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RESEARCH ARTICLE

Evaluation of Methodological and Reporting Quality of Systematic Reviews and Meta-Analyses Published in Veterinary Journals with AMSTAR

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ABSTRACT

The complete and transparent reporting of systematic reviews and meta-analyses increases the quality of such studies. Although there are different tools to examine methodological quality, little research has been conducted on the quality of these studies in animal health. The objective of this study was to evaluate the complete reporting of systematic reviews and meta-analyses published in veterinary journals with "**A** **M**ea**S**urement **T**ool to **A**ssess Systematic **R**eviews" (AMSTAR). The journal's impact factor, the number of authors, the number of studies included, and the research period were extracted as article characteristics. Total quality scores were calculated according to the AMSTAR tool, and scores were compared using the aspects of the articles. This study assessed 207 systematic reviews and meta-analyses published in 130 veterinary journals. AMSTAR quality scores were higher for meta-analyses with fewer than five authors compared to studies with five or more authors (P=0.009). Our findings indicate that about half of all studies (51.2%) were of moderate quality regarding methodology and reporting. According to the evaluation with AMSTAR, 64.6% of systematic reviews and meta-analyses were of high quality. In conclusion, the reporting quality of the studies was good, but generally, there was insufficient information on assessing publication bias.

Keywords: AMSTAR, Meta-analysis, Reporting quality, Systematic review, Veterinary medicine

INTRODUCTION

Evidence-based studies are critical to clinical decision-making in human and veterinary medicine, as they integrate the best research evidence with clinical expertise and patient values. According to the hierarchy of studies, systematic reviews and meta-analyses are classified as the highest level of evidence [1,2]. A systematic review synthesizes the results from all available studies on a particular subject and comprehensively analyzes the collated studies' results, strengths, and limitations. A meta-analysis, on the other hand, is a statistical method that combines the findings of independent studies on the same subject, which is suitable for systematic review [3]. Therefore, animal health clinical decision-making should be based on aggregating the best evidence rather than the results of individual studies [4].

Systematic reviews and meta-analyses are essential for clinical decisions in veterinary sciences as they allow the quantitative evaluation of treatment effects and uncertainty [1,5-8]. Using such studies as a decision-making tool in clinical practice is not new, yet these studies are becoming increasingly more common in the literature [2,9].

The quality and reliability of systematic reviews and meta-analyses depend on many concepts, such as research questions, comprehensive literature review, and quality of the original studies. Excellent systematic reviews and meta-analyses should have a detailed methodology that can be reproduced [3]. Although clear methodology is a feature of systematic review and meta-analysis, the methodology may be incompletely or inadequately reported. Poor reporting and methodological quality may hinder the provision of appropriate information to clinicians [9].

Evaluating the quality of the systematic reviews and meta-analyses is essential and recommended in animal health to improve the reporting quality of these studies [7,10,11]. The increasing number of such studies has brought along the implementation of various standards to increase the quality of these studies. Some journals refer to specific reporting guidelines for systematic reviews and meta-analyses and recommend that authors follow these guidelines. Various

guidelines, checklists, and assessment tools for different study designs have been developed to improve and evaluate the quality of such studies [12-17]. These guidelines lead authors to report their results as fully as possible, thus providing more transparency in the reporting process. These tools, with checklists, are frameworks developed to improve the quality of systematic reviews and meta-analyses by checking whether the authors report the results adequately and transparently. **A** **M**ea**S**urement **T**ool to **A**ssess **S**ystematic **R**eviews (AMSTAR), one of these tools, is the only recently developed assessment tool with proven reliability and validity designed to evaluate the methodological quality of systematic reviews and meta-analyses [7,18,19]. The AMSTAR tool is an evaluation criterion rather than a reporting guide [18]. It consists of eleven questions of denominated items that examine the creation of a literature review plan, literature selection, and data extraction, inclusion and exclusion criteria, a list of included studies and their evaluation criteria, appropriateness of methods used to combine individual research results and conflict of interest information [7].

