Veterinarians' Knowledge, Attitudes, and Practices (KAP) Regarding Gastrointestinal Strongyloses and Anthelmintic Resistance in Sheep Flocks in North-East Algeria

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Abstract

Introduction : Gastrointestinal strongyles (GIS) are major constraints in small ruminant production, yet little is known about veterinarians' roles in managing them in Algeria.

Material and Methods : This cross-sectional online survey assessed the knowledge, attitudes, and practices (KAP) of 106 veterinarians from northeastern Algeria regarding GIS and anthelmintic resistance (AR).

Results : Most relied on clinical diagnosis (65%), with only 35% using coproscopy and fewer than 20% applying it post-treatment. Routine flock deworming was common—85% systematically treated ewes and 69% treated lambs more than twice per year. Macrocyclic lactones (41%) and benzimidazoles (27%) dominated prescriptions, often in long-acting forms (76%). Visual weight estimation (94%) and uniform dosing (72%) increased underdosing risk. Over half kept no treatment records, and <1% used fecal egg count reduction tests (FECRT). Although 76% were aware of AR and 84% viewed it as a major issue, 31% still observed persistent infections.

Discussion : Overall, GIS control remains largely empirical, with limited diagnostics and heavy drug reliance, promoting resistance. Improving diagnostic access, farmer education, and veterinary training is essential for sustainable parasite management. Targeted training programs, improved access to diagnostic tools, and the implementation of structured national monitoring systems are urgently needed to curb the further emergence and spread of anthelmintic resistance in Algerian small-ruminant production.

Keywords: Anthelmintic resistance; Knowledge, Attitudes and Practices (KAP); Gastrointestinal strongyles; Sheep; Algeria.

1-Introduction

Gastrointestinal strongyles (GIS) are among the main sanitary and economic constraints in sheep production worldwide [1]. These nematodes impair growth, milk yield, carcass quality, and fertility, while severe infections, particularly with *Haemonchus contortus*, can cause anemia, edema, and sudden death [2,3]. Even subclinical infestations entail significant losses: parasitized sheep produce only 85% of expected weight gain and 78% of milk yield, with an estimated €345 million annual loss in Europe [4].

Chemical dewormers remain the primary control method, yet they are often applied routinely and without diagnostic confirmation. Such misuse has accelerated the development of anthelmintic resistance (AR), increasingly reported across Africa [5,6]. In the Maghreb, benzimidazole resistance is well established in Morocco [7], and genomic data from Tunisia confirm emerging resistant loci in local breeds [8].

In Algeria, AR has been recognized for nearly two decades, with reduced efficacy of benzimidazoles and macrocyclic lactones documented in the east [9]. According to Bentounsi and Cabaret [10], empirical veterinary practices, limited resources, and weak monitoring systems exacerbate the issue.

Despite accumulating evidence of anthelmintic resistance in Algerian sheep flocks, no previous KAP study has evaluated the knowledge, attitudes, and practices of veterinarians regarding GIS control and AR in Algeria. This represents a critical gap, as veterinarians are the primary actors shaping treatment strategies, diagnostic use, and farmer awareness. Understanding their decision-making patterns is therefore essential for designing effective and sustainable control programs.

This study aimed to (1) assess veterinarians' knowledge, attitudes, and practices regarding gastrointestinal strongyle (GIS) control and anthelmintic resistance (AR), and (2) identify factors associated with empirical versus evidence-based parasite management in northeastern Algeria. We hypothesized that limited access to diagnostics, insufficient training, and routine prophylactic deworming would be key determinants driving suboptimal practices and potentially accelerating AR emergence.

Within this context, the present study explores the human dimension of parasite control. It reports a survey assessing the knowledge, attitudes, and practices (KAP) of veterinarians in northeastern Algeria, aiming to update national data and position Algeria within regional and global perspectives. By focusing on veterinarians as key actors, this research highlights behavioral and professional drivers shaping sustainable GIS management in low- and middle-income contexts.

2-Materials and methods

2-1-Study area

This study was conducted from June 2023 to January 2025 in three northeastern Algerian provinces—Constantine (36.28° N, 6.62° E), Sétif (36.31° N, 5.56° E), and Mila (36.36° N, 6.15° E). These areas were selected based on previous research to better understand factors driving AR in local sheep systems [9].

