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Assessment of occupational exposure to mycobacterial infections in farmers and slaughterhouse workers

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Abstract
The present study was conducted to identify risk factors associated with mycobacterial infection among high-risk occupational groups, as Tuberculosis, particularly zoonotic tuberculosis, are an important occupational disease for farmers and slaughterhouse workers. Data was collected through a structured questionnaire to farmers and slaughterhouse workers (94 respondents) on farm-level practices, livestock characteristics, and occupational behaviors. Information included herd size, rearing systems, introduction of new animals, handling of sick animals, milk and meat handling practices, and personal protective measures. Statistical analysis was performed using descriptive statistics, Chi-square tests, and multivariate logistic regression with SPSS software. Multivariate logistic regression identified significant risk factors for mycobacterial infection, including poor handling of sick animals (aOR=2.24, 95% CI, P=0.03) and unhygienic slaughtering/handling of raw meat (aOR=7.93, 95% CI, P=0.03). Consumption of raw milk was rare (6.45%) and did not emerge as a major risk in this population. This study highlights the occupational vulnerability of farmers and slaughterhouse workers to mycobacterial infections, particularly tuberculosis. Improving the awareness about the occupation risks *viz*., encouraging the use of personal protective equipment, regular screening programs, hygienic handling of animals and meat will play a pivotal role in mitigating zoonotic tuberculosis at the human-animal interface.

Keywords: Mycobacterial infection, zoonotic tuberculosis, occupational exposure, farmers, slaughterhouse workers, risk factors

Introduction
Zoonotic tuberculosis caused by Mycobacterium bovis and other members of the Mycobacterium tuberculosis complex, pose to be a significant global public health problem. Farmers, dairy handlers, and slaughterhouse workers are among the most vulnerable groups due to their continious occupational exposure to infected animals, animal products, and contaminated environments (Ayele *et al*., 2004; Ashford *et al*., 2001) [2, 1]. Transmission of disease occurs through direct contact with infected animals, handling raw meat, consumption of unpasteurized milk, and inhalation of aerosols droplets (Devi *et al*., 2021; Grange, 2001) [5, 3]. Moreover, global systematic reviews indicate a pooled prevalence of tuberculosis of nearly 19% among livestock-related occupational groups, emphasizing the magnitude of the problem. In many regions, awareness about zoonotic TB remains scarce, with unsafe practices such as unhygienic slaughtering, raw milk consumption, and improper disposal of animal waste still prevalent (Jenkins *et al*., 2011) [7].
Against this backdrop, the present study was undertaken to identify potential risk factors for mycobacterial infection among farmers and slaughterhouse workers. By examining farm-level management practices, animal health data, and occupational behaviors, the study aims to provide scientific evidence that can inform targeted interventions to reduce zoonotic transmission and protect both human and animal health.

Materials and Methods

Data collection

A questionnaire was prepared to obtain data to identify the potential risk based on existing literature and experts' opinion. Open-ended and closed-questions regarding farm level datasuch as farm type, livestock possession, rearing methods, introduction of new animals, veterinary healthcare provider, and dairy animal data on breed, age, calving, milk production, pregnancy status were included in the schedule and data were collected at the time of sample collection. Information on herd level data, practices followed by the farmers during farming and meat handling practices followed by slaughter house workers to identify the risk factors of mycobacterial infection to humans was collected. A number of factors included in the study were farm size, rearing system, introduction of new animals, a contact with chronic sick animals, handling raw milk, consuming raw milk, slaughtering the animals, and consuming uncooked meat. All respondents were informed that participation in this study was voluntary and that they did not have to answer all of the questions.

Statistical Analysis

The data collected from the questionnaire were recorded in a MS excel spreadsheet. First, data were summarised using descriptive statistics for demographic characteristics and other factors. All continuous predictor variables (herd size, age of the animal, parity and weight) were categorized prior to logistic regression analysis. Subsequently, the data were analysed using the conditional logistic regression by SPSS software. Bivariate analysis was performed using the Chi squared test. Variables with a p-value ≤ 0.20 in the bivariate analysis were included in a multivariate logistic regression model (Bapat *et al.*, 2017) [4].

