

Comprehensive evaluation of dairy ewe welfare in Algerian intensive farms using the BIENE protocol

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Article Info	Abstract
Article history: Received: 08 March 2025 Accepted: 06 January 2026 Available online: 15 May 2026	<p>This study is the first to apply the behaviour, immunity, nutrition and environment (BIENE) protocol to assess dairy ewe welfare in intensive farms in Algeria. A total of 1,964 ewes from 50 farms in the Algiers region were evaluated between December 2022 and March 2023 using 13 animal-based indicators related to nutrition, housing, health, and behavior. Moderate tooth loss affected $54.67 \pm 3.32\%$ of ewes, and $20.38 \pm 2.78\%$ had a low body condition score (< 2). Housing problems included fleece moisture ($11.28 \pm 2.55\%$) and over 40.00% soiling of flanks and hindquarters. Health issues, such as mild anemia (23.55%), lameness (26.45%), nasal discharge ($35.47 \pm 4.43\%$), and labored breathing ($8.79 \pm 1.47\%$), were observed. In terms of behavior, most ewes appeared attentive and active, although 40.55% showed fear and 19.90% aggression. Flight time increased from 2.50 ± 0.07 sec to 3.80 ± 0.07 sec, and animals maintained greater distance from the corridor (2.79 ± 0.08 m) than from the observer (1.85 ± 0.06 m). Principal component analysis of qualitative behavior assessment identified three clusters, including well-being, discomfort, and vitality. Spearman correlation analysis showed that relaxed ewes had better body condition score ($r = 0.29$) and were less likely to be lame ($r = -0.32$) or anemic ($r = -0.37$). Vigorous ewes showed fewer signs of respiratory distress ($r = -0.32$), while apathetic ones were more prone to poor conditioning ($r = 0.31$) and injuries ($r = 0.30$). The BIENE protocol proved effective in detecting major welfare issues in intensive Algerian sheep farming.</p>
Keywords: Algeria Animal welfare Behavioral indicators BIENE protocol Dairy sheep	

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Introduction

Sheep are small ruminants raised worldwide for their meat, milk, wool, hides, and manure.¹ In North Africa, sheep meat is the most profitable product, accounting for 40.00% of total red meat production.² In Algeria, sheep farming contributes to over 50.00% of red meat production and represents 10.00 - 15.00% of the agricultural gross domestic product, making it a key pillar of the national economy and food security.³ With an estimated value exceeding one billion dinars, the sector provides income for many families and occupies vast grazing areas, including 12 million hectares of steppe land. Algerian sheep farming is characterized by a wide diversity of breeds, such as Ouled Djellal, Rembi, Hamra, Berbere, Barbarine, D'Man, Sidaou, Tâadmit, and Tazegzawt, all adapted to varied pedoclimatic conditions.³

However, despite its economic and sociocultural importance, the sector faces many challenges. Health

constraints, nutritional deficiencies, climatic hazards, and poor management practices can compromise animal welfare in both extensive and intensive systems.

In recent years, animal welfare has attracted growing interest at both national and international levels, in response to societal expectations,⁴ for more ethical and sustainable livestock production. Scientific studies highlight the influence of farming systems on welfare; extensive systems promote natural behaviors,^{5,6} but increase exposure to environmental and parasitic stressors, while intensive systems offer more control, but may restrict movement and social interaction, potentially causing stress.⁷

To address these concerns, several protocols have been developed to assess sheep welfare.^{8,9} Among the most widely used are animal needs index (ANI35L),¹⁰ animal welfare indicators (AWIN),⁸ behaviour, immunity, nutrition and environment approach (BIENE),¹¹ and more recent protocols designed for meat sheep in Tunisia¹² and dairy sheep farms.¹³ These tools differ in structure and

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scope. The ANI35L is mainly based on environmental indicators. In contrast, both AWIN and BIENE rely on direct animal-based measures and are grounded in the five freedoms of animal welfare. However, the implementation of AWIN is longer and more complex in the field. The BIENE, by contrast, stands out for its simplicity, speed, and ease of use, making it particularly well suited to a variety of field conditions. While recent protocols are adapted to dairy sheep systems, they do not fully integrate the five freedoms, which may limit their comprehensiveness.