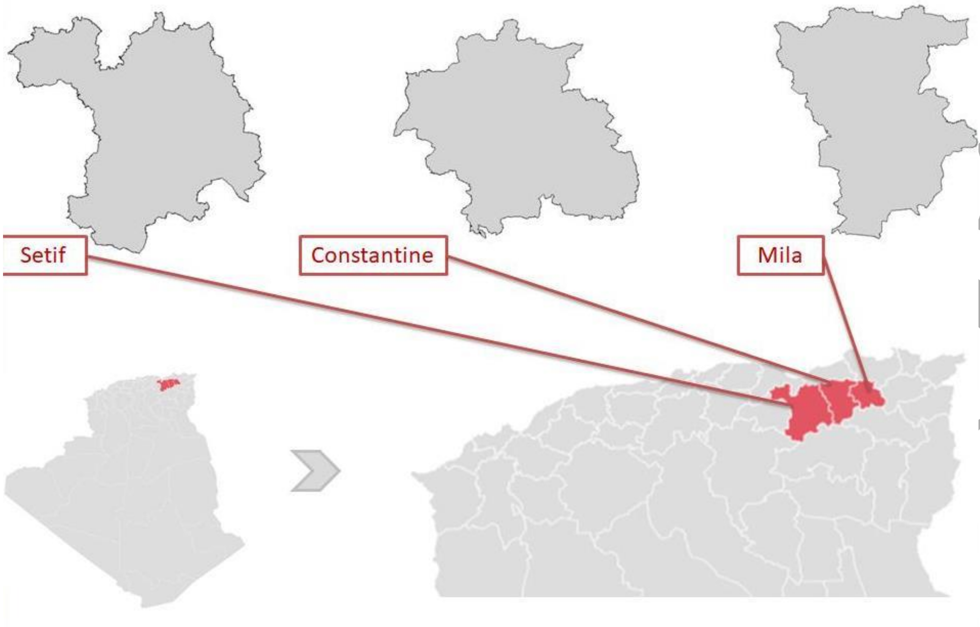

Figure 1. Map of the study area showing the three provinces (Constantine, Mila, and Sétif) in northeastern Algeria where the questionnaire survey was conducted.

2-2- Questionnaire and Data Collection

An online questionnaire was created with Google Forms and distributed to veterinarians practicing rural medicine in northeastern Algeria. The aim was to collect information on anthelmintic use, health management, and gastrointestinal strongyle (GIS) control in sheep flocks.

A total of 106 veterinarians participated voluntarily and anonymously after providing informed consent. The questionnaire included 29 items: 10 multiple-choice, 5 dichotomous (yes/no), 10 single-choice, and 4 open-ended questions, designed to capture both quantitative and qualitative data.

It comprised five sections covering: (1) general information on practice type and region; (2) GIS diagnostic and control methods; (3) treatment and intervention protocols; (4) perceptions of AR; and (5) overall parasite management and farmer behavior.

The questionnaire was pre-tested for clarity and adjusted based on feedback. All responses were automatically anonymized after participants were informed about the study's objectives.

Items relating to farmers' practices (e.g., treatment frequency, pasture management, record-keeping) were based on veterinarians' professional impressions derived from routine field interactions with sheep owners, rather than on direct observation or farmer interviews. Thus, responses reflect veterinarians' perceptions of farmer behavior rather than measured on-farm practices.

2-3-Data Analysis

Data collected via Google Forms were exported to Microsoft Excel (2021) for cleaning and coding, then analyzed in R software (version 4.4.2). Descriptive statistics summarized categorical variables as frequencies (n) and percentages (%), providing an overview of veterinarians' knowledge, attitudes, and practices (KAP) toward gastrointestinal strongyle management.

Pearson's chi-square (χ^2) test was used to assess associations between categorical variables; Fisher's exact test was applied when expected counts were <5. Statistical significance was set at $p < 0.05$, with $p < 0.01$ and $p < 0.001$ indicating higher significance levels. Exact Clopper–Pearson 95% confidence intervals (CI) were calculated for proportions.

To explore relationships among KAP variables, Multiple Correspondence Analysis (MCA) was performed, followed by Hierarchical Cluster Analysis (HCA) on MCA coordinates using Ward's method. This approach identified veterinarian profiles ranging from empirical to evidence-based management.

Figures and visualizations were generated in R using *FactoMineR*, *factoextra*, and *ggplot2*, with interpretations based on variable contributions to principal dimensions.

3-Results

3-1-Knowledge and practices of veterinarians regarding the management of GIS

Table 1 presents veterinarians' knowledge and practices regarding gastrointestinal strongyle management. Geographic location (Constantine, Mila, Sétif) had no significant influence ($p = 0.31$), indicating consistent approaches across regions. In contrast, farm type showed highly significant variation ($p < 0.0001$): most veterinarians worked in mixed farming systems (72.6%), while 22.6% specialized in sheep and 4.7% in dairy cattle, suggesting that GIS control is mainly integrated into mixed production systems.