Results

The distribution of demographic status of the cattle tested were presented in Table 1, 2, 3. About 2.23% of cattle were male and rest were female. About 61.49% of cattle was between 2-4 years of age. Around 58.06% were newly bought. Multivariate logistic regression was used to identify risk factors associated with Mycobacterial infection and adjusted odds ratios (aORs) for each variable were identified. Significant variables were included in the logistic regression model. Factors with p-value < 0.05 in the logistic regression model were considered statistically significant. Finally, variables such as gender, contact with sick animals, handling raw milk, consuming raw milk, contact with aborted animals, slaughtering of animals, handling raw meat and consuming raw meat were included to identify the potential risk factors by logistic regression model. Adjusted odds ratio value revealed that, there was evidence of association of factors with mycobacterial infection. In the present study, it was identified that odds of infection among those who followed poor handling practice of sick animals was 2.24 (95% CI; P=0.03) times greater than those who did not. Unhygienic Handling of raw meat and its disposal was 7.93 (95% CI P=0.03) times greater odds of infection (Table 4).

Discussion

Occupational diseases are human infection caused by zoonotic pathogens during human-livestock contact at work. At present, tuberculosis is one among predominant occupational diseases globally. Systematic reviews conducted by Mia *et al*., 2022 reported that the global pooled prevalence of tuberculosis of 19% (95% CI: 09-30) among the various livestock-related occupational groups. The association between poor handling practice of sick animals and its occupational exposures had increased risk of infection has been reported by the previous study conducted by Gompo *et al*., 2020 [6] which is in agreement with the present study. This study identified that handling raw meat and its disposal increased the risk of mycobacterial infection which justifies early report stating consumption of unpasteurized milk or raw meat products, contact with sick animals, aerosol inhalation of infective droplet or tissue is route of transmission of Tuberculosis by Devi *et al*., 2021 [5]. It was reported that human animal contact in markets and slaughter houses are also risk factors for Tuberculosis (Jenkins *et al*., 2011) [7]. Interestingly, most of the respondents were not aware about this risk, majority of them are contacting with sick animals. The results of the study showed that consuming of raw milk is not a common practise in the study area, which contrary to the study reported by Bapat *et al*., 2017 [4]. All the respondents reported this as unrisky practice which indicates good consumption pattern in the study region.

Table 1: Status of dairy animal level parameters

Sex of the animal	**Male**	**15**
	Female	**655**
Age of animal	Less than 2 years	58
	2-4 years	412
	4-6 years	110
	More than 6 years	90
Source of animal	Brought	382
	Farm born	288
Pregnancy status	Yes	30
	No	640
Milking status	Yes	326
	No	329
Calving status	Less than 2	212
	2-4 times	207
	More than 5 times	63

Table 2: Characteristics of farm and management practices

Variables	Category	Frequency number (n)	%
Herd status	Positive	15	16.12%
	Negative	72	77.41%
TB symptoms in the farm	Yes	9	9.6%
	No	62	66.66%
	Don't know	22	23.65%
Herd size (no's of cattle)	Less than 5	73	78.49%
	6-10	15	16.12
	More than 10	5	5.3%
Rearing system	Intensive	3	3.22%
	Semi-intensive	33	35.48%
	Extensive	57	61.29%
Grazing	Yes	68	73.11%
	No	25	26.88%
Introduction of new animal	No	39	41.93%
	Yes	54	58.06%
Presence of other species on the farm	Yes	47	50.53%
	No	46	49.46%
Co-grazing of heifers with sheep and/or goats.	Yes	35	37.63%
	No	58	62.36%

Table 3: Participation in practices posing the farmers at high risk for Mycobacterial infections

Practices	Categories	Frequency	%
Unhygienic slaughtering or handling of raw meat	Yes	15	16.12%
	No	78	83.87%
Handling of milk-Unhygienic practices during milking	Yes	62	66.66%
	No	31	33.33%
Consuming raw milk	Yes	6	6.45%
	No	87	93.54%
Use of personal protective equipment	Yes	9	9.67%
	No	84	90.32
Not cleaning or disinfecting the shed after partition	Yes	26	27.95%
	No	67	72.04%
Early screening for disease	Yes	15	16.12
	No	78	83.87%

Table 4: Risk factor identification of mycobacterial infection by Multivariate logistic regression

variables	Adjusted OR	P-Value
Gender	0.801	0.350
Contact with sick animals	2.24	0.032
Unhygienic Handling of raw meat and its disposal	7.93	0.013
Consuming raw milk	2.69	0.165
Slaughtering animals	4.65	0.571
Consuming uncooked meat	2.24	0.561

Conclusion

This study highlights that poor handling of sick animals, unhygienic practices in raw meat processing, and inadequate protective measures significantly increase the risk of mycobacterial infection among farmers and slaughterhouse workers. The findings highlights the occupational vulnerability of these groups and emphasize the need for strengthening biosecurity measures, promoting hygienic practices, and enhancing awareness of zoonotic transmission pathways.

Conflict of interest: Not available

Financial support: Not available

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