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CONHECIMENTOS, ATITUDES E PRÁTICAS DOS PRODUTORES PECUÁRIOS SOBRE ANTIBIÓTICOS: DESENVOLVIMENTO E ANÁLISE DA FIABILIDADE DE UM QUESTIONÁRIO

KNOWLEDGE, ATTITUDES, AND PRACTICES OF LIVESTOCK FARMERS ON ANTIBIOTIC USE: QUESTIONNAIRE DEVELOPMENT AND RELIABILITY ASSESSMENT

CONOCIMIENTOS, ACTITUDES Y PRÁCTICAS DE LOS GANADEROS SOBRE LOS ANTIBIÓTICOS: ELABORACIÓN Y ANÁLISIS DE FIABILIDAD DE UN CUESTIONARIO

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RESUMO

Introdução: A resistência aos antimicrobianos (RAM) é um problema de saúde pública global em crescimento. A sua mitigação requer uma abordagem «Uma Só Saúde» e os produtores pecuários desempenham um papel fundamental na garantia da saúde e do bem-estar animal e na promoção da gestão responsável dos antibióticos.
Objetivo: Desenvolver e avaliar a fiabilidade de um questionário como instrumento para captar os conhecimentos, atitudes e práticas dos produtores pecuários relativamente à RAM e ao uso de antibióticos.
Métodos: Estudo metodológico com foco na avaliação da fiabilidade do questionário constituído por três secções e desenvolvido com base numa revisão compreensiva da literatura. Entre janeiro e fevereiro de 2026, foram recrutados produtores que trabalham com bovinos, suínos e/ou pequenos ruminantes, na região Centro de Portugal. Foi realizado um teste-reteste com um intervalo de 2 a 3 semanas. A reprodutibilidade foi determinada com o coeficiente de correlação intraclasse (CCI; intervalo de confiança de 95%) e a consistência interna foi calculada utilizando o alfa de Cronbach.
Resultados: No total, 10 produtores completaram o estudo. Duas secções com itens da escala de Likert foram avaliadas quanto à fiabilidade e a maioria dos itens (23 de 27) apresentou CCI > 0,4, demonstrando, no geral, uma boa reprodutibilidade. Foi demonstrada uma boa consistência interna pelos valores do alfa de Cronbach de 0,833 e 0,765 para o teste e o reteste, respetivamente.
Conclusão: O questionário desenvolvido é uma ferramenta fiável para recolher os conhecimentos, atitudes e práticas dos produtores pecuários sobre a RAM e o uso de antibióticos.

Palavras-chave: resistência aos antimicrobianos; uso de antibióticos; Uma Só Saúde; produtores pecuários; fiabilidade do questionário

ABSTRACT

Introduction: Antimicrobial resistance (AMR) is a rising global public health problem. Its mitigation requires a «One Health» approach, and livestock farmers have a key role in ensuring animal health and welfare and in promoting antibiotic stewardship.
Objective: To develop and assess the reliability of a questionnaire as an instrument to capture livestock farmers' knowledge, attitudes, and practices regarding AMR and antibiotic use.
Methods: A methodological study focused on assessing the reliability of a questionnaire consisting of three sections and developed based on a comprehensive review of the literature. Between January and February 2026, livestock producers working with cattle, swine, and/or small ruminants were recruited in the Central region of Portugal. A test-retest was conducted with an interval of 2 to 3 weeks. Reproducibility was determined using the intraclass correlation coefficient (ICC; 95% confidence interval), and internal consistency was calculated using Cronbach's alpha.
Results: In total, 10 farmers completed the study. Two sections with Likert scale items were assessed for reliability, and most items (23 out of 27) showed ICC>0.4, demonstrating overall good reproducibility. Good internal consistency was demonstrated by Cronbach's alpha values of 0.833 and 0.765 for test and retest, respectively.
Conclusion: The developed questionnaire is a reliable tool to collect livestock farmers' knowledge, attitudes, and practices on AMR and antibiotic use.

