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Assessment of hygiene practices at the human−animal interface: A One Health perspective

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ABSTRACT

Objective: This mixed-methods study aims to develop and validate a comprehensive hygiene tool from a One Health perspective to document the assessment of hygiene at the human-animal interface.

Methods: This mixed-methods study consisted of two components: a narrative review of the development of tool, followed by validation. The tool development was conducted in two phases. Phase 1 was a literature review, while phase 2 focused on the development and validation.

Results: Tool version 1 consisted of 37 questions to assess personal hygiene practices among 16 households with livestock. Face validity, content validity, and multi-rater kappa scores were used to validate tool version 1. The questions with kappa score exceeding 0.74 were retained for further test. A total of 29 questions were obtained and incorporated into tool version 2, which was subsequently employed to evaluate the personal hygiene practices among 62 households with stock. The median total scores for 16 households and 62 households were 10.5 (range: 6-16) and 16 (range: 10-22), respectively.

Conclusions: Many studies have assessed hygiene practices among livestock farmers, yet none used a validated assessment tool. Thus, this validated tool will facilitate the measurement of hygiene in human-animal interactions.

KEYWORDS: Water, sanitation and hygiene (WASH); Hygiene; One Health; Human-animal interference

1. Introduction

Poor water, sanitation and hygiene (WASH) practices pose a significant risk for the transmission of infectious diseases, particularly zoonotic ones. In emergencies, schools and communities emphasize WASH, while human-animal interaction is neglected. When dwelling with humans, animals' well-being is given less attention. Hygiene refers to acts that can lead to good health and cleanliness, such as frequent hand washing, face washing, and bathing with soap and water[1].

Significance

This study describes its potential to improve the understanding and underscores the importance of hygiene at the human-animal interface. It contributes to enhancing the ability to assess and address hygiene practices crucial for preventing zoonotic diseases. By creating a tool, this study enables comprehensive evaluation of hygiene standards in settings where humans and animals interact, aiding in implementing effective prevention measures and promoting the One Health approach.

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In contrast, the World Health Organisation defines hygiene as the conditions and practices that help maintain health and prevent diseases. Hygiene has a broader aspect and includes many activities, such as hand washing at critical times[2], nail hygiene, foot hygiene, bathing, cloth hygiene, and oral hygiene. However, data represent only hand washing with soap and water. WaterAid's Hygiene framework defines hygiene as behaviours that encourage the widespread adoption of good practices that keep people and their environment clean, enhance dignity, prevent the spread of diseases, reduce under-nutrition and maintain health[2]. This explanation clarifies that hygiene extends beyond human health to encompass environmental cleanliness. However, animal health is missing in this definition. Most of the time, hygiene is included in water, sanitation and hygiene, known as WASH. The global statistics indicate the differential situations of hygiene. When studying environmental cleanliness, considering animals' hygiene is vital as humans live in an ecosystem and share a common environment. Globally, improving WASH has the potential to prevent at least 9.1% of the disease burden (measured in disability-adjusted life years) or 6.3% of all deaths (according to 2008 figures)[2]. Pit latrines, used by adults and children, can reduce the incidence of diarrhoea by 36% or more[2].

Furthermore, improvements in both water quality and quantity are associated with a 20% reduction in the incidence of diarrhoea[3]. Handwashing with soap at critical times, especially before eating and after contact with excreta, can reduce the incidence of diarrhoeal disease by up to 47% the prevalence of eye infections such as trachoma and conjunctivitis by approximately 45%, and respiratory infections by about 20%[4]. Globally, 829 000 people die each year from diarrhoea due to inadequate water, sanitation, and hand hygiene[5]. Three billion people, accounting for 40% of the world's population, do not have access to facilities at home to wash their hands with water and soap. Since 2015, the population with access to essential hygiene services has increased by over 500 million, from 5.0 billion (67%) to 5.5 billion (71%), at a rate of 300 000 people per day. However, 2.3 billion people still lacked essential services in 2020, including 670 million without hand washing facilities[6]. In India, only 68% of households have basic hygiene facilities, while 29% and 3% still live with limited and no facilities for hygiene in 2020[7]. Zoonoses are estimated to be responsible for 2.5 billion cases of human illness and 2.7 million deaths worldwide each year[8].