This study represents the first application of the BIENE protocol in Algeria. It offers the opportunity to identify the main risk factors affecting dairy sheep welfare in barns and to explore the practical challenges of implementing the protocol under local farming conditions. Given the variability in management practices observed in the field, it was hypothesized that farms with inadequate housing and feeding conditions would present more welfare issues, and that the BIENE protocol would effectively reveal these differences. Therefore, the objectives of this study were to (I) assess the welfare status of dairy sheep using the BIENE protocol, (II) identify the main risk factors associated with poor welfare outcomes, and (III) provide recommendations to improve on-farm management practices. This study contributes novel insights by applying a standardized, animal-based protocol to a production system remaining poorly documented, with implications for enhancing the welfare, productivity, and sustainability of sheep farming in Algeria.

Materials and Methods

Study area and sample. This study was conducted in the Mitidja plain of the Algiers region (northern central Algeria), being characterized by a Mediterranean climate favorable to lowland livestock farming. The target population was defined using the 2022 database from,¹⁴ which included only sheep farms with at least 20 ewes. A total of 50 accessible and volunteer farms were selected using a purposive sampling strategy based on the flock size and presence of dairy ewes. In total, 1,964 ewes aged between 1 and 5 years (1,055 multiparous and 909 primiparous), belonging to the Ouled Djellal ($n = 1,230$) and Rumbi ($n = 734$) breeds, and all housed in barns, were evaluated. Ethical approval was not required for this study, as the animals were only observed and handled with the utmost respect for their welfare.

Scoring method. Animal welfare was assessed using the BIENE protocol,¹¹ combining individual-level indicators, including body condition, lameness, anemia, and respiratory signs, and group-level indicators, including cleanliness, human-animal relationship, and behavioral expression. Two trained veterinarians performed the evaluations. Prior to the main study, a preliminary survey was conducted on six farms to harmonize scoring methods and

ensure inter-observer reliability. Each ewe was clinically examined using standardized scoring criteria. Body condition was assessed on a 1 to 5 scale,¹⁵ and grouped into three categories, including ≤ 2 (thin), 3 (good condition), and ≥ 4 (obese). Dental status was scored based on incisor wear, including 0 (no missing teeth), 1 (at least one missing secondary incisor), and 2 (at least one missing primary incisor). Fleece moisture was evaluated visually and by touch, including 0 (dry), 1 (moderately moist), and 2 (very moist). Lameness was scored from 0 (none) to 2 (severe) by observing gait. Respiratory signs were scored from 0 to 2 based on the frequency and severity of spontaneous coughing, nasal or ocular discharge, and labored breathing. Anemia was assessed using the Faffa Malan Chart (FAMACHA®) method including score 0 (red conjunctiva; no anemia), 1 (pink; mild anemia), and 2 (pale/white; severe anemia). Skin lesions, observed on the head, neck, or body, were scored from 0 (absent) to 2 (multiple or severe). Cleanliness was evaluated on the flanks and hindquarters using a 0 (clean) to 2 (very dirty) scale. Emotional state was assessed through qualitative behavior assessment (QBA). The observer stood still near the group for 10 min, ensuring minimal visibility to the animals. Afterwards, 21 behavioral descriptors, including calm, fearful, curious, apathetic, and sociable, were each scored on a 125 mm visual analogue scale, where 0 indicated the absence of the expression and 125 its maximum intensity. In large flocks, animals were split into two subgroups to ensure observation quality.¹⁶ The human-animal relationship was assessed using a standardized flight response test. The evaluator first stood behind a fence, outside the pen, for 3 min, then entered the corridor and waited for 2 min before walking slowly (0.40 m sec^{-1}) toward the animals without making eye contact. When the first ewe bypassed the evaluator, they stopped and recorded the following indicators: Flight time (FT)1, corresponding to the time taken for the last ewe to pass by the evaluator, FT2, the time required for the flock to reach the end of the corridor, distance to flock head (DFH), which is the distance between the evaluator and the front of the flock at the moment of stopping, and distance to the far end of the corridor, which is the distance between the evaluator and the end of the corridor. These parameters provide insight into the animals' reactivity to the human presence and quality of the human-animal relationship.