Keywords: antimicrobial resistance; antibiotic use; One Health; livestock farmers; questionnaire reliability

RESUMEN

Introducción: La resistencia a los antimicrobianos (RAM) es un problema de salud pública mundial cada vez más grave. Su mitigación requiere un enfoque «Una Sola Salud» y los ganaderos desempeñan un papel fundamental a la hora de garantizar la salud y el bienestar de los animales y de promover el uso responsable de los antibióticos.
Objetivo: Desarrollar y evaluar la fiabilidad de un cuestionario como instrumento para recabar los conocimientos, actitudes y prácticas de los ganaderos en relación con la RAM y el uso de antibióticos.
Métodos: Estudio metodológico centrado en la evaluación de la fiabilidad de un cuestionario compuesto por tres secciones y elaborado a partir de una revisión exhaustiva de la bibliografía. Entre enero y febrero de 2026, se seleccionó a productores que trabajan con ganado vacuno, porcino y/o pequeños rumiantes en la región central de Portugal. Se llevó a cabo una prueba de repetición con un intervalo de 2 a 3 semanas. La reproducibilidad se determinó mediante el coeficiente de correlación intraclase (CCI; intervalo de confianza del 95 %) y la consistencia interna se calculó utilizando el alfa de Cronbach.
Resultados: En total, 10 ganaderos completaron el estudio. Se evaluó la fiabilidad de dos secciones con ítems de escala Likert y la mayoría de los ítems (23 de 27) mostraron CCI > 0,4, lo que demuestra una buena reproducibilidad general. Se demostró una buena consistencia interna mediante los valores del alfa de Cronbach de 0,833 y 0,765 para la prueba y la repetición de la prueba, respectivamente.
Conclusión: El cuestionario elaborado es una herramienta fiable para recopilar los conocimientos, las actitudes y las prácticas de los ganaderos sobre la RAM y el uso de antibióticos.

Palabras clave: resistencia a los antimicrobianos; uso de antibióticos; una sola salud; ganaderos; fiabilidad del cuestionario

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INTRODUCTION

Antimicrobial resistance (AMR) is a growing public health problem, in particular antibiotic-resistant pathogens (Ho et al., 2025). Although a natural process, the selection of drug-resistant bacteria is promoted by the use of antibiotics in humans, animals, and agriculture and is further aggravated by their inappropriate use in all these sectors (Ho et al., 2025). The World Health Organization's One Health approach recognizes the interdependence and connection between the health of humans, animals, and the environment, being necessary to effectively mitigate AMR emergence and spread (Van Puyvelde et al., 2018).

Evidence indicates that human antimicrobial use is associated with AMR in animals, and vice versa, and that reduction in antibiotic consumption is correlated with decreased AMR (Allel et al., 2023; ECDC et al., 2024). In 2021, EU/EEA mean values for the consumption of antimicrobial medicines in humans and food-producing animals were 125.0 and 92.6 mg/kg estimated biomass, respectively, with Portugal's values being 101.8 and 149.9 mg/kg (ECDC et al., 2024).

In the context of the One Health framework, livestock farmers are crucial veterinary stakeholders in promoting antibiotic stewardship (Kovacs et al., 2025). Farmers' livestock management and antibiotic use depend on their knowledge, attitudes, and perceptions regarding AMR (Kovacs et al., 2025). Hence, to promote coordinated antibiotic stewardship among all stakeholders, it is necessary to identify farmers' potential risk behaviors and gaps in knowledge for the successful implementation of educational interventions. Of note, training and educational initiatives targeting farmers and veterinarians can significantly improve antimicrobial stewardship and successfully reduce antibiotic use in livestock (Borelli, Ellis, Pamphilis, et al., 2023; Farrell et al., 2021; Matheou et al., 2025).

In Portugal, data on knowledge, attitudes, and practices (KAP) of livestock farmers regarding AMR and antibiotic use are very scarce and focused on certain species (small ruminants) and on biosafety (M. de A. Pereira et al., 2026). Therefore, this study aimed to design and assess the reliability of a self-administered questionnaire targeted at livestock farmers.