Despite the increase in systematic reviews and meta-analyses published in veterinary journals, few studies have evaluated the methodological quality of such studies. Therefore, this study aimed to assess the completeness of reporting systematic reviews and meta-analyses published in veterinary journals using AMSTAR.

Material and Methods

Data Collection

Systematic reviews and meta-analyses published in the Thomson Reuters Clarivate Analytics database containing the word "veterinary" in the journal title were selected for data collection. Of the journals found, the authors scanned articles published between 2016 and 2021 independently using the following search terms: "meta-analysis" and "systematic review" in the article title. The inclusion criteria were: (1) studies written in English and (2) studies available in full text. Exclusion criteria were: (1) abstracts or conference proceedings, (2) protocol or guidelines, and (3) narrative reviews. Data collection took place between 31 January and 25 February 2022.

Assessment of Reporting Quality

The AMSTAR tool was used for methodological quality assessment. The AMSTAR tool developed by Shea et al.[18] consists of eleven question-denominated items. For each question on the presence of a quality item, two possible actions can be performed: "Yes," if the quality item is present, 1 point will be assigned; "No/Not Applicable" for reviews not reporting this quality item, 0 points will be given. In AMSTAR, the aggregated quality score is calculated as the sum of the scores of all items (0-4 points: Low level; 5-8 points: Moderate level; 9-11 points: High level) [7].

Data Extraction

To examine the characteristics of the included studies, the following information was extracted: publication year, journal index class (SCI-expanded, not SCI-expanded), journal's impact factor, number of studies included, research period, information about research funding, and number of authors. The research period refers to the time between the publication years of the studies included in the meta-analysis.

Study Procedure and Data Analysis

The characteristics of included studies were summarized descriptively, with n (%) and median (minimum-maximum) following the data type (categorical and continuous). All reviewed articles were divided into systematic reviews only (SR), systematic reviews and meta-analyses (SR/MA), and meta-analyses only (MA) based on their titles. The methodological quality of each included study was evaluated by two authors independently using the AMSTAR tool. Any disagreements between the authors were resolved by consensus. Final AMSTAR scores were obtained by summing the scores assigned to each item. First, the total quality scores were compared according to the study's characteristics in each study type. The median was used as the threshold value for grouping studies to ensure a similar sample size to compare characteristics as described above. Then, the total AMSTAR score was compared between SR, MA, and SR/MA without separating them according to the relevant characteristics. Because the data did not meet parametric test assumptions, the Kruskal-Wallis test was used to compare more than two groups, and the Mann-Whitney U test was used to compare groups in pairs. Journal index class (Science Citation Index-expanded or not) feature was not compared due to insufficient sample size in the groups. IBM SPSS v23.0 software was used for data analysis, and P values less than 0.05 were considered significant.

Results

One hundred thirty journals included 'veterinary' in the Thomson Reuters Clarivate Analytics database. During the search period, two hundred and seventeen individual studies were identified, including "systematic review" and/or "meta-analysis" words in the title. Further, ten studies were excluded for the following reasons: conference paper or abstract (n=2), protocol or guide describing the implementation of the meta-analysis (n=2), and narrative reviews (n=6). Thus, two hundred and seven studies were included, fully meeting the specified inclusion/exclusion criteria.

Table 1. Descriptive statistics of the included studies published in veterinary journals between 2016-2021 (n=207) (categorical variables)

Study Characteristics	Categories	n	%
Study type	SR/MA SR MA	79 84 44	38.2 40.6 21.3
Publication year (all study types)	2016	20	9.7
	2017	22	10.6
	2018	28	13.5
	2019	27	13.0
	2020	45	21.7
	2021	65	31.4
Journal Index (all study types)	SCI-expanded Not SCI-expanded	181 26	87.4 12.6
Funding support (all study types)	Yes	91	44.0
	No	116	56.0

SR: Systematic Review, MA: Meta-analysis, SR/MA: Systematic review and meta-analysis

