



Original Article

One Health Bulletin



One Health risk perception among the urban vulnerable dwellers of Gujarat, India: A cross-sectional assessment

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ABSTRACT

Objective: To assess One Health risk perception and local knowledge concerning threats arising from the interaction of humans, animals, and the environment at the community level with a particular emphasis on zoonotic disease transmission at Ahmedabad and Gandhinagar City, Gujarat, India, where the majority are vegetarians.

Methods: A cross-sectional design with cluster sampling was employed with 387 participants participated in a quantitative survey, comprising 192 livestock handlers and 195 non-livestock handlers. Additionally, 20 in-depth interviews explored qualitative insights. Data were processed using MS Excel and analysed using Stata version 14.

Results: In our study, we observed varied risk perceptions among predominantly female participants. Among livestock handlers, 23.4% acknowledged the potential for zoonotic transmission, while this awareness increased to 41.0% among non-livestock handlers. Although handwashing after animal contact and work was common among livestock handlers, only 20.3% recognized the pivotal role of hygiene in preventing zoonotic diseases. Similarly, 37.0% of livestock handlers and 47.2% of non-livestock handlers understood the risks associated with consuming raw milk and meat, which reveals a statistical difference between these two groups ($P=0.000$). Another significant difference was observed in the perception on animal waste disposal sites with 58.9% of livestock keepers and 80.0% of non-livestock keepers considering such sites as risky factors ($P=0.000$). Furthermore, vaccination awareness was high, with 85.4% of livestock handlers and 88.7% of non-livestock handlers being aware of vaccination as a preventive measure against zoonotic diseases. Interestingly, non-livestock individuals demonstrated a higher level of awareness

regarding zoonotic diseases compared to their livestock counterparts.

Conclusions: This study emphasizes the urgent need for collaborative One Health interventions to address zoonotic disease risks among livestock handlers in India. By bridging knowledge gaps and promoting proactive measures, we can effectively safeguard public health and well-being in the face of emerging zoonotic threats.

KEYWORDS: Risk perception; Livestock and non-livestock; Awareness; Knowledge; Behaviour

Significance

One key factor in zoonotic disease transmission is the presence of risk factors at the human-animal-environment interface. However, there is still a lack of knowledge regarding risk factors, especially among livestock farmers who are most vulnerable to zoonoses. This study examines risk assessment among livestock handlers and non-livestock handlers in Gujarat, India, from a One Health perspective.

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How to cite this article: Ganasva P; Yasobant S, Patel K, Saxena D. One Health risk perception among the urban vulnerable dwellers of Gujarat, India: A cross-sectional assessment. One Health Bull 2024; 4(4): 181-188. doi: 10.4103/ohbl.ohbl_7_24

Article history: Received 24 January 2024
Accepted 18 July 2024

Revision 12 April 2024
Available online 27 August 2024

1. Introduction

The One Health concept highlights the interconnectedness of human, animal, and environmental health, emphasizing the need for collaborative, interdisciplinary approaches to address shared health challenges. Zoonotic diseases, which can be transmitted between animals and humans, pose a significant global health threat. Factors such as close human-animal interaction, poor hygiene practices, urbanization, and climate change contribute to the risk of zoonotic diseases. The One Health approach recognizes the intricate connection between human health, animal health, and the environment. It operates collaboratively across sectors and disciplines at local, regional, and global levels, aiming to optimize health outcomes by acknowledging the interdependence of people, animals, plants, and the environment[1]. One Health encompasses a wide array of issues, including emerging, reemerging, and endemic zoonotic diseases, neglected tropical diseases, vector-borne diseases, antimicrobial resistance, environmental pollution, climate change, and other health threats shared by humans, animals, and the environment.

Zoonotic diseases have emerged as a global concern, with 2.5 billion cases of human illness and 2.7 million human deaths attributable to zoonoses annually worldwide[2]. In India, zoonotic diseases are on the rise, with 816 zoonotic pathogens identified among 1407 human pathogens, including 57 protozoa, 317 fungi, 208 viruses, 287 helminths, and 538 bacteria and rickettsia. These diseases are responsible for 2.2 million fatalities and 2.4 billion cases of human illnesses in India and globally, with the COVID-19 pandemic exemplifying the global health emergency posed by zoonotic diseases[3].

The WHO reported on 3 October 2023 that approximately 60% of emerging infectious diseases originated from animals, both wild and domestic, with 75% of these being zoonotic[4]. India, with its dense population, close human-animal contact, poor sanitation, and substantial livestock population, is particularly susceptible to zoonotic diseases[5].

Research conducted in India has revealed that different categories of livestock workers possess differing degrees of awareness and knowledge regarding zoonoses. According to Wright *et al.*, the Van Gujjar community of North India focused more on animal illnesses and had less knowledge of zoonotic diseases[6]. Singh *et al.* emphasized the need for education among Punjabi livestock handlers who have a low awareness of certain zoonotic diseases and consume raw milk[7]. However, Prabhakar *et al.* discovered that butchers in Andhra Pradesh had better awareness, with 60% of them being aware of prevalent zoonotic diseases and how to

control them. All these studies called for the necessity of a focused education campaign to raise awareness of the risk of zoonotic diseases in India[8]. In Gujarat, India, where agriculture and livestock farming are vital for many communities' income, zoonotic diseases like brucellosis, rabies, avian flu, leptospirosis, bovine tuberculosis, dengue, and Crimean-Congo hemorrhagic fever are of prime concern. These diseases account for significant proportions of zoonotic cases in the region, reflecting the importance of addressing them[9].