1. METHODS

1.1 Questionnaire development

This self-administered questionnaire, developed in Portuguese, was based on a comprehensive review of relevant literature (Borelli, Ellis, Pamphilis, et al., 2023; Borelli, Ellis, Tomlinson, et al., 2023; Haimbodi et al., 2024; Omolo et al., 2024; Shrestha et al., 2025; Tufa et al., 2023). Briefly, a search was conducted in PubMed, restricted to articles from 2015 to 2025. Exclusion criteria were: (i) non-livestock animal species, namely pets, zoo animals, wild and/or exotic animals; (ii) veterinarians as sole target population; (iii) upper-middle-income and lower-middle-income economies. The applied search string was the following:
(farmer) AND (attitude* OR perception* OR belie* OR knowledge) AND (food-producing OR livestock) AND (survey OR cross-sectional OR questionnaire) AND (anti-infective agent* OR antimicrobial* OR antibacterial*)*.

From the initial 87 articles screened, a total of 6 studies were included and reviewed for information on questions applied to livestock farmers. Three sections were defined in the present questionnaire: sections 1 (antibiotics and their use) and 2 (antibiotic resistance) comprised a series of statements for the participants to indicate their level of agreement. Options consisted in a 5-point Likert scale, from totally disagree to totally agree, and the option "don't know/don't answer". Section 3 referred to sociodemographic and professional data, namely age, gender, education level, type of livestock farming (bovine – dairy, bovine – beef, pigs, sheep, and/or goats), number of animals, and years of experience.

1.2 Face and content validity

Face validity was established by one psychology expert and by one Portuguese language expert. Assessed parameters included organization, grammar and syntax, appropriateness of the questions, potential ambiguity, and logical sequence of the statements (Alumran et al., 2012; A. F. Pereira et al., 2026).

To ensure clarity, comprehensiveness, and relevance of included items, content validity was verified by a panel of four experts in the areas of veterinary medicine, public health, pharmacy, pharmacology, and pharmacoepidemiology. Content validity measures to what extent the set of items fully represent all aspects to be evaluated (Connell et al., 2018; Rattray & Jones, 2007).

1.3 Pilot study: test-retest reliability

To assess the questionnaire's reliability, a test-retest was conducted in the Central Region of Portugal, from January to February 2026, and the target population was livestock farmers working with cattle (beef and/or dairy), small ruminants, and/or swine. Paper questionnaires were given to the same participants on two occasions, with an interval of 2-3 weeks (Boswell et al., 2023; Rajan et al., 2025; Tabibian et al., 2025). This period is ideal for preventing respondents from recalling their previous answers and ensures timely data collection on the same target population (Rajan et al., 2025).

Through convenience sampling, at least 10 participants were recruited (Bujang et al., 2024). No restrictions were imposed on age, gender, number of animals, or years of experience. All participants voluntarily provided their informed consent to participate in the pilot study.

1.4 Psychometric tests and statistical analysis

Data were analyzed using IBM SPSS Statistics, version 30.0 (IBM Corp., New York, United States). Descriptive statistics, namely frequencies, percentages, and 25, 50 and 75th percentiles (PCT), were used to summarize the data. To assess any potential transcription errors, data were randomly verified.

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In sections 1 and 2, the reproducibility of the questionnaire's items was assessed using the intraclass correlation coefficients (ICCs), with the respective 95% confidence intervals (CIs) (Weir, 2005). ICCs were calculated using a two-way analysis of variance (ANOVA) mixed-effects model, single measures (Mallah et al., 2022; Neto et al., 2025; A. F. Pereira et al., 2026). For this KAP questionnaire, ICC values >0.4 were considered acceptable (Agosti et al., 2024; Mallah et al., 2022) since, at early stages of questionnaire development, a moderate ICC cutoff value may allow the retention of potentially useful items while excluding random data. Further, lower test-retest reliability is expected for items assessing attitudes, awareness, knowledge, and situation-dependent behaviors compared to items designed to assess habits or routine practices (Bae et al., 2010; Kim et al., 2015; T. K. Koo & Li, 2016; Liu et al., 2024).
The questionnaire's internal consistency was estimated through Cronbach's alpha coefficient. Cronbach's alpha ranges from 0 to 1 and defines the extent to which items within a test or instrument measure the same concept in a consistent manner. In instruments using Likert scales, values ≥ 0.70 are considered good (Khan et al., 2025; Ranganathan et al., 2024).