Statistical analysis. Descriptive statistics (mean \pm SD) were used to summarize the data for each welfare indicator. For categorical variables derived from the BIENE protocol, individual scores were first converted into percentage scores representing the proportion of animals (or farms) within each category. The mean \pm SD of these percentage scores was then calculated to describe the variability among farms. The QBA results were analyzed using principal component analysis (PCA) to explore the

structure of emotional expression and relationships between behavioral descriptors. Spearman's correlation coefficients were calculated to assess associations between welfare indicators. Correlation significance was tested using a two-tailed test at two thresholds, including $p < 0.05$ (significant) and $p < 0.01$ (highly significant). All analyses were performed using SPSS Software (version 20.0; IBM Corp., Armonk, USA).

Results

The present study provides a detailed overview of welfare conditions in sheep farms in the Algiers region, Algeria, using the BIENE protocol (Table 1). All results are expressed as mean \pm SD of the percentage scores for each welfare indicator category, calculated across the 50 evaluated farms.

Tooth loss. Moderate dental issues, defined as the loss of at least one secondary incisor, were observed in 54.67 \pm 3.32% of ewes, while 40.73 \pm 3.31% had no missing teeth.

Table 1. Summary statistics of welfare criteria observed in sheep.

Parameters	Score description	Mean \pm SD
Tooth loss	0: Normal dentition	40.73 \pm 3.31
	1: Moderate wear/missing teeth	54.67 \pm 3.32
	2: Severe loss affecting chewing	5.23 \pm 1.43
BCS	BCS \leq 2 (underconditioned)	50.30 \pm 2.78
	BCS = 3 (adequate)	20.38 \pm 2.31
	BCS $>$ 4 (obese)	29.32 \pm 2.75
Fleece moisture	0: Dry	89.13 \pm 2.55
	1: Moist/wet	11.28 \pm 2.55
Flank cleanliness	0: Clean	14.45 \pm 3.41
	1: Slight soiling	42.80 \pm 4.96
	2: Heavy soiling	42.49 \pm 5.36
Anemia	0: Pink mucosa	72.85 \pm 4.75
	1: Slightly pale	23.55 \pm 4.43
	2: Very pale or white	3.59 \pm 1.06
Nasal discharge	0: None	60.51 \pm 4.94
	1: Mild serous	35.47 \pm 4.85
Ocular discharge	2: Purulent/profuse	2.11 \pm 0.55
	0: None	86.36 \pm 2.92
Labored breathing	1: Present	13.72 \pm 2.95
	0: Normal	91.38 \pm 1.48
Coughing	1: Difficult/audible	8.79 \pm 1.47
	0: None	93.90 \pm 0.89
Neck injuries	1: Present	6.10 \pm 0.89
	1: Superficial wound	0.60 \pm 0.04
Head injuries	2: Deep/infected wound	1.00 \pm 0.33
	1: Superficial lesion	7.59 \pm 1.25
Body injuries	2: Severe wound	0.20 \pm 0.06
	1: Minor scratch	4.15 \pm 0.77
HQ cleanliness	2: Deep wound/bleeding	1.17 \pm 0.38
	0: None	41.00 \pm 3.71
	1: Mild soiling	33.00 \pm 3.30
Lameness	2: Heavy soiling	26.00 \pm 2.90
	0: None	71.26 \pm 4.43
	1: Mild/intermittent	26.45 \pm 4.26
	2: Marked/constant	2.24 \pm 0.50

BCS: Body condition score, HQ: Hindquarters.

Severe tooth loss (at least one primary incisor missing) was less frequent (5.23 \pm 1.43%).

Body condition score (BCS). Half of the ewes (50.30 \pm 3.07%) had a normal body condition (score 3), while 32.00 \pm 2.79% were slightly overweight (score 4), and 20.38 \pm 2.31% of ewes were under-conditioned (score \leq 2).

Fleece moisture. Most ewes (89.13 \pm 2.55%) had dry fleece, indicating satisfactory housing conditions, while 11.28 \pm 2.55% exhibited moisture in their coat.

Cleanliness. It was varied by body region. On the flanks, 42.80 \pm 4.96% of ewes were soiled, and 14.45 \pm 3.41% were clean. In contrast, hindquarter hygiene showed greater variability; 41.00% of ewes were clean, 33.00% were moderately dirty, and 26.00% were very dirty.

Lameness. The majority of ewes (71.26 \pm 4.43%) showed no signs of lameness, while 26.45 \pm 4.26% presented moderate lameness, and 2.24 \pm 0.50% exhibited severe symptoms.