Risk is defined as the likelihood of an adverse event occurring, coupled with the potential consequences of that event. It encompasses both the probability of occurrence and the harm or loss associated with it[10]. Understanding and raising awareness about One Health risks are essential for public health safety, population protection, and the development of preventive measures and early detection. Factors contributing to increased zoonotic disease risk include close human-animal contact, poor sanitation and hygiene practices, urbanization, globalization, migration of people with live animals, environmental changes, climate factors, inadequate knowledge of disease transmission, and insufficient surveillance and monitoring.

The several advantages of the risk perception of zoonotic diseases are based on the One Health management theory[11]. It serves as a foundation for comprehensive and predicting how the public will react to health risks, which facilitates the creation of successful risk communication plans[12]. Given that perceptions are a major factor in determining health behaviour, this is especially crucial when it comes to changing health-related behaviours. Moreover, risk management techniques' efficacy can be assessed with the aid of a methodology designed to quantify the advantages of a One Health approach[13].

Vulnerable populations for zoonotic disease infections include rural communities engaged with livestock, individuals living near livestock houses without livestock, wildlife and forest workers, veterinary professionals, and populations settled informally in overcrowded urban areas. These groups are at higher risk due to their proximity to potential sources of zoonotic diseases.

In India, many zoonotic diseases remain undocumented in both the government and private sectors due to insufficient interaction between human and animal health sectors. Awareness among community health workers and the general population regarding zoonotic diseases and their signs and symptoms is limited. There is a lack of significant evidence regarding awareness, knowledge, and risk perception related to zoonotic diseases.

2. Methods and materials

2.1. Study design and setting

A cross-sectional study was conducted on risk perception and local knowledge about animal-human-environment interference at the community level at Ahmedabad and Gandhinagar City, Gujarat, India, from January to May 2023.

Gujarat state has 33 districts and an average population of 63.91 million[14]. The present study covered two districts, Ahmedabad and Gandhinagar of the Gujarat state with the majority of its people being vegetarians.

2.2. Study subjects and sampling techniques

This study included livestock handlers and non-livestock handlers who lived near the areas of livestock farms. A Quantitative survey was used, and the qualitative survey was used for additional key information collection through verbal communication during the quantitative data collection. A cluster sampling technique was chosen for the data collection. The households with livestock farming and households with non-livestock handlers at Gandhinagar and Ahmedabad, as well as random areas were selected.

2.3. Sample size

In the absence of pan Gujarat study on risk perception level at the community level, we have calculated the sample size based on the last study conducted in Ahmedabad[15], following the equation of $n = [DEFF * Np(1-p)] / [(d^2/Z^2(1-\alpha/2 * (N-1) + p * (1-p))]$, in which n refers to population size (for finite population correction factor), p means hypothesized % frequency of outcome factor in the population, d refers to confidence limits as % of 100 (absolute +/- %) and DEFF stands for design effect (for cluster surveys).

With the average awareness level of 52%, considering 95%CI, population of 8 million of two surveyed area and DE=1, the total sample size calculated was 387.

The sample collection of the participants was not pre-decided due to the availability of the participants.

2.4. Study data collection

2.4.1. Quantitative survey

Data was collected by using the structural questionnaire in the local language. All questions were entered in the Kobo collect tool. This questionnaire engaged participants for 5 to 10 minutes. The questionnaire covered sociodemographic information, occupational information, personal behavior, and community risk perception on zoonotic diseases question. This form is for the person handling

the livestock and non-livestock handlers. The tool was pilot-tested before data collection to test and refine the questions; however, no statistical methods were used to validate the questionnaire. The tool was divided into three sections: first, demographic details of the participants; second, personal behaviour; and third, perception about the zoonotic disease risks. The personal behaviour section includes questions related to the personal behaviour of the participant during the exposure to various risk factors that can occur during the interference of human-animal-environment such as consumption of raw milk and undercooked or raw meat, purchasing meat, animal bite or scratch, etc. These questions can shed light on potential risk factors for zoonotic disease transmission. The question related to the perception of zoonotic disease risk in this study will be helpful in implementing effective disease prevention measures and interventions for policymakers.

2.4.2. Qualitative survey and inclusion criteria

A total of 20 participants were additionally selected for qualitative interviews. Age, sex, geographical area, education levels, and practice are factors considered for the selection. Those participants give additional key information in depth. All additional key information collected through the verbal communication during the quantitative data collection.