1.5 Ethics and consent to participate

The research protocol received ethics approval from the Ethics Committee of the University of Trás-os-Montes and Alto Douro (reference Doc23-CE-UTAD-2025, on 05/03/2025). All individual participants provided their written informed consent before participating in the study. To ensure confidentiality, all questionnaires were coded with numbers and deposited in a locked cabinet, with access restricted to the research team members.

2. RESULTS

The process of questionnaire development and the test-retest study are detailed in Figure 1. The 26-item questionnaire was revised by the panel of experts; nine statements were redrafted, two were rearranged, and one was added. The final questionnaire included two sections with a total of 27 statements, and another section for sociodemographic and professional data.

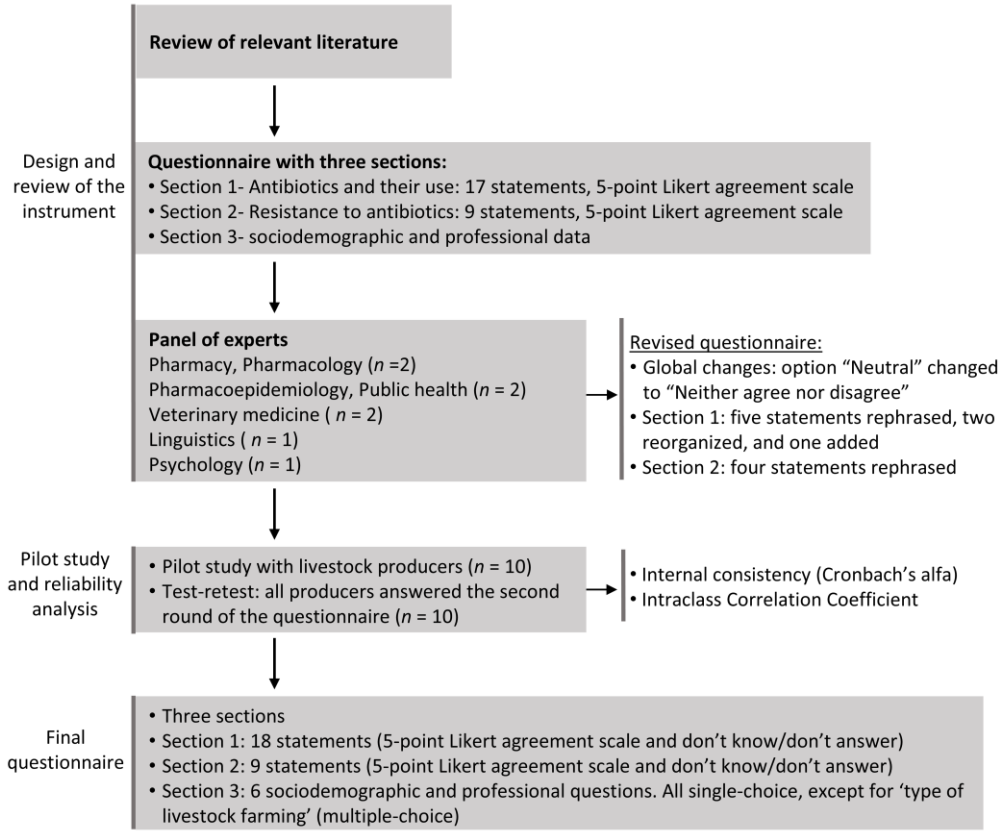


Figure 1 - Workflow of questionnaire design, review and test-retest pilot study

Ten farmers answered the questionnaire on two occasions within a 2-3 week interval. Participants worked with dairy cattle (80%), beef cattle (50%), and/or sheep (10%) and most of them (80%) had more than 20 years of experience (Table 1).