Table 2. Descriptive statistics of the included studies published in veterinary journals between 2016-2021 (n=207) (continuous variables)

Study Characteristics	Median	Minimum	Maximum
Journal Impact Factor*	2.67	0.05	3.69
Number of included studies	28	4	578
Research period of included studies (year)	21	1	117
Number of authors	5	1	23

* *n=204 (Information about the impact factor of one journal in which only three articles were published was not available)*

Characteristics of the Included Studies

The descriptive statistics of the characteristics of the included studies are given in *Table 1* and *Table 2*. The number of SR (40.6%) included in the study was observed to be higher than MA and SR/MA. As a result of the literature review covering 2016-2021, an increase has been observed in the number of SR/MA in animal health. At the same time, most (87.4%) of the journals in which these articles were published were covered by the Science Citation Index (SCI-expanded). The impact factor values of the journals varied between 0.05 and 3.69. The number of studies included in the evaluated SR, SR/MA, and MA ranged from 4 to 578, with study periods ranging from 1 to 117 years. The number of authors in the included studies ranged from 1 to 23.

Methodological Quality Assessment

The summary of the methodological quality assessment results of the studies examined according to the AMSTAR tool is provided in *Fig. 1*. The AMSTAR score for 79 SR/MA studies ranged from 4 to 11, with a median of 9.00. One study (1.3%) was rated as "low," twenty-seven studies (34.2%) were rated as "moderate," and fifty-one studies (64.6%) were rated as "high" according to the methodological quality. For 84 SR, the final AMSTAR score ranged from 2 to 11, with a median value of 7.00. Twelve (14.3%) of these SR studies were rated as low, fifty-eight studies (69.0%) were rated as moderate, and 14 (16.7%) studies were rated as high quality. As for the 44 MA studies, the final AMSTAR score ranged from 1 to 11, with a median value of 7.00. Twelve (27.3%) of SR were rated as low, twenty-one (47.7%) of these were rated

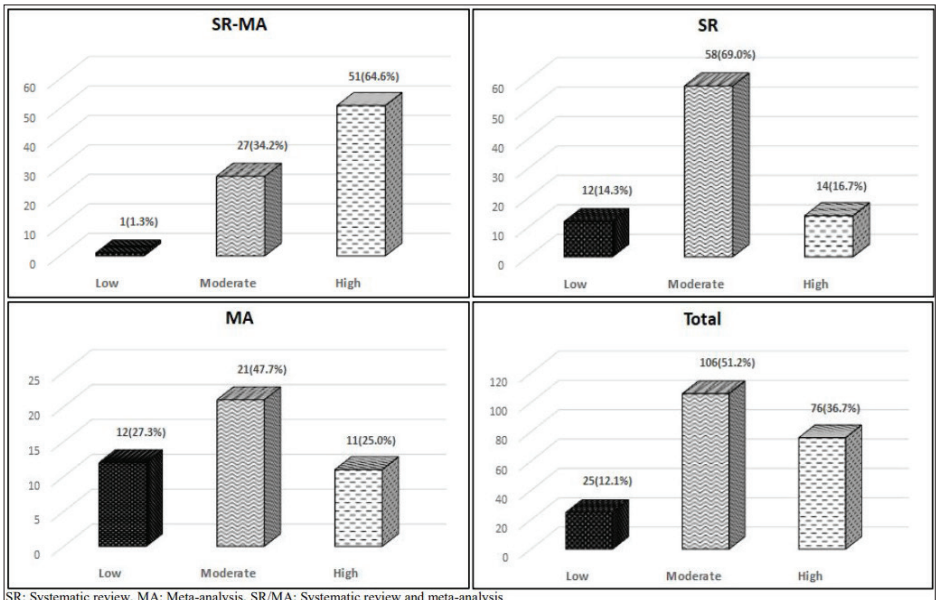

Fig 1. Quality assessment results according to AMSTAR of included studies published in veterinary journals between 2016 and 2021

Table 3. *Question content of AMSTAR [18] and summary of quality assessment criteria for included studies published in veterinary journals between 2016 and 2021*