Health indicators. Anemia was generally low, with 72.85 \pm 4.75% of animals showing healthy conjunctival coloration (score: 0), while 27.15% had signs of mild (score: 1) or severe anemia (score: 2). Respiratory health was good overall; 60.51 \pm 4.94% of ewes had no nasal discharge (score: 0), and only 8.79 \pm 1.47% showed signs of labored breathing (score: 2).

Injuries. Mild injuries were relatively common, affecting 7.59 \pm 1.25% of ewes on the neck, 4.15 \pm 0.77% on the body, and 0.60 \pm 0.04% on the head. Severe injuries were rare, occurring in less than 2.00% of cases across all body regions.

Flight test. During the flight test, ewes reacted more sensitively in the second exposure, with a longer flight distance recorded 2.79 \pm 0.08 m in test two vs. 1.85 \pm 0.06 m in test one; $p < 0.0001$; Table 1), indicating increased avoidance behavior upon repeated human presence.

Qualitative behavior assessment (QBA). Overall, positive behaviors (*e.g.*, vigorous, curious, and attentive) predominated in the flocks, while negative descriptors (*e.g.*, fearful and apathetic) were rarely scored. The PCA analysis of the QBA data identified three major behavioral components, including relaxation, discomfort, and vigor, which together explained 36.82% of total variance (Fig. 1).

Correlation analysis. Spearman correlation analysis revealed several significant relationships between welfare indicators and behavioral states (Table 2). Notably, a relaxed emotional state was negatively correlated with under-conditioned body score (BCS \leq 2; $r = -0.37$ and $p < 0.01$) and positively associated with normal BCS (score: 3; $r = 0.29$ and $p < 0.05$), and absence of lameness (score: 0; $r = -0.32$ and $p < 0.05$). Conversely, apathetic behavior was positively associated with low BCS (BCS \leq 2; $r = 0.31$ and $p < 0.05$) and moderate injuries (score: 2; $r = 0.30$ and $p < 0.05$). Vigor showed a negative correlation with lameness (score: 0; $r = -0.32$ and $p < 0.05$), supporting its value as a potential indicator of physical health.

These results confirm that emotional expression (QBA) is linked to the specific welfare outcomes and can provide complementary insights into the overall state of the animals.

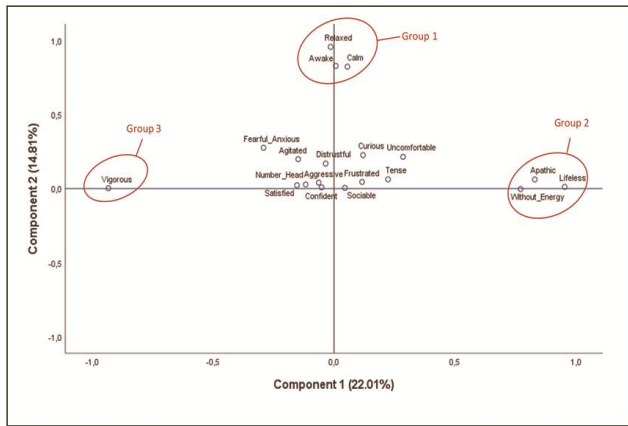


Fig. 1. Principal component analysis of emotional expression descriptors from qualitative behavior assessment in 50 dairy sheep farms in the Algiers region, Algeria, based on the (BIENE) protocol.

Table 2. Significant spearman correlations between behavioral and welfare indicators in sheep.

Variable 1	Variable 2	Correlation coefficient (r)	Significance
Relax	BCS ≤ 2.00	-0.37	**
Relax	BCS: 3.00	0.29	*
Relax	LM: 2.00	-0.32	*
Apathy	Vigor	-0.28	*
Apathy	BCS ≤ 2.00	0.31	*
Apathy	LM: 2.00	0.30	*
Vigor	LM: 2.00	-0.32	*

BCS: Body condition score; LM: Lameness.

*: $p < 0.05$ (significant); **: $p < 0.01$ (highly significant).

Discussion

This study is among the first to apply the BIENE protocol to assess the welfare of ewes in intensive farming systems in Algeria. The findings revealed multiple welfare concerns and underlined the need for targeted inter-ventions. Although few studies have used the BIENE protocol specifically, comparisons were made with other validated welfare assessment frameworks, such as AWIN and Welfare Quality®, which share common indicators and principles.