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Table 1 - Sociodemographic and professional characteristics of participants (n = 10)

Characteristics	*n* (%)
Gender	
Male	6 (60)
Female	4 (40)
Age (years)	
Median (PCT25, PCT75)	56.5 (43.8, 70.5)
Education	
Primary school (1st to 4th years)	3 (30)
Middle school (5th to 6th years)	3 (30)
Upper secondary education (10th to 12th years)	2 (20)
Higher education	2 (20)
Type of livestock farming [(a)]	
Bovine (dairy)	8 (80)
Bovine (beef)	5 (50)
Sheep	1 (10)
Number of animals	
Median (PCT25, PCT75)	40 (26.3, 60.3)
Years of experience	
10-14	2 (20)
≥ 20	8 (80)

Note: PCT = percentile; [(a)] = multiple-choice question.

The questionnaire's reliability was assessed through reproducibility (ICCs; Table 2) and internal consistency (Cronbach's alpha). A proposed interpretation for ICCs is that values <0.4 indicate poor reproducibility, values between 0.4 and 0.75 indicate fair to good reproducibility, and values >0.75 indicate excellent reproducibility (Rosner, 2006). In the test-retest reliability study, ICC values ranged from 0.25 (95% CI 0.04–0.74) for item 3 to 0.97 (95% CI 0.87–0.99) for item 16. Most (23) items showed ICC values >0.4, indicating overall good ability to generate reproducible results. Good internal consistency was demonstrated by Cronbach's alpha values of 0.833 and 0.765 for test and retest, respectively.

Table 2 - Test-retest reliability assessment of the knowledge, attitudes, and practices (KAP) items: intraclass correlation coefficients (ICCs) and respective 95% confidence intervals (CI) and *p*-value

Sections and statements	ICC (95% CI)	*p*-value
Section 1 – Antibiotics and their use *Please indicate your level of agreement with each of the following statements (totally disagree, disagree, neither agree nor disagree, agree, totally agree, don't know/don't answer)*		
1. Antibiotics only kill bacteria.	0.79 (0.36–0.94)	0.002
2. Antibiotics can be used in animals to increase weight or productivity.	0.70 (0.17–0.92)	0.009
3. Antibiotics can be used against any disease that the animal has.	0.25 (-0.42–0.74)	0.230
4. Over time, antibiotics have been losing effectiveness and I note that my animals take more time to heal from disease.	0.87 (0.57–0.97)	<0.001
5. Sometimes I give antibiotics to animals when they get sick, even without consulting the veterinarian.	0.88 (0.59–0.97)	<0.001
6. I believe that antibiotics solve most animal diseases.	0.60 (0.00–0.88)	0.025
7. Every week, or frequently, I give antibiotics to one or several of my animals because they are sick, to prevent them from getting sick or for other reason.	0.38 (-0.29–0.80)	0.128
8. I usually consult the veterinarian before treating my animals with antibiotics.	0.78 (0.33–0.94)	0.002
9. I usually stop the antibiotic treatment as soon as the animal gets better.	0.68 (0.13–0.91)	0.011
10. If the animal does not get better, I increase the dose or the number of times I give the antibiotic.	0.57 (-0.05–0.87)	0.034
11. It is important to follow all instructions given by the veterinarian when prescribing antibiotics.	0.56 (0.07–0.87)	0.038
12. I try to keep myself informed about the rules and laws that are in force regarding the use of antibiotics in animals.	0.60 (0.00–0.88)	0.025
13. I have a specific place where I keep antibiotics.	0.41 (0.26–0.81)	0.116
14. I speak with other farmers to know what antibiotic to use when I have a sick animal.	0.67 (0.11–0.91)	0.012
15. Over the years, I have been using less antibiotics in my animals.	0.73 (0.24–0.93)	0.005
16. I return leftover antibiotic bottles to the pharmacy or to my veterinarian.	0.97 (0.87–0.99)	<0.001
17. I have used an expired antibiotic to try to treat a sick animal.	0.60 (-0.01–0.88)	0.027
18. I keep antibiotics in a place with controlled temperature and humidity.	0.27 (-0.40–0.75)	0.214
Section 2 – Antibiotic resistance *Please indicate your level of agreement with each of the following statements (totally disagree, disagree, neither agree nor disagree, agree, totally agree, don't know/don't answer)*		
19. Antibiotic resistance is a public health problem that affects both animals and people.	0.64 (0.06–0.90)	0.017
20. The use of antibiotics in animals contributes to the occurrence of the resistance problem.	0.64 (0.06–0.90)	0.017
21. I believe that more restrictions on the use of antibiotics can affect the animals' well-being and health.	0.37 (-0.30–0.80)	0.130
22. Antibiotic resistance is not a problem in veterinary medicine.	0.58 (-0.04–0.88)	0.032
23. The occurrence of resistance is only associated with the use of antibiotics in human health.	0.34 (-0.33–0.78)	0.153
24. Antibiotic resistance has already affected me directly, either me or my family.	0.41 (-0.27–0.81)	0.111
25. The inappropriate use of antibiotics in animals worries me.	0.71 (0.18–0.92)	0.008
26. Besides antibiotics, there are other alternatives to treat infections caused by bacteria.	0.81 (0.40–0.95)	0.001
27. In my livestock farming, I try to practice the best measures for preventing disease in my animals, such as biosecurity, good hygiene and vaccination.	0.76 (0.28–0.93)	0.004