Use of diagnostic tools differed significantly ($p = 0.005$). Although 64.2% reported using complementary diagnostics, mainly coproscopy, only 12.3% performed it regularly, whereas 47.2% never did ($p < 0.0001$). This reveals a discrepancy between awareness and consistent diagnostic application.

Other diagnostic methods (autopsy, scraping, colonoscopy, adhesive tape test) were rarely mentioned. The choice of anthelmintics also differed significantly ($p < 0.0001$): 75.5%

preferred long-acting formulations, while 24.5% used short-acting ones. This practical preference for prolonged protection, however, increases the potential risk of developing AR.

Table 1. Knowledge and practices of veterinarians regarding GIS management.

Variables	Categories	Frequency (n)	Percentage (%)	95% CI	Khi^2	ddl	p-value
Q1 – Rural activity area	Constantine	44	41.51	[0.321 – 0.509]	2.36	2	0.31
	Mila	32	30.19	[0.217 – 0.387]			
	Sétif	30	28.3	[0.198 – 0.368]			
Q2 – Type of farming	Mixed farming	77	72.6	[0.642 – 0.811]	61.5	2	<0.0001
	Sheep	24	22.6	[0.151 – 0.311]			
	Dairy cattle	5	4.7	[0.009 – 0.094]			
Q3 – Additional diagnostic	Yes	68	64.2	[0.547 – 0.736]	7.8	1	0.005
	No	38	35.8	[0.264 – 0.453]			
Q4 – Frequency of coproscopies	Never	50	47.2	[0.377 – 0.566]	29.6	3	<0.0001
	Rarely	23	21.7	[0.142 – 0.302]			
	Sometimes	20	18.9	[0.113 – 0.264]			

	Often	13	12.3	[0.066 – 0.189]			
Q5 – Other complementary examinations used	Autopsy	1	0.94	[0.000 – 0.028]	–	–	–
	Scraping	1	0.94	[0.000 – 0.028]			
	Colonoscopy	1	0.94	[0.000 – 0.028]			
	Adhesive tape	2	1.89	[0.000 – 0.047]			
Q6 – Type of anthelmintic used	Long acting	80	75.5	[0.670 – 0.830]	21.2	1	<0.0001
	Short acting	26	24.5	[0.170 – 0.330]			

Legend: NS = not significant; $p < 0.05$ = significant; $p < 0.01$ = highly significant; $p < 0.001$ = very highly significant.

3-2-Treatment practices in lambs and ewes

Table 2 summarizes treatment practices for lambs and ewes.
For lambs, treatment frequency differed very highly (p < 0.001): most veterinarians (68.9%) treated lambs more than twice per year, 27.4% once, and 3.8% never. Group treatment predominated (65.1%) over partial treatment (34.9%) (p < 0.01), reflecting a preventive rather than selective approach. Drug choice also varied significantly (p < 0.001), with macrocyclic lactones (40.6%) and benzimidazoles (27.4%) dominating, while salicylanilides (10.4%) and imidazothiazoles (<1%) were seldom used.

For ewes, 84.9% were systematically treated, 14.2% occasionally, and <1% never (p < 0.001), indicating widespread routine deworming. Recommendations also varied significantly (p < 0.001): 57.6% treated entire flocks, while 25.5% targeted specific physiological stages and 26.4% treated during grazing; selective treatments remained rare (9.4%).

Drug preferences in ewes showed very high variability (p < 0.001), dominated by benzimidazoles (55.7%) and macrocyclic lactones (49.1%). About one-third (35.8%) reported combining drug classes to counter resistance.

Table 2: Treatment practices in lambs and ewes

Variables	**Frequency (n)**	**Percentage (%)**	**95% CI**	**χ^2 test**	**Significance**
Q7 – Lamb treatments				χ^2=61.2	***p* < 0.001**
>2 times	73	68.9	[0.601 – 0.777]		
Once	29	27.4	[0.189 – 0.358]		
Never	4	3.8	[0.009 – 0.075]		
Q8 – Treatment strategies (lambs)				χ^2=9.2	*p < 0.01**
Entire group	69	65.1	[0.557 – 0.736]		
Part of the group	37	34.9	[0.264 – 0.443]		
Q9 – Anthelmintic (lambs)				χ^2=48.6	***p* < 0.001**
Benzimidazoles	29	27.4	[0.189 – 0.358]		
Macrocyclic Lactones	43	40.6	[0.311 – 0.500]		
Salicylanilides	11	10.4	[0.047 – 0.160]		
Imidazothiazoles	1	0.9	[0.000 – 0.028]		
Other	4	3.8	[0.009 – 0.075]		
Q10 – Ewes treatments				χ^2=135.4	***p* < 0.001**
Always	90	84.9	[0.774 – 0.915]		
Sometimes	15	14.2	[0.075 – 0.208]		

