreover, contamination in the milk transport chain can pose a significant public health threat. Economic losses due to brucellosis were estimated as an average loss of 18.2 United States dollars (USD) per buffalo, 6.8 USD per cattle, 0.7 USD per sheep, 0.6 USD per pig, and 0.5 USD per goat in India in 2015.[10] Brucellosis is an established occupational health hazard i.e. people who are frequently exposed to animals at work are at high risk of disease transmission. The main cause remains to ignore protective measures often due to the lack of awareness and strict regulations.[11] Military dairy farms in Bangladesh are an important source of milk and bear a significant number of dairy cattle (mostly cross-bred) as well as attendants. Previously, brucellosis has been reported at these farms.[12,13] Research work on knowledge, attitudes, and practices related to brucellosis has been done in endemic settings but is missing for Bangladesh.[11,14] To overcome this gap, the current study was designed to evaluate the knowledge, awareness and practices prevailing among the workers at these farms.

MATERIALS AND METHODS

A cross-sectional study was conducted involving farm workers and their households of eight military dairy farms (Savar, Ishurdy, Chatttogram, Jashore, Lalmonirhat, Cumilla, Shornodip and Trishal) in different regions in Bangladesh during the period from March to August 2020 (Fig.1). The sample size was calculated based on the following formula.[15]

$$n = \frac{N}{1 + Ne^2} \quad (1)$$

Where, N = Study population size = 1977
e = Precision = 3% = 0.03

These assumptions produced a sample size of 711. Out of 1977 persons 715 were randomly selected. A structured questionnaire was administered in the local language among the

selected persons to collect data on knowledge, awareness, and practices concerning disease management with a focus on brucellosis. Knowledge about brucellosis was assessed by asking the workers if they had heard about a disease called brucellosis. At the beginning of the interview workers were informed about the purpose of the study and their consent were also taken by using a customized consent form.