2.5. Data analysis

For the quantitative survey, data were entered using MS Excel with pre-structured data entry by using the kobo toolbox. Independent variables like socio-demographic data, occupation history, personal behaviour, and community risk perception among the zoonotic diseases are reported to inform the proportion. Based on individual characteristics, their understanding and perception of the risks associated with zoonotic diseases were assessed. Statistical analysis was done using Stata. In Stata the descriptive analysis and analysis of frequencies and percentages of all independent variables were done. *Chi-square* test was used to find *P* value for socio-demographic variable, personal behaviour of participants and agreed as a risk perception on zoonotic diseases.

For qualitative survey, there were no pre structured questionnaires. During the data collection, we interacted with people and obtained valuable information through verbal communication. However, not all of this information was recorded in the field.

2.6. Ethical approval

The study was approved by the ethical research and review committee of the Parul Institute of Public Health (No. PIPH/FOM/PU/2023-2024/182-5.). This study has taken signed consent from the participants who agreed to take part in it.

3. Results

In the present study, total 387 participants were involved out of which 49.6% were livestock handlers and 50.4% of participants were households with non-livestock. The majority 54.5% of participants were female.

Table 1. Demographic variables.

Variables	Total <i>n</i> = 387	Household with livestock <i>n</i> = 192	Household with non-livestock <i>n</i> = 195	<i>P</i>
Sex				
Male	176 (45.5)	83 (43.2)	93 (47.7)	0.378
Female	211 (54.5)	109 (56.8)	102 (52.3)	
Marital status				
Married	342 (88.4)	174 (90.6)	168 (86.2)	0.358
Unmarried	34 (8.8)	13 (6.8)	21 (10.8)	
Widow	11 (2.84)	5 (2.6)	6 (3.1)	
Education				
Illiterate	77 (19.9)	48 (25.0)	29 (14.9)	0.039
Primary	99 (25.6)	52 (27.1)	47 (24.1)	
Secondary	190 (49.1)	83 (43.2)	107 (54.9)	
Higher secondary school	21 (5.4)	9 (4.7)	12 (5.4)	

Data were presented by *n*(%).

As shown in Table 1, the marital status among households with livestock handlers and non-handlers does not significantly differ from each other as $P = 0.358$. There was a comparable distribution of sex and marital status among both groups.

Half of the participants have secondary education whereas 19.9% were illiterate, 25.6% of participants found with completed primary education and only 5.4% of respondents had graduation degree of higher secondary schools. The majority of livestock handlers 43.2% have secondary education and 25.0% were illiterate as compared to non-livestock handlers only 14.9% were illiterate. Additionally, 54.9% of non-livestock handlers have secondary education. In both groups, only 5.4% of participants have completed their graduation degree. The education status among households with livestock handlers and non-livestock handlers significantly differed from each other as $P = 0.039^*$. Education level significantly influenced personal behaviour,

with literate participants demonstrating higher awareness of hygiene and sanitation practices.

As shown in Table 2, 23.4% of livestock keepers and 41.0% of non-livestock keepers believed zoonotic diseases could be transmitted from animals to humans. Regarding waste from poultry or cattle sheds spreading infection, only 33.3% of livestock handlers agreed with that. Furthermore, only 20.0% of participants in both groups recognized hygiene and sanitation as necessary to limit infection risks from nearby poultry or cattle farms. Approximately 37.0% of livestock keepers and 47.2% of non-livestock keepers were agreed that drinking raw milk or eating raw meat can cause diseases. Around 78% of participants comprised both groups were aware of that infectious diseases (zoonotic diseases) can be transmitted due to consuming products from wild animals. Of respondents who lived near the animal waste disposal site, 58.9% of livestock keepers and 80.0% of non-livestock keepers agreed that the site could be risky, which is found with statistical difference as $P = 0.000$. The majority of participants in both clusters, 98.4% and 99.5% respectively, said the proper sewage system is necessary to prevent diseases.

Totally 85.4% live livestock handlers and 88.7% non-livestock handlers were aware about vaccination is necessary to prevent diseases in livestock or pets, while 99.5% respondents in both groups understood about maintaining animal hygiene and sanitation could prevent infectious diseases. In both groups more than 97.0% were aware about that the hand hygiene practices were required to prevent diseases in humans and presence of mosquito breeding site near house could be a spread of diseases.

As shown in Table 3, only 10.4% of livestock keepers and 7.2% non-livestock keepers were drinking purified or boiled water. Participants around 11.5% of livestock keepers did not wash their hands after handling animals and 12.3% of non-livestock keepers did not wash their hands after work, while 53.7% of livestock handlers never drank unboiled milk compared to 76.9% of the counterpart,

Table 2. Risk perception for zoonotic diseases.