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3. DISCUSSION

In this study, a questionnaire for identifying livestock farmers' KAP related to AMR and antibiotic use in animals was developed. Following the face and content validation steps, the reproducibility and internal consistency of the questionnaire were assessed in a pilot study, demonstrating it to be a reliable tool to be self-administered in the target population.

Developing validated instruments to identify and measure factors that influence antibiotic misuse and/or overuse is of utmost importance (Alumran et al., 2012). Deductive and inductive methods are used for the design of comprehensive survey tools (Boateng et al., 2018; Gupta et al., 2025) and these methods correspond to, respectively, literature review and feedback from experts and/or individuals from the target population. It is recommended to combine both methods when generating items, allowing researchers to define the relevant domain based on a theoretical basis and, subsequently, identify appropriate questions to assess it (Boateng et al., 2018; Gupta et al., 2025). The present questionnaire was developed following a comprehensive review of the literature and involving researchers with extensive experience in questionnaire-based studies and in epidemiology, contributing to the quality of the data collection tool (Dean, 2015). Consultation with experts from different areas is essential to ensure face and content validity. At this stage, the questionnaire may be adjusted to increase reliability and improve the collection of relevant data (A. F. Pereira et al., 2026). A clear introduction to the study, clear instructions on the completion of the questionnaire, and the definition of scientific terms, namely "antibiotic resistance", were included to ensure understanding by the participants (Dean, 2015). Additionally, to promote respondents' engagement, the section containing sociodemographic and professional data was presented at the end (Lietz, 2010).

For this questionnaire, a 5-point Likert scale was selected. These scales are recognized by their usefulness in collecting opinions, attitudes, and perceptions, being often applied in veterinary medicine (M. de A. Pereira et al., 2026; Wilson et al., 2023). The five options provided allowed participants to express positive, negative, and neutral views, helping to reduce response bias and improve data reliability (M. Koo & Yang, 2025; Lozano et al., 2008). The options "Neither agree nor disagree" (M. Koo & Yang, 2025), as well as "don't know/don't answer" (Goodfellow, 2023), are critical to avoid forced choices from the respondents and, thus, ensure that their true perspective is accurately reported (Goodfellow, 2023; M. Koo & Yang, 2025).