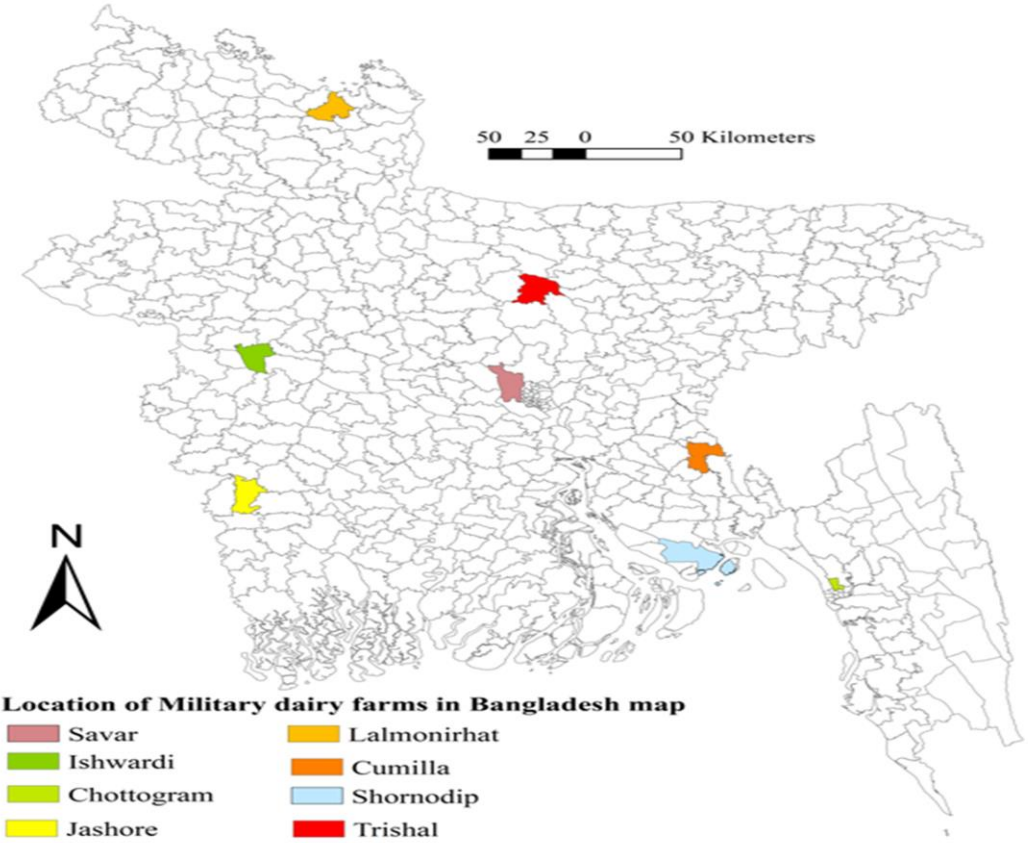

Fig. 1. Map of Bangladesh showing the location of military dairy farms

Questionnaire design and data collection

The military dairy farms were selected based on operational convenience and a range of social and spatial differences across the country. Table 1 shows the demographic characteristics of the selected military dairy farms. Keeping the system of animals in all these farms was recorded overall at 2.39% seroprevalence of Brucella infection with all the CFT, SAT and ELISA assays and 3.09% with RBT, whereas only 0.20% of tested milk samples showed positive with MRT in the lactating dairy cows. *B. abortus* is the causal agent of bovine brucellosis which is identified for the first time as an etiological agent of human brucellosis in occupationally exposed dairy farm workers in Bangladesh. Only 55.4% of the farm workers knew brucellosis as a human disease. None of the workers and their families was reported to consume raw milk and its products. Limited biosecurity and biosafety measures are also being practiced with good veterinary service on the side and hygienic / animal health status in generally prevailed on these farms. The highest number of worker population (359/1971) was found at military

dairy farm Lalmonirhat and the highest worker population density was observed at military farm Trishal (340 per km^2). It is worthy to mention that, though the area of military farm Shornodip was the largest but it had been observed lowest number of population and density as it was located on an isolated island (Table 1). A total of 715 workers were taken for interviews with an average of 89 workers per military dairy farm being selected. A structured questionnaire (available on request from the corresponding author) was used to gather information on workers and their families, knowledge about brucellosis, and potential risk for contracting brucellosis.

Table 1. Demographic characteristics of the selected military dairy farms of different area in Bangladesh

S/N	Division	Military dairy farm	Area (km^2)	Workers	Density (/km^2)	Sampled	In living (%)	Out living (%)
1.	Dhaka	Savar	2.11	385	182	100	50	50
2.	Rajshahi	Ishurdy	1.3	305	235	95	50	50
3.	Chattogram	Chattogram	0.86	205	238	85	50	50
4.	Khulna	Jashore	1.21	295	244	90	50	50
5.	Rongpur	Lalmonirhat	1.93	359	186	120	50	50
6.	Chattogram	Cumilla	0.36	190	528	80	50	50
7.	Chattogram	Shorndip	3.16	058	018	50	100	-
8.	Mymensingh	Trishal	0.53	180	340	95	50	50
	Overall / Average	-	11.46	1977	246.38	715	56.25	43.75

In living = Workers live within the farm area Out living = Workers are non-residential

The first part of the questionnaire included questions on demographic characteristics, knowledge about brucellosis, and on herd management practices that could pose a risk for animals (Table 2 and Table 3). The second part of the questionnaire focused on awareness of brucellosis in humans, potential routes of transmission, and information on risky practices within households. Major risky practices associated with herd management and in the household are described in Table 4 and Table 5.

Each of the selected dairy farms was visited for 4 to 5 days and 18 to 20 workers were interviewed each day. The author explained the objectives and the participant information sheet. Workers were told that participation in the study was absolutely voluntary and that the identification of the farm/herd/household would not be disclosed for participating in the interview.

Data analysis

Data on knowledge, awareness and practices were entered into a Microsoft Excel 2010 (MS excel) (Microsoft Corp, Redmond WA, USA) spread sheet and transferred to R 4.1.0 for analysis.