No.	Questions	Household with livestock <i>n</i> = 192	Household with non-livestock <i>n</i> = 195	<i>P</i>
1	Diseases can be transmitted from animals to humans	45 (23.4)	80 (41.0)	0.000
2.	Waste from poultry farms and cattle sheds can be a source to spread infection	64 (33.3)	104 (53.3)	0.000
3.	Hygiene and sanitation is necessary to limit the risk of infection due to nearby poultry or cattle farm	39 (20.3)	38 (19.5)	0.846
4.	Drinking raw milk or eating raw meat can cause disease	71 (37.0)	92 (47.2)	0.000
5.	Consuming products from wild animals can lead to zoonotic diseases	150 (78.5)	153 (78.3)	0.892
6.	Living near to the animal waste disposal site could be risky	113 (58.9)	156 (80.0)	0.000
7.	Proper sewage system is necessary to prevent diseases	189 (98.4)	194 (99.5)	0.307
8.	Vaccination of livestock/pets is required to prevent disease spread	164 (85.4)	173 (88.7)	0.107
9.	Maintaining animal hygiene and sanitation is required to prevent diseases	191 (99.5)	194 (99.5)	0.991
10.	Hand hygiene is necessary to prevent infectious diseases	187 (97.4)	194 (99.5)	0.096
11.	Presence of mosquito breeding sites near house can lead to spread of diseases.	191 (99.5)	193 (99.0)	0.571

Data were expressed as *n*(%).

Table 3. Personal behaviour of both studied groups.

Table 1: Personal behaviour of four studied groups								
No.	Questions	Households with livestock			Households with non-livestock			P
		n = 192			n = 195			
		Never	Often	Always	Never	Often	Always	
1	Do you purify/boil water before drinking?	166 (86.5)	6 (3.1)	20 (10.4)	174 (89.2)	7 (3.6)	14 (7.2)	0.522
2	Do you wash your hands after work or after handling the animal?	22 (11.5)	19 (9.9)	151 (78.7)	24 (12.3)	31 (15.9)	140 (71.8)	0.186
3	Do you find any faecal materials near your house?	82 (42.7)	15 (7.8)	95 (49.5)	137 (70.3)	10 (5.1)	48 (24.6)	0.000
4	Do you eat food after an animal has touched it?	187 (97.4)	2 (1.0)	3 (1.6)	191 (97.4)	2 (1.0)	2 (1.0)	0.896
5	Does any animal come inside the household where you live in?	147 (76.6)	15 (7.8)	30 (15.6)	154 (79.0)	13 (6.7)	28 (14.4)	0.839
6	Do you purchase meat from wet markets? (For non-vegetarian participants, n = 10)	0	0	2 (1.0)	5 (2.6)	1 (0.5)	2 (1.0)	-
7	Do you eat raw or undercooked meat? (For non-vegetarian participants, n = 10)	2 (1.0)	0	0	8 (4.1)	0	0	-
8	Do you drink unboiled milk?	103 (53.7)	16 (8.3)	73 (38.0)	150 (76.9)	18 (9.2)	27 (13.9)	0.000
9	Do you find any dead animal surrounding to your household?	190 (99.0)	2 (1.0)	0	193 (99.0)	1 (0.5)	1 (0.5)	0.513
10	Do animal ever scratch or bite you?	189 (98.4)	3 (1.6)	0	195 (100.0)	0	0	0.008
11	Have you slaughtered an animal? (For non-vegetarian participants, n = 10)	2 (1.0)	0	0	8 (4.1)	0	0	-
12	Have you hunted an animal? (For non-vegetarian participants, n = 10)	2 (1.0)	0	0	8 (4.1)	0	0	-
13	Do you prefer open defecation?	190 (99.0)	0	2 (1.0)	187 (95.9)	0	8 (4.1)	0.058
14	Do you face the issue of water logging in or around your house?	186 (96.9)	4 (2.1)	2 (1.0)	183 (93.9)	12 (6.2)	0	0.050

Data were expressed as n(%).

Table 4. Risk perception of livestock handlers on zoonotic diseases according to education.

No.	Questions	Education				p
		Illiterate	Primary	Secondary	Higher secondary school	
		n = 48	n = 52	n = 83	n = 9	
1	Diseases can be transmitted from animals to humans	7 (14.6)	17 (32.7)	14 (16.9)	7 (77.8)	0.001
2	Waste from poultry farms and cattle sheds can be a source to spread infection	15 (31.3)	25 (48.1)	18 (21.7)	6 (66.7)	0.027
3	Hygiene and sanitation is necessary to limit the risk of infection due to nearby poultry or cattle farm	7 (14.6)	10 (19.2)	19 (22.9)	3 (33.3)	0.723
4	Drinking raw milk or eating raw meat can cause disease	13 (27.1)	28 (53.9)	23 (27.7)	7 (77.8)	0.007
5	Consuming products from wild animals can lead to zoonotic diseases	33 (68.8)	44 (84.6)	64 (77.1)	9 (100.0)	0.410
6	Living near to the animal waste disposal site could be risky	26 (54.2)	36 (69.2)	43 (51.8)	8 (88.9)	0.292
7	Proper sewage system is necessary to prevent diseases	46 (95.8)	52 (100.0)	82 (98.8)	9 (100.0)	0.369
8	Vaccination of livestock/pets is required to prevent disease spread	38 (79.2)	44 (84.6)	73 (88.0)	9 (100.0)	0.642
9	Maintaining animal hygiene and sanitation is required to prevent diseases	48 (100.0)	51 (98.1)	83 (100.0)	191 (99.5)	0.439
10	Hand hygiene is necessary to prevent infectious diseases	44 (91.7)	51 (98.1)	83 (100.0)	9 (100.0)	0.033
11	Presence of mosquito breeding sites near house can lead to spread of diseases	47 (97.9)	52 (100.0)	83 (100.0)	9 (100.0)	0.389
12	Do you mix any medicine with the animal feed?	9 (18.8)	17 (32.7)	12 (14.5)	6 (66.7)	0.013

Data were expressed as n (%).