Never	1	0.9	[0.000 – 0.028]		
Q11 – Recommendations for ewe treatment				χ²=56.3	***p* < 0.001**
Entire flock	61	57.6	[0.481 – 0.670]		
Part flock	10	9.4	[0.047 – 0.151]		
Physiological stage	27	25.5	[0.170 – 0.340]		
Grazing season	28	26.4	[0.179 – 0.349]		
Q12 – Anthelmintic (ewes)				χ²=67.9	***p* < 0.001**
Benzimidazoles	59	55.7	[0.462 – 0.651]		
Macrocyclic Lactones	52	49.1	[0.386 – 0.585]		
Salicylanilides	11	10.4	[0.047 – 0.160]		
Sulfonamides	5	4.7	[0.009 – 0.094]		
Other	4	3.8	[0.001 – 0.074]		
Combines classes	38	35.8	[0.266 – 0.452]		

Legend: NS = not significant; $p < 0.05$ = significant; $p < 0.01$ = highly significant; $p < 0.001$ = very highly significant.

3-3-Veterinarians' perception, treatment practices, and use of diagnostic tools

Table 3 summarizes veterinarians' perceptions, treatment practices, and diagnostic use in parasite management.

Regarding satisfaction (Q13), 41.5% wished to improve their management, 34.9% were satisfied, and 21.7% saw room for improvement ($\chi^2 = 41.70$; $p < 0.001$), suggesting awareness of the need for better control strategies.

For grazing onset (Q14), most reported February (30.2%) or March (40.6%) ($\chi^2 = 23.29$; $p < 0.001$), while grazing cessation showed no significant difference ($\chi^2 = 5.39$; $p = 0.067$), indicating consistency in end-of-season timing.

Dosing practices (Q15) revealed that 71.7% used uniform doses versus 28.3% weight-based adjustments ($\chi^2 = 17.74$; $p < 0.001$). Weight was estimated visually by 94.3%, rarely via scales (3.8%) or measuring tape (1.9%) ($\chi^2 = 177.9$; $p < 0.001$), showing a strong reliance on subjective estimation.

Treatment recording (Q17) was inconsistent: 52.8% kept records, 47.2% did not ($p = 0.553$). Coproscopy (Q18) was seldom practiced—82.1% never used it, 7.6% before deworming, and 9.4% before and after ($\chi^2 = 213.9$; $p < 0.001$)—indicating limited diagnostic integration in parasite control.

Table 3: Veterinarians' perception, treatment practices, and use of diagnostic tools

Variables	**Frequency (n)**	**Percentage (%)**	**95% CI**	**χ²**	**ddl**	**p-value**
Q13 – Satisfaction with parasite management				41.70	3	<0.001***
No, want to improve	44	41.5	[0.321 – 0.509]			
No, cannot improve	2	1.9	[0.000 – 0.047]			
Yes, but but could improve	23	21.7	[0.142 – 0.302]			
Yes, fully satisfied	37	34.9	[0.264 – 0.443]			
Q14 – Month of grazing onset				23.29	2	<0.001***

March	43	40.6	[0.311 – 0.500]			
February	32	30.2	[0.217 – 0.387]			
January	12	11.3	[0.057 – 0.179]			
Q14 – Month of grazing end				5.39	2	0.067
April	22	20.8	[0.132 – 0.283]			
June	16	15.1	[0.085 – 0.226]			
September	13	12.3	[0.066 – 0.189]			
Q15 – Dosage Estimation				17.74	1	<0.001***
Same dose per group	76	71.7	[0.632 – 0.802]			
Based on individual weight	30	28.3	[0.198 – 0.368]			
Q16 – Estimation of body weight				177.9	2	<0.001***
Visual Estimate	100	94.3	[0.896 – 0.981]			
Scale	4	3.8	[0.009 – 0.075]			

Measuring tape	2	1.9	[0.000 – 0.047]			
Q17 – Recording of deworming treatments				0.35	1	0.553
Yes	56	52.8	[0.377 – 0.566]			
No	50	47.2	[0.434 – 0.623]			
Q18 – Modalities of coproscopy use				213.9	3	<0.001***
before deworming	8	7.55	[0.028 – 0.132]			
before and after deworming	10	9.43	[0.047 – 0.151]			
after deworming	1	0.94	[0.000 – 0.028]			
Never	87	82.08	[0.745 – 0.887]			

NS = Not significant; $p < 0.05$ = Significant; $p < 0.01$ = Highly significant; $p < 0.001$ = Very highly significant.