Tooth loss, particularly of permanent incisors, is a common condition in sheep and has significant implications for animal welfare, feeding behavior, and productive longevity. In our study, $54.67 \pm 3.32\%$ of ewes exhibited moderate dental issues, and $5.23 \pm 1.43\%$ showed severe tooth loss. These figures are considerably higher than the 4.56% reported in French flocks,⁷ and align with findings from other regions; 55.00% of Rembi sheep in Algeria showed similar dental problems,¹⁷

and up to 60.00% of cull ewes in the UK had missing or loose teeth.¹⁸ Tooth loss is frequently attributed to aging, coarse or abrasive feed, soil type, and the absence of regular dental monitoring factors observed across different farming systems.^{18,19} Regardless of context, these conditions impair feed intake, reduce body condition, and contribute to premature culling. Although not routinely included in farm-level protocols due to the practical constraints, dental evaluation is a relevant animal-based welfare indicator. Its inclusion in welfare assessments, as emphasized previously,^{20,21} can support early identification of at-risk animals and guide better management decisions.

The BCS is a fundamental animal-based welfare indicator, reflecting nutritional status and metabolic balance. In our study, $20.38 \pm 2.31\%$ of ewes were under-conditioned (BCS < 2), exceeding the 10.26% reported in French flocks.²² Contextual differences, such as farm size, feed management, and water access, may explain this disparity, with smaller Algerian flocks (< 50 ewes) more prone to undernutrition.¹² In a national survey of 52 Tunisian flocks, reported a mean BCS of 2.40, yet 47.00% of ewes had a BCS of 2.00, suggesting elevated nutritional risk in many individuals. This work confirms the reliability and feasibility of BCS as a welfare measure in extensive systems.²³ Acceptable average BCS (2.25) was observed in post-partum ewes in Spain, but the importance of identifying individual under-conditioned animals despite flock averages was emphasized.²⁴ Sustained low BCS negatively impacts reproduction, immunity, and productivity,^{8,11,19,24} while its critical role at mating was highlighted.²⁵ These findings support the inclusion of BCS and detection of individual nutritional issues as a cornerstone of welfare monitoring and farm management.

It is a key indicator of environmental quality and thermoregulation in sheep, as a wet fleece compromises wool insulation and increases heat loss, thereby contributing to thermal stress.^{11,26} In our study, $11.28 \pm 2.55\%$ of sheep exhibited fleece moisture (score: 1.00), a proportion higher than the 1.70% reported under controlled conditions,⁷ but lower than the 52.93% observed in outdoor systems.²⁷ These differences are likely related to the variations in housing systems, particularly with regard to bedding management and ventilation. Persistent moisture in the fleece can promote the development of myiasis,⁸ fleece rot, bacterial growth,²⁸ and aphid infestation,^{29,30} all of which negatively impact the health and welfare of sheep.²⁴

Flank cleanliness is a relevant animal-based welfare indicator, as it reflects environmental hygiene, bedding quality, and exposure to moisture or mud.^{8,26,27,29} In our study, $42.49 \pm 5.36\%$ of ewes had soiled flanks (score: 1), while only $14.45 \pm 3.41\%$ were classified as clean (score: 0). These findings are consistent with previous studies, although the proportion of clean animals was lower than

that reported in some other contexts.¹¹ This discrepancy may be due to the insufficient bedding maintenance, inadequate drainage, and overcrowding. In Algeria, such issues are often aggravated by poor barn design, absence of bedding, poor ventilation, and exposure to draughts, all of which contribute to soiling and discomfort. In France, one study reported 42.50% of ewes with very dirty flanks (score: 2), compared to 11.53% in their own data, illustrating variability across systems.¹¹ Dirty flanks are not only a sign of poor environmental conditions but may also increase the risk of skin infections, ectoparasitic infestation, and dermatophytosis,³⁰ ultimately compromising animal welfare and health.