Table 5. Risk perception of non-livestock handlers on zoonotic diseases according to education.

No.	Questions	Education				p
		Illiterate	Primary	Secondary	Higher secondary school	
		n = 29	n = 47	n = 107	n = 12	
1	Diseases can be transmitted from animals to humans	9 (31.0)	22 (46.8)	42 (39.3)	7 (58.3)	0.157
2	Waste from poultry farms and cattle sheds can be a source to spread infection	12 (41.4)	32 (68.1)	53 (49.5)	7 (58.3)	0.479
3	Hygiene and sanitation is necessary to limit the risk of infection due to nearby poultry or cattle farm	6 (20.7)	5 (10.6)	25 (23.4)	2 (16.7)	0.591
4	Drinking raw milk or eating raw meat can cause disease	10 (34.5)	30 (63.8)	44 (41.1)	8 (66.7)	0.158
5	Consuming products from wild animals can lead to zoonotic diseases	20 (69.0)	37 (78.7)	86 (80.4)	10 (83.3)	0.769
6	Living near to the animal waste disposal site could be risky	20 (69.0)	40 (85.1)	85 (79.4)	11 (91.7)	0.407
7	Proper sewage system is necessary to prevent diseases	29 (100.0)	47 (100.0)	106 (99.1)	12 (100.0)	0.843
8	Vaccination of livestock/pets is required to prevent disease spread	24 (82.8)	43 (91.5)	95 (88.8)	11 (91.7)	0.127
9	Maintaining animal hygiene and sanitation is required to prevent diseases	28 (96.6)	47 (100.0)	107 (100.0)	12 (100.0)	0.124
10	Hand hygiene is necessary to prevent infectious diseases	28 (96.6)	47 (100.0)	107 (100.0)	12 (100.0)	0.124
11	Presence of mosquito breeding sites near house can lead to spread of diseases	29 (100.0)	47 (100.0)	105 (98.1)	12 (100.0)	0.645
12	Do you mix any medicine with the animal feed?	4 (13.8)	10 (21.3)	9 (8.4)	0	0.105

Data were expressed as n (%).

which showed a significant difference. Many respondents in both groups washed their hands daily after work and handling animals. No more than 2% participants in both groups ate food after an animal had touched it. Only 15.6% livestock keepers and 14.4% non-livestock keepers reported that animals came inside the household daily. Only 1% of respondents in both groups purchased meat from wet markets at all times. Both groups did not eat raw or undercooked meat. Both groups did not slaughter or hunt animals. Only 1.0% of livestock keepers and 4.1% of non-livestock keepers were still used to open defecation. The majority of participants have toilet facilities in the household boundary. Only 2.0% of livestock handlers were facing the issue of water logging around their house.

While investigated according to education levels as shown in the Table 4, 14.6% illiterate livestock handlers and 77.8% graduated participants were agreed diseases can be transmitted from animal to humans. Livestock handlers risk perception is significantly differed from each other according to education level as $P=0.001$. The majority of literate respondents and 31.3% of the illiterate agreed that cattle sheds could be spread the diseases. Their risk perception significantly differed among participants of different educational levels as $P=0.027$. As compared to the literate, only 27.1% of illiterate agreed that drinking raw milk or eating raw meat can cause diseases. Risk perception of this perspective among the illiterate and literate significantly differed as $P=0.007$. The perception of hand hygiene was significantly different from each other as $P=0.033$, although all the groups showed more than 90% participants being aware of this, there was still singinificance between the illiterate and the literate. Furthermore, literate participants were aware of the infectious diseases and modes of transmission. Their risk perception is high as compared to illiterate participants.

As depicted in Table 5, 31.0% of the illiterate non-livestock participants were aware of the risk of zoonotic diseases, whereas 58.3% of those with a higher secondary school education demonstrated such awareness. However, no significant difference was observed among the groups with different educational levels in non-livestock handling.

As shown in Supplementary Table 1, 52.1% illiterate livestock keepers and 33.3% literate participants drank raw milk. There was significant difference from each other as $P = 0.034$. Also, 4.2% of the participants who were illiterate practiced daily open defecation, whereas none of the literate participants did so. Obviously, education affected participants personal behaviour, as literate participants were more aware about hygiene and sanitation.

Personal behavior of non-livestock according to education levels are shown in Supplementary Table 2, but there is no statistical difference was found in both illiterate and literate groups. Personal behavior of both groups according to sex were shown in Supplementary Table 3 and 4 with no statistical difference found.

3.1. Qualitative analysis

Twenty participants engaged in in-depth verbal communication, revealing common perceptions and beliefs regarding zoonotic diseases and related aspects.