3-4- Treatment management and perception of gastrointestinal parasitism Farmers' anthelmintic practices showed wide variability, consistent with veterinarians' observations. The most common behaviors were insufficient treatment (38.7%) and habitual use (33%), while only 27.4% followed veterinary advice. Less frequent practices (5–19%) included overtreatment and treatments without prior assessment. Differences were highly significant ($\chi^2 = 72.3$, $p < 0.001$), confirming the predominance of empirical approaches despite guidance.

Most veterinarians viewed gastrointestinal parasitism as minor to moderate: 37.5% reported effective control, 35.8% occasional cases, and 31.1% persistent problems despite repeated deworming ($\chi^2 = 1.53$, $p = 0.465$, NS), suggesting possible reduced efficacy or emerging resistance.

Anthelmintic choice was mainly influenced by ease of use and broad spectrum (21.7% each), followed by efficacy (19.7%), availability (18.9%), and cost (18.1%) ($\chi^2 = 2.84$, $p = 0.586$, NS). Practical constraints included withdrawal period (75.5%), reduced efficacy (42.5%), and high cost (38.7%) ($\chi^2 = 58.7$, $p < 0.001$).

Awareness of overuse was high (73.6%, $\chi^2 = 30.1$, $p < 0.001$), and resistance was the main reason for limiting treatments (83.9%, $\chi^2 = 92.7$, $p < 0.001$). Overall, veterinarians show clear awareness of AR, emphasizing the need for evidence-based management and farmer training.

Table 4: Treatment management and perception of GIS

Variables	Frequency (n)	Percentage (%)	95% CI	χ²	p-value
Q19 – Management of treatments (ewes)				72.3	<0.001***
Insufficient	41	38.7	[0.292–0.481]		
Governed by habit	35	33.0	[0.245–0.425]		
vet's recommendation	29	27.4	[0.189–0.358]		
Too frequent	20	18.9	[0.133–0.264]		
Without prior assessment	17	16.0	[0.094–0.236]		
Based on flock management	9	8.5	[0.039–0.153]		
With prior assessment	9	8.5	[0.039–0.153]		
Ffarmer decision	6	5.7	[0.021–0.117]		
Q20 – Importance of parasitism (GIS)				1.53	0.465 NS
Minor issue	40	37.5	[0.281–0.472]		
Moderate importance	38	35.8	[0.265–0.452]		
Recurrent problem	33	31.1	[0.225–0.406]		
Q21 – Advantages of anthelmintics				2.84	0.586 NS
Ease of administration	55	21.7	[0.167–0.272]		
Broad spectrum	55	21.7	[0.167–0.272]		

High efficiency	50	19.7	[0.150–0.251]		
Wide range of products	48	18.9	[0.143–0.243]		
Moderate cost	46	18.1	[0.136–0.234]		
Q22 – Practical limitations				58.7	<0.001***
Withdrawal period	80	75.5	[0.673–0.837]		
Reduced efficacy	45	42.5	[0.329–0.524]		
Significant cost	41	38.7	[0.292–0.481]		
Ecotoxicity	17	16.0	[0.094–0.236]		
Q23 – Risks of overuse				30.1	<0.001***
Yes	78	73.6	[0.648–0.818]		
No	28	26.4	[0.182–0.359]		
Q24 – Reasons for reduced use				92.7	<0.001***
Resistance emergence	89	83.9	[0.762–0.910]		
Poor timing	36	34.0	[0.251–0.435]		
Delayed lamb immunity	23	21.7	[0.142–0.302]		

NS = Not significant; $p < 0.05$ = Significant; $p < 0.01$ = Highly significant; $p < 0.001$ = Very highly significant.

3-5- Diagnostic tools and perception of AR

Table 5 summarizes veterinarians' perceptions of diagnostic tools and AR. Most respondents (84.9%) judged current diagnostic tools insufficient to assess treatment needs, while only 15.1% found them adequate ($\chi^2 = 59.2$, $p < 0.001$), revealing major diagnostic limitations. The main barriers cited were high cost (48.1%), time constraints (38.7%), and poor field practicality (34.9%), whereas lack of reliability was less mentioned (12.3%) ($\chi^2 = 44.8$, $p < 0.001$), underscoring economic and logistical constraints.