Univariate logistic regression analysis

For every correct answer to each question, a score of "1" was allotted and '0' for the wrong answers. The total score was added and those who scored above the mean (12.05 ± 1.74) was categorized as "good" and those who scored equal to and below mean was defined as "poor" knowledge of brucellosis. Similarly, for the attitude related questions, a score of "1" was allotted for the correct answers and "0" for the wrong answers. If the attitude scores were more than or equal to mean (8.32 ± 1.61) it was considered as "favorable attitude" and if the scores were less than mean score, it was considered as "unfavorable" towards brucellosis.

Table 2. Demographic and other characteristics of the military dairy farm workers in Bangladesh (n=715)

S/N	Characteristics	Category	Frequency, %	S/N	Characteristics	Category	Frequency, %
1.	Military farm	Lalmonirhat	057 (07.9)	3.	Education	Primary	500 (69.0)
		Trishal	111 (15.5)			Secondary	174 (24.3)
		Chattogram	125 (17.5)			≥College	041 (05.7)
		Cumilla	070 (09.8)	4.	Occupation	Animal attendant	110 (15.4)
		Ishwardi	110 (15.4)			Cleaner	210 (29.4)
		Jeshore	099 (13.8)			Milkmen	222 (31.0)
		Savar	089 (12.4)			VFA & Artificial	163 (22.8)
		Shornodip	054 (07.6)			Inseminator	
2.	Age (year)	18-24	151 (21.1)	5.	Duration of	≤3	532 (74.4)
		25-34	239 (33.4)		service (years)	>3	183 (25.6)
		35-44	168 (23.5)				
		>44	157 (22.0)				

Table 3. Overall responses of the dairy farm workers on the knowledge of brucellosis (n = 715)

S/N	Questions / Statement	Knowledge, %	
		Adequate	Inadequate
1.	Did you hear about the brucellosis as an animal disease?	396 (55.4)	319 (44.6)
2.	Do you know that participants can acquire any diseases from animals?	370 (51.7)	345 (48.3)
3.	Did you hear about the brucellosis as human disease?	002 (00.3)	713 (99.7)
4.	Do you know that contact with aborted fetus or placental membrane can lead to brucellosis in humans?	060 (08.4)	655 (91.6)
5.	Do you know that consumption of raw milk can transmit brucellosis in humans?	0	715 (100)

Table 4. Overall responses of the dairy farm workers on the awareness of brucellosis (n = 715)

S/N	Questions / Statement	Awareness	
		Yes %	No%
1.	Brucellosis causes fever	434 (60.7)	281 (39.3)
2.	Night sweat is a symptom of brucellosis	103 (14.4)	612 (85.6)
3.	Brucellosis causes malaise	068 (09.5)	647 (90.5)
4.	Is brucellosis responsible for anorexia?	023 (03.2)	692 (96.8)
5.	Headache is an important symptom of brucellosis	037 (05.2)	678 (94.8)
6.	Brucellosis is responsible for arthralgia?	012 (01.7)	703 (98.3)
7.	Brucellosis is a high risk disease for animal attendant and workers	302 (42.2)	413 (57.8)

Table 5. Overall responses of the dairy farm workers on the practices of brucellosis (n = 715)

S/N	Questions / Statement	Practices	
		Yes %	No %
1.	Do you use hand gloves while handling fetal membranes and dead fetus?	535 (74.8)	180 (25.2)
2.	Do you wash your hands after handling animals?	673 (94.1)	042 (05.9)
3.	Do you drink raw milk?	0	715 (100)
4.	Do you wash hand before and after milking?	683 (95.5)	032 (04.5)

To assess the knowledge, awareness and practices of brucellosis, the total number of correct answers were divided by the number of total questions to calculate the proportion of correct answers. The adequate and inadequate knowledge was categorized based on median proportion. However, the cutoff to classify favorable attitude/awareness and appropriate practices was considered 60%. The military farm workers' demographic and other factors associated with brucellosis knowledge, awareness and practices were analyzed separately. Age and duration of service were converted into categorical variables for analysis. The military farm workers' knowledge (adequate versus inadequate), awareness (yes versus no) and practices (appropriate versus inappropriate) on brucellosis were considered as the outcome and their demographic and other characteristics were used as explanatory variables.