3.1.1. Participants' perception on zoonotic diseases

Many participants, including livestock handlers, were unaware of zoonotic diseases. Some 10 participants believed that animals, especially cows, are sacred and incapable of spreading diseases. They attributed their and their ancestors' good health to living closely with animals, fostering a sense of immunity.

However, about five participants recognized that illnesses could be transmitted from animals to humans, particularly through contact with sick animals or failing to wash hands after handling them. Despite this awareness, trust in vaccination was limited. Some preferred faith healing over vaccination, associating certain diseases, like lumpy skin disease, with superstitions and smallpox.

3.1.2. Participants' perception on hygiene and sanitation

Around 12 participants reported washing their hands after handling live animals, although the majority used plain water instead of soap or disinfectant. Participants rarely wore protective clothing during work, believing that animal contact and their surroundings posed no disease risk. They often bathed in the early morning after animal-related tasks. Some considered animal waste sites near their homes beneficial for chemical-free agriculture and other activities.

However, a few participants expressed concerns about improper waste disposal leading to mosquito and fly proliferation and the potential spread of infectious diseases.

3.1.3. About animal vaccination status

Most participants claimed that their animals were vaccinated, although they were unsure which vaccines were administered or for which diseases. Veterinary doctors or government officials typically conducted vaccinations, but participants rarely received documentation for their animals' vaccination status. The timing and intervals of vaccinations were also unclear to many.

3.1.4. Participants' perception on consuming raw milk or meat

A majority of participants regularly consumed raw milk, believing it to be extremely healthy and nutrient-rich. They considered it beneficial for strong bones, muscles, and digestive health. Some were wary of buffalo milk due to its thickness.

However, a non-livestock breeder expressed concerns about animals eating waste from disposal sites, potentially contaminating raw milk.

Additionally, some participants associated animal product consumption with heart diseases, obesity, and zoonotic diseases like

COVID-19, swine flu, and bird flu.

3.1.5. Perception on cow urine

About half of the participants believed in the medicinal properties of cow urine, using it to treat various diseases and even selling it to others. Some participants claimed that cow urine could cure conditions like diabetes mellitus, skin diseases, and cancer, considering it a pure form of treatment.

3.1.6. About animal and human health

Participants typically consulted veterinary doctors for sick animals, and treatment was based on observed signs and symptoms. Medications were administered according to the doctor's prescriptions. Some participants supplemented their animals' diets with calcium for better growth and development.

Although many cattle handlers experienced illnesses like coughs, colds, and fevers, they rarely sought formal diagnosis or investigation, instead opting to treat themselves based on symptoms. In summary, while some participants, particularly livestock farmers exhibited unawareness of zoonotic diseases, others recognized the potential for illness transmission from animals to humans, and limited trust in animal vaccination. Hygiene practices varied, with many participants washing hands after handling animals but often using only water. Despite concerns about improper waste disposal, some considered waste sites near their household beneficial. Most participants claimed that animals were vaccinated, yet specifics were unclear. Additionally, beliefs in the medical properties of cow urine were common. These findings underscore a blend of traditional beliefs, limited awareness, and practices shaping the perception and behaviour of zoonotic diseases.

4. Discussion

Zoonotic diseases are indeed a global concern, and this study conducted in Gujarat, India, sheds light on the prevailing challenges and misconceptions among livestock handlers and non-livestock individuals.

This study findings highlight a significant lack of awareness and knowledge about zoonotic diseases in both livestock and non-livestock populations. This knowledge gap is particularly concerning given the close proximity between humans and animals in this context. Many participants had limited understanding, and they believed that animals were sacred or that had have built immunity from lifelong exposure contribute to this knowledge gap. Similar findings have been reported in other studies, emphasizing the need for targeted education and awareness campaigns[16,17].

Poor practices related to hygiene and sanitation were evident in the study, while some participants did wash their hands, the use of plain

water and the absence of protective clothing indicate that there is room for improvement in this area. The belief that animal waste is beneficial for agriculture and other purposes may contribute to these practices. Addressing these misconceptions and promoting proper hygiene is crucial for disease prevention[18,19].

The consumption of raw milk was prevalent among participants, with beliefs in its health benefits. However, there was limited awareness of the potential risks associated with raw milk consumption, including contamination from animals eating waste. Similar findings have been reported in other studies, emphasizing the need to educate individuals about the potential health hazards of consuming raw animal products[20,21].

Participants had varying levels of knowledge about vaccination, and some relied on faith healing over-vaccination for certain diseases like lumpy skin disease. Ensuring proper education and access to vaccinations for livestock is crucial for disease control, as has been emphasized in previous studies[22,23].

Risk perception regarding zoonotic diseases was generally low, with many participants believing that animals could not transmit diseases. This perception is rooted in cultural beliefs and a lack of information. Sensitizing the population to the risks of zoonotic diseases, as well as promoting proper hygiene and vaccination, is essential for reducing these risks.

This research has addressed integrated finding from both quantitative and qualitative analyses, emphasizing the importance of One Health approach to address the risk factors. Furthermore, this study highlights the need for education campaigns, community engagement and interdisciplinary collaboration for health promotion and social behaviour.