Awareness of AR was high: 76.4% recognized its existence, 22.6% were unaware, and 0.9% gave no response ($\chi^2 = 63.5$, $p < 0.001$). Knowledge mainly stemmed from personal experience

(43.8%) and scientific reading (29.2%), with fewer citing training (16.1%) or conferences (10.9%) ($\chi^2 = 37.6$, $p < 0.001$), showing the predominance of practical learning over formal education.

Regarding the national situation, 62.3% confirmed the presence of resistance, 27.4% were uncertain, and 10.4% denied it ($\chi^2 = 41.7$, $p < 0.001$). These results highlight both a strong awareness of resistance and significant diagnostic and training gaps, emphasizing the need for accessible diagnostic tools and targeted continuing education to promote evidence-based parasite control.

Table 5: Diagnostic tools and perception of AR

Variables	Frequency (n)	Percentage (%)	95% CI	χ^2	df	p-value
Q25 – Diagnostic tools				59.2	1	<0.001***
Insufficient to properly assess need	90	84.9	[0.774–0.915]			
Sufficient to properly assess need	16	15.1	[0.085–0.226]			
Q26 – Reasons for insufficiency				44.8	3	<0.001***
Too costly	51	48.1	[0.387–0.575]			
Too time-consuming	41	38.7	[0.292–0.481]			
Limited practicality	37	34.9	[0.264–0.443]			
Lack of reliability	13	12.3	[0.067–0.202]			
Q27 – Awareness of resistance				63.5	2	<0.001***
Yes	81	76.4	[0.675–0.841]			
No	24	22.6	[0.150–0.316]			
No response	1	0.9	[0.000–0.052]			
Q28 – Source of knowledge				37.6	3	<0.001***
Personal experience	60	43.8	[0.342–0.535]			
Reading scientific article	40	29.2	[0.214–0.384]			

Training course	22	16.1	[0.101–0.238]			
Scientific congress	15	10.9	[0.062–0.181]			
Q29 – Perception of resistance in Algeria				41.7	2	<0.001***
Yes	66	62.3	[0.521–0.715]			
No	11	10.4	[0.055–0.175]			
No idea	29	27.4	[0.189–0.367]			

The multiple correspondence analysis and hierarchical clustering identified three distinct veterinarian profiles regarding GIS and AR management in sheep. **Cluster 1** (“intermediate cautious”) included veterinarians using some diagnostic tools and irregular dosing but lacking systematic follow-up. **Cluster 2**, the largest, represented an “empirical” profile marked by routine mass deworming without parasitological confirmation, creating high selection pressure for resistance. **Cluster 3** corresponded to a “selective and sustainable” profile, characterized by treatments adapted to physiological stages or grazing periods and higher awareness of resistance risks.

These results reveal a persistent dominance of empirical practices over evidence-based strategies, despite emerging awareness among some veterinarians. Bridging this gap requires improved access to diagnostics, continuing education, and targeted awareness programs to promote selective, sustainable parasite control aligned with targeted selective treatment principles.