Using the FAMACHA® scoring system as a validated tool for monitoring anemia and guiding targeted parasite control,^{11,31} it was found that $72.85 \pm 4.75\%$ of ewes showed no signs of anemia (score: 0), while $23.55 \pm 4.43\%$ had mild anemia and $3.59 \pm 1.06\%$ were severely anemic (score ≥ 2). These results are comparable with findings from France,^{21,32} where 56.82% of animals were anemia-free and 3.11% showed severe anemia, suggesting generally effective parasite control in our study population. However, the persistence of anemia in some animals may not be solely linked to the parasitism. In smaller Algerian farms, anemia may also result from nutritional deficiencies, irregular water access, or chronic stress related to the sub-optimal housing and management conditions. Our findings are consistent with validation studies of the FAMACHA® method, which reported strong correlations between conjunctival color and hematocrit levels, confirming the tool's diagnostic reliability.^{32,33} In those studies, the prevalence of severe anemia was also low, reinforcing the credibility of our observations. These results support the relevance of the FAMACHA® chart as a selective and practical welfare indicator, especially in regions where routine blood testing is not feasible. Differences between studies may reflect variations in climate, parasite species, or farm infrastructure.

Respiratory signs, including labored breathing, coughing, nasal discharge, and ocular discharge, are key animal-based indicators in sheep welfare assessments.^{11,22} In our study, $91.38 \pm 1.48\%$ of ewes showed no signs of respiratory distress, while $8.79 \pm 1.47\%$ exhibited deep breathing, in line with results reported in France.²¹ The low prevalence of labored breathing may reflect seasonal or environmental influences, such as cold drafts and poor airflow, being common in Algerian barns lacking insulation or ventilation.³⁴ Coughing was also rare ($6.10 \pm 0.89\%$), consistent with French findings,¹⁴ though it may indicate poor air quality caused by ammonia accumulation, dust, or moist bedding.³⁵ In contrast, nasal discharge was more frequent in our sample than French study, where 95.72% of ewes were symptom-free.¹³ This may point to underlying respiratory conditions, such as oestrosis or enzootic nasal adenocarcinoma,³⁶ likely exacerbated by

sub-optimal hygiene and elevated humidity.³⁷ Ocular discharge, although rare, may be linked to the environmental irritants, such as airborne particles, stirred during bedding or feeding.¹¹ Altogether, these observations highlight how respiratory health in sheep is shaped by housing quality, hygiene, and environmental stressors, factors that should be prioritized in welfare improvement strategies for small-scale farms.

Lameness is a major welfare concern in sheep farming, affecting over 80.00% of flocks worldwide.³⁸ In our study, $26.45 \pm 4.26\%$ of ewes exhibited moderate lameness, and $2.24 \pm 0.50\%$ severe cases, substantially higher than those reported in France,^{7,21} and Greece (1.90 - 6.80%).³⁹ This elevated prevalence likely reflects context-specific factors, such as high stocking densities, abrasive flooring, prolonged confinement, and irregular hoof trimming, especially in small-scale systems. Lameness reduces feed intake, fertility, and milk yield, and has been associated with lower colostrum quality and lamb survival.^{38,40-42}

In our study, injuries showed a notable prevalence, ranging from mild to severe, primarily affecting the neck, head, and body. Among the 1,964 ewes examined, 199 ($7.59 \pm 1.25\%$) had mild neck injuries, 12 ($0.60 \pm 0.04\%$) had mild head injuries, and 95 ($4.15 \pm 0.77\%$) had mild body injuries. Severe injuries were recorded in 16 ewes (1.00%) for the neck, four (0.20%) for the head, and 23 (1.17%) for the body. These rates are higher than those observed formerly,^{7,21} reporting only isolated cases in French flocks (one mild head injury and one severe body injury). Injuries likely result from overcrowding and competition for limited resources in poorly designed facilities, remaining common in Algerian small-scale farms. In contrast, better infra-structure and spatial planning in European farms may reduce trauma risk.⁴³ These results underscore the importance of housing design and group management in mitigating injury risk and promoting animal welfare.