We frequently overlook animal health and environmental hygiene in the ecosystem. Climate change, emergencies, schools, urban areas, and health care facilities all underline the need for WASH, yet human-animal conflict receives the least attention[9]. WaterAid's Hygiene framework explored hygiene promotion in at-risk groups, such as school-aged children, women during menstruation, food hygiene, people living with HIV/AIDS, disabled and older people in emergencies[2]. However, hygiene promotion among livestock farmers is implicit in this vulnerable group. A customized assessment tool was developed by Ledo *et al*. (2020) to better prevent contamination, positively contributing to milk safety and pest control practices, including hand and clothing hygiene practices during milk reception and handling, milk cooling and storage methods, floor type, cleaning agents, and dedicated cleaning equipment[10]. However, this assessment tool did not measure other courses related to livestock (*i.e*., birthing & bathing of livestock). The expanding livestock population poses a significant environmental danger in the form of animal excrement[11].

One Health is a collaborative, multisectoral, and transdisciplinary approach that works locally, nationally, and globally to achieve optimal health outcomes, recognizing the interconnection between people, animals, plants, and their shared environment[12]. Zoonotic disease transmission through various routes highlights that safe water, sanitation, and hygiene are equally crucial for animals. Despite the well-known concepts of One Health and zoonotic diseases, hygiene in human-animal interactions is the least explored among available personal hygiene assessment tools, especially in environments shared by humans and animals[13,14]. This study aimed to document known hygiene practices at the human-animal interface to develop and validate hygiene assessment tools in their shared environment.

2. Subject and methods

2.1. Development of questionnaire

The key indicators of hygiene identified from the narrative review were used to generate questions in tool version 1. Based on insights from *Healthy Villagers: A Guide for Communities and Community Health Workers*[15] and the core questionnaire by Joint Monitoring Programme for hygiene were used to formulate questions about the location of animal sheds and handwashing[16]. Phase 1 is divided into phase 1a and phase 1b. Phase 1a conducted a literature review focused on assessing hygiene at the human-animal-environment interface, which involved searching in databases such as PubMed and Google Scholar. All the literature was summarised and synthesized for the key indicators of hygiene assessment, which provided the base for the tool development (Table 1). Other questions were related to the personal hygiene of the livestock farmers and different hygiene practices while interacting with livestock (such as milking, birthing, cleaning shed, *etc*.), personal hygiene of livestock (including hygiene of different body regions, types of water feed, utensils, baths, *etc*.), and shared environmental

hygiene (such as the cleaning of sheds or barns, the distance of sheds from houses, presence of flies/rodents, *etc*.) Out of all 37 questions, ten were based on observation, and the remaining questions were asked to the respondent.

2.2. Tool validation

The tool validation process was carried out in two phases: face validity and content validity. Face validity was assessed by two experts on each question in terms of format and provided options. During the face validity process, none of the questions was eliminated, but both experts agreed that an "other" option should remain available for open-ended answers. Content validity was assessed using two methods: Item-level content validity (I/CVI) and Scale-level content validity(S/CVI)[17]. The I/CVI was done by scoring each question, ranging from 0 to 1. A score of 0 was interpreted as irrelevant, and a score of 1 was interpreted as highly pertinent or relevant. The I-CVI was calculated for each item, and the sum of scores received for each question from the five experts was divided by the total number of experts. The calculated I-CVI for each question was 0.8, 0.6, 0.4 and 1. According to Lynn 1986, I-CVI above 0.79 was interpreted as relevant, 0.70 to 0.79 indicated that the item should be revised, and below 0.70 required elimination of the items[17].

The development of the questionnaire was considered to be phase 1b. At the end of phase 1b, the first hygiene tool, consisting of 37 items, was prepared and broadly categorized under respondent's hygiene. Hygiene practices for contacting livestock, including the use of separate clothing, gloves, shoes, *etc*. were addressed. The questions related to environmental hygiene, such as the locations of toilets, animal sheds and shed cleaning were also included. Furthermore, inquiries related to livestock hygiene included the type of drinking water, type of utensil used for livestock, type of animal feed, storage of animal feed to assess cross-contamination, health check-up, *etc*. In the end, indirect indicators such as knowledge regarding zoonotic disease transmission were also included.

Content validity involved quantitative scoring of each item. The item was scored using the Likert Scale to determine whether the item was relevant to measuring hygiene at human-animal interfaces. The five WASH experts were asked to score each item using the following rating: a) score 0 if the item was not relevant to hygiene, b) score 1 if the item was high relevant. Content validation was done through two methods: a) The item-level content validity index (I/CVI), b) the scale-level content validity index (S/CVI). The I/CVI was calculated for each question: the experts' total scores were given to each question divided by the total number (five) of experts. After calculating the I/CVI of each question, interpretation was made according to Lynn 1986. The question was considered as relevant if a score is greater than 0.79, scores ranging from 0.70 to 0.79 required revision, and any score below 0.70 was eliminated. Then, S-CVI/ Universal agreement was calculated by dividing the total number of questions that received a score of 1 by the total number of questions.