Pilot testing the questionnaire with a small sample of the target population helps identify potential problems with wording and clarity, response format, the length and structure of the questionnaire, and also helps assess the contextual relevance of each question/item (Dey et al., 2025; Luke, 2025). Similar to the present work, in other farmer-related studies, a sample size of $N = 10$ for test-retest was also employed, as well as a period of 2-3 week interval (Skaczkowski et al., 2024; Tahernejad et al., 2025). If the retest is administered in a very short interval, participants may remember their previous answers, introducing recall bias (Sørensen et al., 2025). Nevertheless, a sample size of 10 farmers may limit the estimation and interpretation of ICC values, which were used as one criterion in item evaluation. Since this criterion reflects person-to-person variability, changes in individual responses may have a large effect on the item-level ICC, even more so in small samples (Williams et al., 2025). There are no standard values for acceptable reliability using ICC, and a low value could reflect the small sample size and the lack of variability among the sampled individuals (T. K. Koo & Li, 2016). Therefore, the decision to retain some items with ICC < 0.4 was made also considering their importance in addressing specific farming practices, attitudes, and knowledge, the panel of experts' decision, and the expected validation in a future, larger study.

Besides reproducibility, internal consistency was also assessed through Cronbach's alpha, a parameter that reflects the degree to which items are correlated and, thus, measure the same concept (Rattray & Jones, 2007). Obtained values for test-retest were >0.75 and <0.85, respectively, demonstrating good internal consistency. Values <0.70 may be indicative of poor item grouping, while values >0.90 suggest poor discriminatory power and item redundancy (Rattray & Jones, 2007). Other reports on the topic of AMR and antibiotic use in farmers (Gemeda et al., 2020) or veterinarians (A. F. Pereira et al., 2026) have obtained Cronbach alpha values ranging from 0.32 to 0.82.

Farmers working with food-producing animals are primary stakeholders in animal welfare and health and, consequently, key players against AMR. At the national level, there is a lack of information on livestock farmers' knowledge and perceptions regarding AMR and prudent antibiotic use (M. de A. Pereira et al., 2026), undermining current antimicrobial stewardship efforts. The developed questionnaire will serve as an important instrument to understand farmers' practices and identify potential knowledge gaps, contributing to the design of tailored educational interventions to further encourage and support responsible antibiotic use.

Strengths and limitations

To the best of our knowledge, this is the first questionnaire designed to address KAP of Portuguese livestock farmers working with bovine, swine, and small ruminants about AMR and antibiotic use, providing a more in-depth view of existing gaps. Often, questionnaires focus on farmers of one or two types of livestock (Islam et al., 2025; Raihan et al., 2026; Sumi et al., 2026). The developed self-administered questionnaire considers the variety of production systems, being applicable to small-, medium-, and large-scale farmers of different livestock species, namely dairy cattle, beef cattle, pigs, and small ruminants (sheep and goats). Some limitations should be considered, namely the small sample size, the limited geographical distribution of participants (Central region of Portugal), and the sampling by convenience. Further, construct validity was not determined in the present work due to the small sample size. These limitations are expected to be addressed in subsequent research, using a larger-scale cross-sectional study, strengthening evidence for its applicability across the full target population. Despite these limitations, the main goal was to assess the reliability of a questionnaire for livestock farmers and, in test-retest studies, researchers often recruit around 10 participants (Skaczkowski et al., 2024).

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CONCLUSION

AMR is a leading and ever-increasing cause of death worldwide, threatening not only the health of humans, but also animals and plants and, ultimately, undermining food safety and the sustainability of health and agrifood systems. A One Health approach is required to effectively mitigate this global health crisis. In veterinary medicine, companion animal owners, farmers, veterinarians, and others involved in food production and the wider food industry are key in promoting antimicrobial stewardship. This self-administered questionnaire could be useful for the future development of educational interventions specifically designed for livestock farmers to inform about AMR and encourage good production practices and prudent antibiotic use.

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AUTHOR´S CONTRIBUTION

Conceptualization, B.C., S.R., T.C., A.C.C., P.O., F.R. and M.T.H.; data curation, J.P.; formal analysis, J.P.; funding acquisition, M.T.H.; investigation, J.P.; methodology, J.P., B.C., S.R. and T.C.; project administration, M.T.H.; supervision, A.C.C., P.O., F.R. and M.T.H.; visualization, J.P.; writing – original draft, J.P., B.C., S.R. and T.C.; writing – review & editing, J.P., B.C., S.R., T.C., A.C.C., P.O., F.R. and M.T.H.

CONFLICT OF INTEREST

The authors declare no conflict of interests.

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