In our study, $41.00 \pm 3.71\%$ of ewes had clean hindquarters (score: 0), $33.00 \pm 3.30\%$ were moderately soiled (score: 1), and $26.00 \pm 2.90\%$ were heavily soiled (score: 2). These results are comparable with those reported in France, where 46.98% of ewes were clean.²¹ Similar findings were noted in Tunisia,¹² where flank cleanliness was identified as a key animal-based indicator, particularly sensitive to differences in management between intensive and extensive systems. High levels of soiling in our context likely reflect sub-optimal hygiene, particularly in farms where bedding is not regularly replaced and manure accumulation is poorly managed.²⁰ Additionally, digestive disturbances, such as diarrhea, often triggered by abrupt dietary changes, can further increase flank soiling.⁹ Poor flank cleanliness is not only an indicator of environmental conditions but also a potential risk factor for skin infections and fly strike, which may compromise animal welfare.⁴³

Our assessment of human–animal interactions was based on the flight test and distance from the ewe’s head to the human at the front of the corridor (DFH). Results showed that the FT was significantly shorter during the first exposure (2.50 ± 0.07 sec) compared to the second (3.80 ± 0.07 sec), indicating an increase in avoidance behavior rather than habituation. This contrasts with findings from France,⁷ where a decrease in FT between the first (3.14 sec) and second (3.56 sec) tests suggested progressive adaptation. Another French study reported even longer average FTs (4.18 sec), likely reflecting different environmental conditions and management practices.¹⁶ Similarly, the DFH increased during the second test (DFH2 > DFH1), consistent with previous observations.^{7,16,43} However, the distances measured in our study were considerably shorter than those reported in France (*e.g.*, 2.33 vs. 2.80 m; 2.17 vs. 2.54 m).^{7,16} This discrepancy may reflect higher fear levels in our population, possibly due to the unfamiliarity with the evaluator who, in our case, was an external observer unknown to the animals. In the Algerian context, sheep are rarely in contact with strangers, and human interaction is typically limited to the basic handling for feeding or health care. Also, intensive farming systems often involve prolonged confinement with limited positive human contact, which may contribute to increased distrust and stress in animals.

In our study, positive descriptors, such as attentive and vigorous, predominated, while some negative terms, like suspicious and defensive, were also observed. These expressions may reflect discomfort, fear, or pain, particularly in animals experiencing lameness or subjected to unfamiliar handling. The PCA revealed three main behavioral dimensions; the first was associated with positive emotional states (relaxed and calm), the second with negative affect (apathetic and lifeless), and the third with vitality and alertness (vigorous). This structure highlights the multi-dimensional nature of emotional expression in sheep, consistent with previous studies using QBA in small ruminants and other livestock species.⁴⁴⁻⁴⁸ The PCA appears to be a useful tool for summarizing complex behavioral data and improving the interpretation of QBA outcomes, thereby reinforcing its validity in on-farm welfare assessments.

To date, few studies have statistically explored the direct associations between qualitative behavioral descriptors and physical welfare indicators in sheep. In our study, Spearman correlation analyses revealed significant relationships between QBA terms and measurable health or condition metrics. For example, the descriptor vigorous was negatively correlated with labored breathing, suggesting that more active ewes had better respiratory health. Similarly, animals described as relaxed were less likely to be lame or in poor body condition, while those rated as apathetic showed stronger associations with low BCSs and mild injuries.

These findings support earlier conceptual work,^{9,48} proposed that QBA can reflect underlying physiological states. However, empirical studies applying such correlations remain rare, particularly in small ruminants. Our results therefore offer new evidence in favor of integrating emotional assessments with physical health parameters, contributing to a more holistic understanding of animal welfare. Future research could expand on this by applying multi-variate or longitudinal methods to further explore and validate these relationships.

The BIENE protocol proved to be a valuable tool for identifying welfare issues in intensive sheep farms in Algeria. The observed differences compared to the international studies highlight the need to consider local husbandry practices, environmental conditions, and socioeconomic constraints, when assessing animal welfare. A key strength of this study lies in the identification of significant correlations between emotional states (as assessed through QBA) and key welfare indicators, such as lameness, anemia, and injury. These findings support the use of qualitative behavioral assessments as a promising complementary approach for detecting early signs of compromised health or welfare. However, these relationships require further validation across different production systems, species, and larger populations.

The study also emphasizes that indoor intensive farming systems are a major risk factor for poor welfare outcomes. While these systems offer better control over some parameters, they often lead to poor hygiene, reduced air quality, limited space, and lack of environmental enrichment conditions, being detrimental to ewe comfort, health, and behavior.

Improving welfare in such settings will require targeted interventions, including infra-structure improvements (ventilation, flooring, and bedding), optimized nutrition, better health management, and farmer training. Future research should explore the long-term impacts of these improvements on productivity, animal health, and the overall sustainability of sheep farming in Algeria.

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Conflict of interest

The authors declare no conflict of interest.

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