According to Zamanzadeh *et al*. 2015, content validity was calculated through a combination of CVI and multi-rater kappa[18]. CVI adjusts for chance agreement, while multi-rate kappa was calculated for the degree of consensus.

The modified kappa index was determined using the formula: k=(I-CVI– p_c)/(1– p_c), where k refers to kappa designating agreement on relevance and p_c refers to the probability of chance agreement among the experts and was computed using the formula for a binomial random variable, with one specific outcome (p_c=[N!/A!(N– A)!]×0.5^N; where N=number of experts and A=number of experts agreeing on relevance of an item). k values above 0.74 are considered excellent, between 0.60 to 0.74 good and 0.40 to 0.59 fair.

2.3. Pilot test

The pilot test was conducted in two phases: pilot test 1 and pilot test 2. After pilot test 1, a few questions were revised to provide multiple answer options based on different hygiene practices. The second phase of pilot test utilized tool version 2 of the quantitative questionnaire among 62 households with livestock, consisting of 29 questions.

2.4. Ethical approval

The study was approved by the esteemed Ethical Committee at the Parul Institute of Public Health, Waghodia, Gujarat, India. The assigned protocol number for this approval is PIPH/FOM/DRC/2021-22/57.

Table 1. Key hygiene indicators.

Components	Hygiene indicators
Human hygiene	% of household have access to water for handwashing
	% of household with improved toilet facilities
	% of respondents who used soap for handwashing
	% of respondents wear gloves & shoes while working with livestock
	% of respondents practiced personal hygiene (Cloth & nails)
Livestock hygiene	% of livestock given baths
	% of households that used clean utensils for feed livestock
	% of livestock personal hygiene (absence of dribbling saliva, udder, and tail-head cleanliness)
Shelter environment cleanliness	% of shelters located away from the house*
	% of shelters have clean floor
	% of shelter have absence of flies and rodents

* The standard established by WHO is at least 10 meters.

3. Results

Tool version 1 consisted of 37 questions, with six questions receiving a score of 0.6, and two questions scored 0.4. Therefore, eight questions were eliminated from the tool version 1 due to content validity. Out of the 37 questions, 17 and 12 questions received I-CVI scores of 1 and 0.8, and multi-rater kappa scores were 1 and 0.763, respectively. The total 29 questions received a kappa score >0.74, presenting an excellent degree of agreement. (Table 2).

Further validation was conducted using S-CVI, calculated by the S-CVI/ Universal agreement (S-CVI/UA) and the S-CVI/Average. The S-CVI/UA should be ≥0.8, considered a tool with excellent content validity. The S-CVI/UA was calculated by dividing the number of questions with a score of 1 from five experts by the total number of questions. From experts 1 to 5, the total questions that received a score of 1 were 33, 24, 34, 27, and 37, respectively. Then each count was divided by a total number of questions 37, resulting in S-CVI/UA scores of 0.89, 0.65, 0.92, 0.73, and 1, respectively. The obtained value of S-CVI/UA of tool version 1 was 0.84, indicating excellent validation for this version.

In pilot test 1, which utilized tool version 1, there were 75.0% women and 25.0% men among the 16 participants. The respondents' ages ranged from 22 to 65 years old, with a median age of 29. Of the respondents, 31.3% were illiterate, while 68.9% had completed primary school or higher education. In pilot test 2, which utilized tool version 2, 64.5% of the 62 participants were female, while 35.5% were male, with a mean age of 45.5 years. Meanwhile, 41.9% of the population were illiterate, 32.3% had completed primary school, 19.4% had completed secondary, and 1.6% had received higher education. (Table 3).

In pilot test 1, only 56.3% had improved toilet facility and they reported handwashing after using the improved toilets. Only 81.3% of the respondents reported washing hands after handling animals, while 6.2% reported they did not wash hands, and 12.5% denied answering this question. Additionally, 75% of the respondents reported handwashing with soap. Other animal handling hygiene habits, such as using separate cloth, footwear, face masks, and gloves during animal waste disposal were identified in 12.5%, 81.3%, 12.5% and 6.3% of the 16 respondents, respectively. Furthermore, 12.5% of the participants took a bath after handling animals. Only 18.8% of the 16 respondents washed the animal shed daily. (Table 4).