Univariate logistic regression analyses were used to assess the association between cattle handlers' knowledge, awareness and practices and their demographic and other characteristics**.** Any explanatory variable associated with knowledge, awareness and practices with a p-value of ≤ 0.20 was selected for multiple logistic regression analysis. The collinearity among explanatory variable was assessed using established method.[16]

Multivariable logistic regression analyses

Separate multiple logistic regression models were used to identify demographic and other factors associated with brucellosis knowledge, awareness and practices. The detail method on model selection, model fit, model diagnostics and confounding were described in a previous paper.[15]

RESULTS

Demographic and other characteristics of the dairy farm workers

Table 2 shows the demographic characteristics of the different military dairy farms workers. About 33.4% (n = 239) of farm workers were >25 to 34 years old. Sixty-nine percent of farm workers (n = 500) had a primary level of education. Among farm workers, 31.0% (n = 222) were milkmen. About 75% (n = 532) of the farm workers were working for ≤ 3 years on the military farm.

Participant's knowledge regarding brucellosis

Table 3 shows the participant's knowledge regarding brucellosis. Approximately 55.4% out of 396 participants had adequate knowledge about brucellosis as an animal disease. In this study 51.7% i.e. 370 did know that the disease could be acquired from animals. Only two participants did know that brucellosis could cause human disease and 655 participants did not know that contact with an aborted fetus or placental membrane could lead to brucellosis in humans. None of the participants did know that the consumption of raw milk could transmit brucellosis to humans.

Practices in household

None of the workers and their families consumed raw milk or its products, most of the participants (74.8%) used hand gloves during handling fetal membranes and dead fetuses (Table 5). Overall, 95.5% of all workers used to wash their hands before and after milking. Most (94.1%) of the workers and households washed their hands after handling animals. Only the age of dairy farm workers was found to be significantly associated with knowledge on brucellosis. Dairy farm workers aged between 18 to 24 years and > 44 years were 9.9 (95% CI: 2.9; 33.6) and 5.8 times (95% CI: 1.6; 20.5) more likely to have adequate knowledge of brucellosis than other age groups (Table 6).

Table 6. Univariate association between dairy farm workers demographic and other characteristics and overall knowledge of brucellosis in Bangladesh (n=715)

S/N	Variable	Category	Knowledge, %		Odds ratio (95% CI)	p-value
			Adequate	Inadequate		
1.	Age (years)	18-24	23 (15.2)	128 (84.8)	9.9 (2.9; 33.6)	0.000
		25-34	12 (05.0)	227 (95.0)	2.9 (0.8; 10.5)	0.10
		35-44	03 (01.8)	165 (98.2)	Reference	-
		> 44	15 (09.6)	142 (90.4)	5.8 (1.6; 20.5)	0.006
2.	Occupation	Animal attendant	07 (06.4)	103 (93.6)	0.6 (0.25; 1.9)	0.28
		Cleaner	21 (01.0)	189 (90.0)	Reference	-
		Milk recorder	01 (10.0)	009 (90.0)	1.0 (0.12; 8.3)	1.0
		Milker	16 (07.2)	206 (92.8)	0.69 (0.35; 1.4)	0.30
		VFA & AI workers	08 (04.9)	155 (95.1)	0.5 (0.2; 1.1)	0.07
3.	Education	Primary	37 (07.4)	463 (92.6)	1.6 (0.4; 6.7)	0.55
		Secondary	14 (08.0)	160 (92.0)	1.7 (0.4; 7.8)	0.49
		≥ College	02 (04.9)	039 (95.1)	Reference	-
4.	Duration of service (years)	≤ 3	39 (07.3)	493 (92.7)	Reference	-
		> 3	14 (07.7)	169 (92.3)	1.04 (0.6; 1.9)	0.25

Awareness about brucellosis

Knowledge about brucellosis was significantly associated with the age of the dairy farm workers. The odds of awareness were 1.8 times (95% CI: 1.1; 2.8) higher among dairy farm workers aged between 18 to 24 years than those aged between 25 to 34 years (Table 7).