5. Conclusions

This study underscores the urgent need for targeted awareness campaigns and education on zoonotic diseases in Gujarat, India. Addressing cultural beliefs and providing clear, accessible information on disease transmission, prevention, and proper hygiene practices is critical. Regular screenings of livestock handlers and nearby residents can help identify potential outbreaks early. Furthermore, involving community health workers in these efforts can bridge the gap between healthcare providers and the community, ensuring that essential information reaches those who need it most. The study's limitations include its focus on livestock and non-livestock populations, without involving community health workers who play a crucial role in disseminating health information. Expanding the scope to include these workers and conducting similar studies in different regions can provide a more comprehensive understanding of zoonotic disease awareness and knowledge in India.

In conclusion, the study highlights the importance of education

in influencing risk perception and personal behaviour regarding zoonotic diseases among livestock farmers. Sex of participants does not significantly influence personal behaviour in either group, indicating consistent hygiene practices among both male and female participants and there is a lack of knowledge among participants about zoonotic diseases and the value of immunizations and good hygiene.

Conflict of interest statement

The authors claim there is no conflict of interest.

Funding

This study receives no extramural funding.

Data availability statement

The data supporting the findings of this study are available from the corresponding author upon request.

Authors' contributions

All authors contributed to conception and designing of the manuscript. Critical revision of the manuscript along with supplementing materials for preparing the manuscript thoroughly was done by Pratiksha G and Sandul Y. The data collection was done by Pratiksha G. The work of completing the manuscript was equally contributed by Pratiksha G along with Sandul Y, Krupali P and Deepak S. All authors agree with the content of the manuscript.

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Publisher's note

The Publisher of the *Journal* remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Edited by Liang TC, Qi Y



Original Article

One Health Bulletin

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One Health risk perception among the urban vulnerable dwellers of Gujarat, India: A cross-sectional assessment

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Supplementary Tables

Supplementary Table 1. Personal behaviour of livestock handlers according to education levels.

No.	Questions	Illiterate n = 48			Literate n = 144			P
		Never	Often	Always	Never	Often	Always	
1	Do you purify/boil water before drinking?	44 (91.7)	1 (2.1)	17 (11.8)	122 (84.7)	5 (3.5)	17 (11.8)	0.475
2	Do you wash your hands after work or after handling the animal?	11 (22.9)	8 (16.7)	29 (60.4)	11 (7.6)	11 (7.6)	122 (84.7)	0.002*
3	Do you find any faecal materials near your house?	24 (50.0)	3 (6.3)	21 (43.8)	58 (40.3)	12 (8.3)	74 (51.4)	0.491
4	Do you eat food after an animal has touched it?	47 (97.9)	0	1 (2.1)	140 (97.2)	2 (1.4)	2 (1.4)	0.677
5	Does any animal come inside the household where you live in?	35 (73.0)	4 (8.3)	9 (18.8)	112 (77.8)	11 (7.6)	21 (14.6)	0.766
6	Do you purchase meat from wet markets?(For non-vegetarian participants, n = 2)	0	0	2 (0.2)	0	0	0	-
7	Do you eat raw or undercooked meat?(For non-vegetarian participants, n = 2)	2 (0.2)	0	0	0	0	0	-
8	Do you drink unboiled milk?	18 (37.5)	5 (10.4)	25 (52.1)	85 (59.0)	11 (7.6)	48 (33.3)	0.034*
9	Do you find any dead animal surrounding to your household?	48 (100.0)	0	0	142 (98.6)	2 (1.4)	0	0.412
10	Do animal ever scratch or bite you?	48 (100.0)	0	0	141 (97.9)	3 (2.1)	0	0.313
11	Do you prefer open defecation?	46 (95.8)	0	2 (4.2)	144 (100.0)	0	0	0.014
12	Do you face the issue of water logging in or around your house?	47 (97.9)	0	1 (2.1)	139 (96.5)	4 (2.8)	1 (0.7)	0.367

P* represents for a statistical difference.

Supplementary Table 2. Personal behaviour of non-livestock handlers according to education levels.

No.	Questions	Illiterate n = 29			Literate n = 166			P
		Never	Often	Always	Never	Often	Always	
1	Do you purify/boil water before drinking?	29 (100)	0	0	145 (87.4)	7 (4.2)	14 (8.4)	0.128
2	Do you wash your hands after work or after handling the animals?	3 (10.3)	7 (24.2)	19 (65.5)	21 (12.6)	24 (14.5)	121 (72.9)	0.417
3	Do you find any faecal materials near your house?	17 (58.6)	1 (3.5)	11 (37.9)	120 (72.3)	9 (5.4)	37 (22.3)	0.192
4	Do you eat food after an animal has touched it?	29 (100)	0	0	162 (97.6)	2 (1.20)	2 (1.2)	0.700
5	Does any animal come inside the household where you live in?	19 (65.5)	39 (10.4)	7 (24.1)	135 (81.3)	10 (6.0)	21 (12.7)	0.154
6	Do you purchase meat from wet markets?(For non-vegetarian participants, n = 8)	1 (3.5)	0	1 (3.5)	4 (2.41)	1 (0.6)	1 (0.6)	-
7	Do you eat raw or undercooked meat?(For non-vegetarian participants, n = 8)	2 (6.9)	0	0	0	6 (3.6)	0	-
8	Do you drink unboiled milk?	25 (86.2)	1 (3.5)	3 (10.3)	125 (75.3)	17 (10.2)	24 (14.5)	0.383
9	Do you find any dead animal surrounding to your household?	29 (100)	0	0	164 (98.9)	1 (0.6)	1 (0.6)	0.838
10	Do you prefer open defecation?	26 (89.7)	0	3 (10.3)	161 (97.0)	0	5 (3.0)	0.066
11	Do you face the issue of water logging in or around your house?	25 (86.2)	4 (13.8)	0	158 (95.2)	8 (4.8)	0	0.064