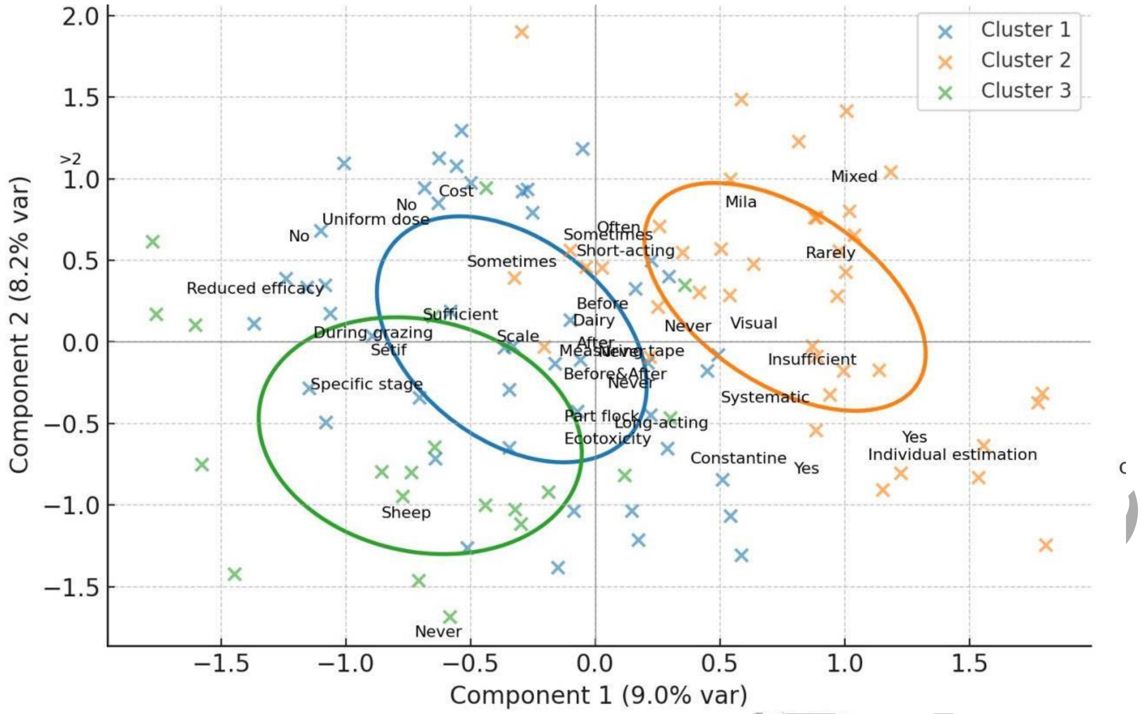

Figure 2 : *The MCA biplot (first two dimensions: 17.2% of variance explained) illustrates veterinarians' distribution according to their knowledge, attitudes, and practices (KAP) on GIS and AR. Hierarchical clustering identified three groups: Cluster 1 (blue) – practitioners cautious but constrained by costs and limited diagnostics; Cluster 2 (orange) – majority with systematic empirical treatments and strong reliance on visual diagnosis; Cluster 3 (green) – minority adopting more selective and stage-based strategies, with awareness of ecotoxic and resistance risks.*

4-Discussion

The survey of veterinarians in northeastern Algeria shows a predominant reliance on clinical diagnosis for gastrointestinal parasitism. Only 64.2% used complementary tests such as coproscopy or blood counts, 47.2% never performed coproscopy, and just 12.3% used it regularly—indicating a major diagnostic gap. This limited diagnostic use mirrors Norway, where 80% of sheep farmers treat prophylactically and only 11% perform prior analyses [11].

Macrocyclic lactones were preferred for lambs (40.6%), mainly ivermectin, doramectin, and abamectin, valued for persistence against strongyles. However, repeated use in naïve lambs accelerates resistance. In Ethiopia, ivermectin efficacy dropped below 92% with cross-resistance to albendazole [12], and in Brazil, ivermectin and moxidectin efficacy fell below 35%, while levamisole and monepantel exceeded 90% [13]. Benzimidazoles (27.4%) ranked second despite widespread resistance—over 86% of European flocks show reduced efficacy, especially against *Haemonchus contortus* [14]. Salicylanilides (10.4%) such as closantel remain effective in some endemic regions [12]. Levamisole use was marginal (0.9%) despite high efficacy in rotation programs [13].

For ewes, 84.9% of veterinarians recommended systematic treatment regardless of infection. In Ireland, only 51% of treatments achieved >95% efficacy, with resistance reported on 69% of farms for benzimidazoles, 39% for levamisole, and suspected for macrocyclic lactones in 11% [15]. About 25.5% of Algerian veterinarians timed treatments to high-risk periods such as lambing. Benzimidazoles (55.7%) and macrocyclic lactones (49.1%) dominated, and 35.8% combined classes empirically. Similar patterns occur in Turkey, where albendazole (99%) and ivermectin (83.2%) predominate while diagnostics remain scarce.

Many veterinarians (41.5%) were dissatisfied with current control but open to improvement, echoing findings in Turkey and Ethiopia [12]. Grazing from February–March to autumn favors larval development (10–25 °C, moderate humidity), sustaining infection pressure. Uniform dosing was common: 71.7% administered the same dose to all animals, and 93.5% estimated weight visually, with 20–30% error leading to underdosing and treatment failure [16]. Comparable patterns occur in South Africa, where older farmers underdose and 68% use expired drugs [20]. Absence of deworming records (52.8%) hampers drug rotation and monitoring, fostering resistant strains [12]. Farmers' practices were considered inadequate (38.7%), routine (33%), or excessive (18.9%), with minimal diagnostic guidance. The Fecal Egg Count Reduction Test (FECRT)—the standard for resistance detection—was almost unused: <1% applied it systematically, and 82% never used it. Across Europe, the lack of FECRT correlates with resistance rates above 85% in benzimidazole-treated flocks [14]. Shortages of diagnostic tools and training, especially in rural areas, perpetuate empirical deworming.