During pilot test 1, 68.8% of the respondents said that they took their livestock for health check-up only when needed. On inquired further they have given different reason such as when the livestock stopped providing milk [1/11(9.1%)], refused to eat fodder [3/11(27.3%)], was ill [5/11(45.5%)], or needed artificial insemination [3/11(27.3%)]. Only 18.8% of the participants were aware of zoonotic disease transmission between humans and animals.

In pilot test 2, 12.9% of people had no access to a toilet and relied on open defecation, whereas 77.4% had improved toilet facilities, and 9.7% did not. Handwashing was done using water and soap by 85.5% of the participants, 85.5% of people dispose of animal waste with their own hands. Among the participants, 9.7% knew that zoonotic diseases could spread from animals to humans. Out of all the 62 participants, 9.7% participants helped livestock during the birthing process with bare hands, 98.4% of participants used footwear while cleaning or visiting the shed. Only 12.7% of the 55 participants washed the dairy cows' udders with water before and after milking, and only 87.3% washed them before milking. Visible floor cleanliness was observed in 14.5% of animal sheds (Table 4).

The hygiene scores are computed by assigning a score to each item in pilot test 1 and pilot test 2, ranging from 0 to 1. The median hygiene score for pilot test 1 was 10.5 (range: 6-16), while that for pilot test 2 was 16 (range: 10-22), as shown in Figure 1.

Table 2. Content validation results for tool version 1 (*n*=37).

Number of questions	Number of expert given score 1*	I-CVI	P_c	Kappa score
17	5	1	0.631	**1**
12	4	0.8	0.156	**0.763**
6	3	0.6	NA	NA
2	2	0.4	NA	NA

NA: Not applicable; * Experts in agreement to relevant items; P_c: Probability of chance agreement.
Kappa score >0.74 are considered as excellent degree of agreement by bold.

Table 3. Demographic characteristics of responents.

Variable	Pilot 1 [*n* (%)] *n*=16	Pilot 2 [*n* (%)] *n*=62
Age (years)		
15-25	3 (18.8)	4 (6.5)
26-35	9 (56.3)	12 (19.4)
36-45	1 (6.3)	19 (30.6)
Above 45	3 (18.8)	27 (43.5)
Sex		
Female	12 (75.0)	40 (64.5)
Male	4 (25.0)	22 (35.5)
Education		
Illiterate	5 (31.3)	26 (41.9)
Never went school but can read and write	NA	3 (4.8)
Primary	7 (43.8)	20 (32.3)
Secondary	3 (18.8)	12 (19.4)
Higher secondary	1 (6.3)	1 (1.6)

Table 4. Hygiene practices.

Variables	Pilot 1 [*n* (%)] *n*=16	Pilot 2 [*n* (%)] *n*=62
Handwash with water & soap	12 (75.0)	53 (85.5)
Improved toilet facility	9 (56.3)	48 (77.4)
Handwash after handling the animals	13 (81.3)	45 (72.6)
Wear separate clothes while handling animals	2 (12.5)	7(11.3)
Wear footwear while visit animal shed	13 (81.3)	61 (98.4)
Wear face mask while handling animals	2 (12.5)	NA
Wear gloves while handling animals waste	1 (6.3)	NA
Disposal of animal waste with naked hands	NA	53 (85.5)
Daily washing animal shed	3 (18.8)	47 (75.8)
Health check-up of animals (stopped giving milk/stopped eating fodder/artificial insemination)	11 (68.8)	NA
Handwash after each use of the toilet	9 (56.3)	62 (100.0)
Took bath after handling the animals	2 (12.5)	20 (32.3)
Knowledge of zoonotic disease transmission	3 (18.8)	6 (9.7)
Visible cloth hygiene	4 (25.0)	52 (83.9)
Visible nail hygiene	6 (37.5)	28 (45.2)
Giving bath to animals	9 (56.3)	27 (43.5)
Udder/teat wash before milking	16 (100.0)	48 (87.3)*
Udder/teat wash before & after milking	NA	7 (12.7)*
Water use for udder wash	15 (93.8)	54 (98.2)*
Source water as a water feed for animals	13 (81.3)	62 (100.0)
Visible udder cleanliness	7 (43.8)	40 (64.5)
Dribbling of saliva from livestock	5 (31.3)	3 (4.8)
Visible cleanliness of utensils used for animal	7 (43.8)	35 (56.5)
Visible flies around livestock	16 (100.0)	24 (38.7)
Animal shed away from the house	8 (50.0)	34 (54.8)
Visible rodent around the animal shed	8 (50.0)	2 (3.2)
Visible floor cleanliness	NA	9 (14.5)
Helped with naked hands during birth process	NA	6(9.7)

*The percentage is based on 55 dairy cows that are producing milk.