Table 7. Univariate association between dairy farm workers demographic and other characteristics and overall awareness of brucellosis in Bangladesh (n=715)

S/N	Variable	Category	Awareness		Odds ratio (95% CI)	p-value
			Yes, %	No, %		
1.	Age (years)	18-24	48 (31.8)	103 (68.2)	1.76 (1.1; 2.8)	0.02
		25-34	50 (20.9)	189 (79.1)	Reference	-
		35-44	36 (21.4)	132 (78.6)	1.0 (0.6; 1.7)	0.90
		> 44	40 (25.5)	117 (74.5)	1.3 (0.8; 2.1)	0.29
2.	Occupation	Animal attendant	26 (23.6)	084 (76.4)	1.1 (0.7; 1.9)	0.65
		Cleaner	45 (21.4)	165 (78.6)	Reference	-
		Milk recorder	03 (30.0)	007 (70.0)	1.6 (0.4; 6.3)	?
		Milkmen	56 (25.2)	166 (74.8)	1.2 (9.8; 1.9)	0.35
		VFA & AI workers	44 (27.0)	119 (95.1)	0.5 (0.2; 1.1)	0.07
3.	Education	Primary	121(24.2)	379 (75.8)	1.0 (0.7; 1.5)	0.98
		Secondary	42 (24.1)	132 (75.9)	1.2 (0.5; 2.5)	0.72
		≥ College	11 (26.8)	030 (73.2)	Reference	-
4.	Duration of service (years)	≤ 3	125 (23.5)	407 (76.5)	Reference	-
		> 3	49 (26.8)	134 (73.2)	1.2 (0.8; 1.7)	0.37

Practices in herd management

In the multivariable logistic regression analysis, both age group and occupation of the dairy farmers were found to be significantly associated with the overall appropriate practices for brucellosis control. Dairy farm workers aged between 18 to 24 years and > 44 years were 2.1 (95% CI: 1.3; 3.4) and 2.9 times (95% CI: 1.8; 4.9) more likely to perform appropriate practice for brucellosis control than those aged between 25 to 34 years (Table 8). In addition, animal attendant performed 8.9 times (95% CI: 2.2; 36.1) more appropriate practices for brucellosis control than milkmen (Table 8).

Table 8. Univariate and multivariate association between dairy farm workers demographic and other characteristics and overall practices of brucellosis in Bangladesh (n=715)

S/N	Variable	Category	Practices, %		Univariable regression		Multivariate regression
			Appropriate	Inappropriate	Odds ratio (95% CI)	p-value	Odds ratio (95% CI)
1.	Age (years)	18-24	118 (78.1)	033 (21.9)	2.0 (1.3; 3.2)	<0.001	2.1 (1.3; 3.4)
		25-34	153 (64.4)	086 (36.0)	Reference	-	Reference
		35-44	116 (69.0)	052 (31.0)	1.3 (0.8; 1.9)	0.29	1.4 (0.9; 2.1)
		> 44	132 (84.1)	025 (15.9)	2.9 (1.8; 4.9)	<0.001	2.1 (1.3; 3.4)
2.	Occupation	Animal attendant	95 (86.4)	015 (13.6)	9.5 (2.4; 37.7)	0.001	8.9(2.2; 36.1)
		Cleaner	144 (68.6)	066 (31.4)	3.3(0.9;11.9)	0.07	3.2 (0.9;12.0)
		Milk recorder	004 (30.0)	006 (60.0)	Reference	-	Reference
		Milkmen	157 (70.7)	065 (29.3)	3.6 (0.9; 13.2)	0.05	3.2 (0.8;11.8)
		VFA & AI workers	119 (73.0)	044 (27.0)	4.1 (1.1; 15.1)	0.04	3.8 (0.9;14.2)
3.	Education	Primary	369(73.8)	131 (26.2)	1.3 (0.7; 2.6)	0.44	-
		Secondary	122 (70.1)	052 (29.9)	1.1 (0.5; 2.7)	0.81	-
		≥ College	028 (68.3)	013 (31.7)	Reference	-	-
4.	Duration of service (years)	≤ 3	390 (73.3)	142 (26.7)	1.1 (0.8; 1.7)	-	-
		> 3	129 (70.5)	054 (29.5)	-	-	-