Veterinarians' perceptions influence risk. About 37.5% considered strongylosis minor and manageable through routine deworming, reinforcing mass treatments without evaluation. Overconfidence in drug efficacy maintains high selection pressure [18]. Meanwhile, 31.1% reported persistent infections despite repeated treatments, suggesting established resistance, similar to Ethiopia [12]. Kaplan et al. [18] emphasized that FECRT remains the only reliable method for early resistance detection, yet its underuse sustains reliance on ineffective drugs.

Operational and economic constraints also shape decisions. Withdrawal periods were the main concern (75.5%), followed by reduced efficacy (42.5%) and high cost (38.7%), leading to preventive or poorly timed treatments that heighten selection pressure [19]. Similar trends in Nordic countries link intensive treatments to rapid resistance spread. Economic constraints promote bulk drug purchases and uniform dosing, risking underdosing of heavier animals. Though less cited (16%), macrocyclic lactones' ecotoxicity—reducing dung fauna by up to 30%—can extend pasture contamination [20].

Most veterinarians (83.9%) recognized that excessive anthelmintic use promotes resistance, reflecting findings from Ireland [15]. Poor flock synchronization (33.9%) and delayed lamb immunity (21.7%) further increase drug dependence. High diagnostic cost (48.1%), time (38.7%), and limited field practicality (34.9%) remain key barriers, as in South Africa [17].

Awareness of resistance was high: 76.4% knew about it, mainly through personal experience (43.8%), similar to South Africa, where >40% identified resistance via treatment failure [17]. Fewer cited scientific publications (29.2%), continuing education (16.1%), or conferences

(10.9%)—patterns resembling Norway [11]. Nationally, 62.3% believed resistance is already established, while 27.4% were uncertain.

In summary, gastrointestinal strongyle control in northeastern Algeria depends heavily on routine flock-wide deworming with macrocyclic lactones and benzimidazoles. Despite awareness of resistance, diagnostics are rarely used and dosing remains imprecise. Minimal coproscopy, widespread use of long-acting formulations, and missing treatment records foster resistance spread. Nonetheless, many veterinarians acknowledge deficiencies and show willingness to improve. Enhancing access to diagnostics, implementing structured resistance monitoring, and strengthening professional training are essential for evidence-based parasite control, improved productivity, and sustainable sheep farming in Algeria and comparable regions of the Global South.

This study has several limitations. Sampling was non-random and voluntary, potentially introducing selection bias, as veterinarians more concerned about parasitism or engaged in continuing education may have been more likely to respond. Practices were self-reported rather than directly observed, which may lead to recall or social desirability bias. Moreover, the study focused only on northeastern Algeria, representing a specific agro-ecological context, and may not fully reflect practices in other regions with different management systems or access to veterinary services. Despite these limitations, the findings provide valuable insights into deworming strategies, diagnostic gaps, and operational barriers.

The findings highlight the urgent need for coordinated interventions. Integrating routine FECRT into regional veterinary services, supported by subsidized diagnostics, would enable early detection of resistance and guide treatment decisions. National training modules on sustainable anthelmintic use, diagnostic interpretation, and resistance management could strengthen veterinarians' technical capacity and reduce reliance on empirical treatments. Standardized treatment-record systems and flock-level monitoring would facilitate drug rotation and risk-based interventions. Awareness campaigns targeting both veterinarians and farmers could further promote best practices, supporting evidence-based decision-making and sustainable sheep production.

Gastrointestinal strongyle control in northeastern Algeria relies heavily on empirical, flock-wide deworming with macrocyclic lactones and benzimidazoles, often with imprecise dosing and minimal diagnostic guidance. Widespread anthelmintic use has *One Health* implications, including ecotoxicity (reduced dung fauna), environmental contamination, and potential interactions with other livestock medications. Improving access to affordable diagnostics, implementing structured resistance monitoring (FECRT), and strengthening continuing professional education are critical to achieving sustainable parasite control, mitigating resistance spread, and protecting both animal health and the environment.

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Author Contributions

MA designed the study, developed the questionnaire, collected and analyzed the data, interpreted the results, and drafted the manuscript. **MA** and **MA (co-authors)** performed statistical analyses and provided methodological and bibliographic support. **OS, NAKH, and NO** contributed to statistical analysis and manuscript revision. **SS, DB, OS, NAKH, NO, and BC** assisted in result interpretation and critically reviewed the final text. All authors read and approved the submitted version.**Conflict of Interest:** The authors declare no competing interests.

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