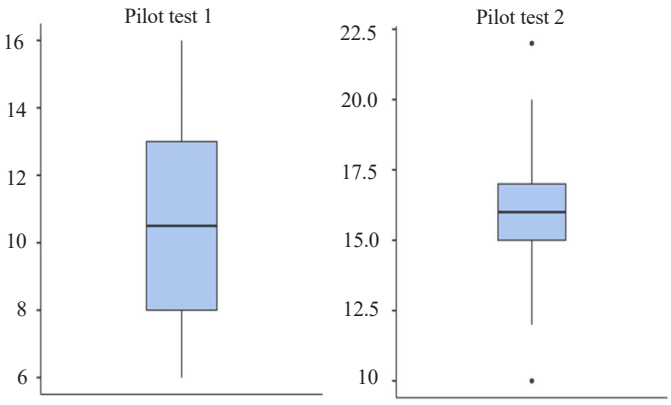


Figure 1. The hygiene scores of pilot tests. The hygiene scores are computed by assigning a score to each item, ranging from 0 to 1. The median total scores for pilot test 1 and pilot test 2 were 10.5 (range: 6-16) and 16 (range: 10-22), respectively.

4. Discussion

In pilot 1 and pilot 2 tests, knowledge of zoonotic diseases was found to be low (18.8% and 9.7%), similar to another study conducted in Vadodara[19]. In this study, respondents used soap as a handwashing material (75.0% and 85.5%), although Berhe *et al*. 2020 discovered that ash was utilized as a handwashing material[20]. In pilot 2, it was determined that only 12.7% of the 55 participants washed dairy cows' udders with water before and after milking, and only 87.3% washed them before milking. A similar result regarding handwashing before milking was obtained in Kenya 2021, however handwashing behaviours after milking were not investigated[21]. Bathing livestock was determined to be moderate in both studies (56.3% and 43.5%). During a pilot test, it was shown that livestock farmers bathe only buffaloes, not cows. Patel *et al*. 2019 analyzed the association between bedding type and udder hygiene, showing a positive correlation between these two variables; however, floor types were not assessed[22]. The environmental hygiene of sheds was evaluated through the presence of flies and rodents in a shelter in this study. Flies were found in all 16 households in pilot test 1 and 24 households in pilot test 2, respectively, while rodents were found in 8 and 2 households, but awareness of cross-contamination by flies and rodents was not investigated.

Assessing hygiene from a One Health perspective, considering human and animal health, is strongly recommended. In this study, a narrative review was used to describe the perspective of hygiene practices. A new hygiene assessment tool was developed and validated

using hygiene components from One Health perspective: personal hygiene of livestock farmers, (including improved toilet facilities, availability of water for handwashing, use of soap for handwashing, wearing clean clothes, and having clip and dirt-free nails), livestock hygiene (including bathing, clean feeding utensils, absence of dribbling saliva, and cleanliness of udder and tail-head); and cleanliness of the shelter (including the location of the shelter, clean floors, absence of flies and rodents). As humans and animals share the same environment, the hygiene of three components becomes critical in preventing the spread of zoonoses, insect-borne diseases, and neglected tropical diseases. As a result, this verified hygiene assessment tool was developed solely to assess hygiene practices in human-animal interactions.

The development of a hygiene assessment tool from a One Health perspective was crucial because it recognize the interconnectedness of human, animal and environmental health. Such a tool can help identify and mitigate health risks arising from poor hygiene practices at the interface of human, animals, and their shared environments, ultimately promoting overall health and well-being.

5. Conclusions

Several occupations and areas have been identified in the literature where humans share a typical environment with animals and birds. Numerous activities occur in this setting where humans have direct contact with animals and birds. Hygiene practices play a significant role in transmitting zoonotic diseases through various routes. Although it is the least investigated and ignored component of water, sanitation, and hygiene. This measurement tool can be used to assess hygiene practices in settings where humans and animals' interface, such as agricultural communities, reducing the risk of zoonotic diseases transmission and promoting a healthier environment. Additionally, it can aid in addressing environmental cross-contamination from agriculture runoff or animal waste, safeguarding public health and ecological integrity.

Conflict of interest statement

The authors declare that there is no conflict of interest.

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Data availability statement

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

Authors' contributions

Tadvi R searched for articles, collected, and interpreted the data, created the tables and figures, drafted, and revised the manuscript. Yasobant S and Patel K also contributed to the study design and review. Saxena D supervised entire process of the research study from development of the tool to the data analysis. All authors approved the final version of the manuscript.

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