DISCUSSION

The current study showed that the knowledge and awareness of brucellosis in the farm workers was moderate. Workers (n = 751) of eight military dairy farms in Bangladesh showed 55.4% of the participants had ever heard about brucellosis. Only a few did know about the zoonotic potential of this disease (0.3%). This agreed with the results from Uganda,[16] Egypt,[17] and Jordan.[18] In contrast, studies from Tajikistan[14] and Kenya[19] showed even lesser awareness about the disease in local workers. The awareness for animal brucellosis in the present study could be attributed to health and school education in the study areas. Furthermore, more than half of the participants were aware of the zoonotic transmission. Indeed, such participants practiced better preventive measures while working at these farms. These findings are supported by Kozukeev et al.[20] who found that good knowledge about disease transmission resulted in better adoption of the protective measures. Another study in Iran demonstrated that being aware of the routes of transmission, i.e. consumption of raw milk or cheese, was associated with a reduced occurrence of human brucellosis infection.[21] This suggested that

improving farmers' knowledge of the disease and the mode of its transmission is likely to reduce the risk of transmission. Hence, the findings from the current study highlighted that despite the maximum of participants who had heard about animal brucellosis, all participants were engaged in at least one risky practice at their farms and households.[22]

Consumption of raw milk is the main risk for brucellosis transmission in humans.[4] In the current study, none of the participants reported consuming raw milk (unpasteurized) and products regularly. Still, the risk for transmission of brucellosis exists, if the disease is present in a herd.[23] This study confirms that the level of school education is associated with the knowledge of brucellosis and the practices in relation to avoiding this disease i.e. risk decreased in person with college graduation when compared to workers with primary or secondary school degrees. Workers with no or school diplomas were less likely to have good hygienic practices at their homes and were putting themselves at more risk of contracting brucellosis. These findings are also in accordance with studies conducted in Yemen[22] and in Tajikistan.[14] Moreover, this analysis demonstrates that the employment of participants with higher qualifications had positive influence on-farm management and household practices. Analysis of risky practice scores indicated that the knowledge of the nature of the disease is important for brucellosis control and may function as the overall predictor of workers' behavior towards risks. This study also found that the level of risk differs across the eight military farms. It has to be stressed that none of the farms is risk-free and if the disease is present in the area, it will finally spread quickly due to the prevalence of risky practices at both farm and household levels. It is important to note that none of the participants was aware of the risk that zoonotic diseases get transmitted from milk to humans.

This study unravels that a poor understanding of the nature of brucellosis and a high level of risky practices present on those farms and in the households contribute equally to the risk that human's contract brucellosis. For low to middle-income countries like Bangladesh, appropriate health education is required to raise awareness not only for brucellosis but also for other zoonotic diseases. Education is the most feasible preventive measure, where testing and slaughtering of infected cattle or milk pasteurization are not common practices at the farm level. A synergistic „One Health" approach to this type of education on the farms would be ideal to boost the change of practices needed at the farm and household level. Programs increase awareness of the disease and promote hygienic and safe handling while assisting lambing or calving. Regulations for proper disposal of abortions and afterbirths should be taken care of with priority. Collaborative and transboundary teamwork of endemic nations will build up a strong response against brucellosis.

ETHICAL APPROVAL

The study protocol for the ethical statement was peer-reviewed and animal research was approved by the Faculty of Veterinary Science of Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh, and the concerned Military authority of the Bangladesh Army (AWEEC/BAU/2021(19), Dated: 14-07-2021; Army Head Quarters, QMG'S, BR, ST DTE, Letter No.4596/3/ST-5; Dated:13June2017). Study objectives were clarified and verbal consent was obtained before collecting data from the participants. All participants were recruited for the study based on their free will to participate.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this article.

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