Supplementary Table 3. Personal behaviour of livestock handlers according to sex.

No.	Questions	Male n = 83			Female n = 109			P
		Never	Often	Always	Never	Often	Always	
1	Do you share utensils with animals?	80 (96.4)		3 (3.6)	100 (91.7)		9 (8.3)	0.188
2	Do you purify/boil water before drinking?	70 (84.3)	2 (2.4)	11 (13.3)	96 (88.1)	4 (3.67)	9 (8.3)	0.486
3	Do you wash your hands after work or after handling the animal?	7 (8.4)	8 (9.6)	68 (81.9)	15 (13.8)	11 (10.1)	83 (76.2)	0.502
4	Do you find any faecal materials near your house?	41 (49.4)	7 (8.4)	35 (42.2)	41 (49.4)	8 (7.3)	60 (55.1)	0.204
5	Do you eat food after an animal has touched it?	81 (97.6)	0	2 (2.4)	106 (97.3)	2 (1.8)	1 (0.9)	0.334
6	Does any animal come inside the household where you live in?	65 (78.3)	10 (12.1)	8 (9.6)	82 (75.3)	5 (4.6)	22 (20.2)	0.034*
7	Do you drink unboiled milk?	47 (56.6)	5 (6.0)	31 (37.4)	56 (51.4)	11 (10.1)	42 (38.5)	0.550
8	Do you find any dead animal surrounding to your household?	81 (97.6)	2 (2.4)	0	109 (100)	0	0	0.103
9	Do animal ever scratch or bite you?	82 (98.8)	1 (1.2)	0	107 (98.2)	2 (1.8)	0	0.727
10	Do you prefer open defecation?	82 (98.8)	0	1 (1.2)	108 (99.1)	0	1 (1.2)	0.846
11	Do you face the issue of water logging in or around your house?	79 (95.2)	2 (2.41)	2 (2.41)	107 (98.17)	2 (1.83)	0	0.254

*P** represents for a statistical difference.

Supplementary Table 4. Personal behaviour of non-livestock handlers according to sex.

No.	Questions	Male n = 93			Female n = 102			P
		Never	Often	Always	Never	Often	Always	
1	Do you purify/boil water before drinking?	84 (90.3)	3 (3.2)	6 (6.5)	90 (88.2)	4 (3.9)	8 (7.8)	0.896
2	Do you wash your hands after work?	14 (15.1)	12 (12.9)	67 (72.0)	10 (9.8)	19 (18.6)	73 (71.6)	0.351
3	Do you find any faecal materials near your house?	71 (76.3)	3 (3.2)	19 (20.4)	66 (64.7)	7 (6.9)	29 (28.4)	0.177
4	Do you eat food after an animal has touched it?	90 (96.8)	1 (1.1)	2 (2.2)	101 (99.0)	2 (1.0)	2 (1.0)	0.329
5	Does any animal come inside the household where you live in?	74 (79.6)	9 (9.7)	10 (10.8)	80 (78.4)	4 (3.9)	18 (17.7)	0.133
6	Do you purchase meat from wet markets?(For non-vegetarian participants, n = 8)	3 (3.2)	1 (1.1)	1 (1.1)	2 (2.0)	0	1 (1.0)	-
7	Do you eat raw or undercooked meat?(For non-vegetarian participants, n = 8)	5 (5.4)	0	0	3 (2.9)	0	0	-
8	Do you drink unboiled milk?	66 (71.0)	12 (12.9)	15 (16.1)	84 (82.4)	6 (5.9)	12 (11.8)	0.130
9	Do you find any dead animal surrounding to your household?	92 (98.9)	0	1 (1.1)	101 (99.0)	1 (1.0)	0	0.366
10	Do you prefer open defecation?	90 (96.8)	0	3 (3.2)	97 (95.1)	0	5 (4.9)	0.556
11	Do you face the issue of water logging in or around your house?	88 (94.6)	5 (5.4)	0	95 (93.1)	7 (6.9)	0	0.666

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How to cite this article: Ganasva P; Yasobant S, Patel K, Saxena D. One Health risk perception among the urban vulnerable dwellers of Gujarat, India: A cross-sectional assessment. *One Health Bull* 2024; doi: 10.4103/ohbl.ohbl_7_24

Article history: Received 24 January 2024 Revision 12 April 2024
Accepted 18 July 2024 Available online 27 August 2024