Item	Status	SR (n=84)		MA (n=44)		SR/MA (n=79)		Total (n=207)	
		n	%	n	%	n	%	n	%
1. Was an 'a priori' design provided?	Yes	61	72.6	29	65.9	62	78.5	152	73.4
	No/not applicable	23	27.4	15	34.1	17	21.5	55	26.6
2. Was there a duplicate study selection and data extraction?	Yes	43	51.2	13	29.5	59	74.7	115	55.6
	No/not applicable	41	48.8	31	70.5	20	25.3	92	44.4
3. Was a comprehensive literature search performed?	Yes	78	92.9	34	77.3	79	100.0	191	92.3
	No/not applicable	6	7.1	10	22.7	0	0.0	16	7.7
4. Was the status of publication (i.e., grey literature) used as an inclusion criterion?	Yes	70	83.3	23	52.3	71	89.9	164	79.2
	No/not applicable	14	16.7	21	47.7	8	10.1	43	20.8
5. Was a list of studies (included and excluded) provided?	Yes	72	85.7	33	75.0	72	91.1	177	85.5
	No/not applicable	12	14.3	11	25.0	7	8.9	30	14.5
6. Were the characteristics of the included studies provided?	Yes	66	78.6	33	75.0	69	87.3	168	81.2
	No/not applicable	18	21.4	11	25.0	10	12.7	39	18.8
7. Was the scientific quality of the included studies assessed and documented?	Yes	41	48.8	18	40.9	50	63.3	109	52.7
	No/not applicable	43	51.2	26	59.1	29	36.7	98	47.3
8. Was the scientific quality of the included studies used appropriately in formulating conclusions?	Yes	44	52.4	10	22.7	52	65.8	106	51.2
	No/not applicable	40	47.6	34	77.3	27	34.2	101	48.8
9. Were the methods used to combine the findings of studies appropriate?	Yes	7	8.3	29	65.9	73	92.4	109	52.7
	No/not applicable	77	91.7	15	34.1	6	7.6	98	47.3
10. Was the likelihood of publication bias assessed?	Yes	2	2.4	22	50.0	52	65.8	76	36.7
	No/not applicable	82	97.6	22	50.0	27	34.2	131	63.3
11. Was the conflict of interest stated?	Yes	61	72.6	34	77.3	64	81.0	159	76.8
	No/not applicable	23	27.4	10	22.7	15	19.0	48	23.2

SR: Systematic Review, MA: Meta-analysis, SR/MA: Systematic review and meta-analysis

as moderate, and eleven studies (25.0%) were rated as high quality. For the total of the studies reviewed (n=207), AMSTAR scores ranged from 1 to 11, with a median of 8.00. Twenty-five (12.1%) of these studies were rated as low quality, 106 (51.2%) were rated as moderate quality, and 76 (36.7%) studies were rated as high quality.

The question contents of AMSTAR and the frequency distribution with percentages are given in *Table 3*. The comparison results and descriptive statistics of the AMSTAR quality scores given jointly by the two researchers according to the study characteristics are shown in *Table 4*. The results are reported separately for SR, MA, and SR/MA, as well as for all studies. As shown in *Table 4*, AMSTAR quality scores were higher for MA with fewer than five authors than studies with five or more authors (P=0.009). Similarly, SR with fewer than five authors had higher AMSTAR scores than studies with five or more authors (P=0.028). Considering the total results, the AMSTAR score of the articles published in journals with an impact factor of 2.67 or more was higher than the studies in journals with an impact factor of less than 2.67 (P=0.018). AMSTAR scores did not differ between the groups formed in other evaluation criteria.

The total AMSTAR score differs significantly between study types (P<0.001). Only the difference between SR and MA was not significant (P=0.869).

Discussion

In the current study, we evaluated the methodological quality of the systematic reviews and meta-analyses published in veterinary journals with the AMSTAR tool. Within the scope of this study, 207 systematic reviews and meta-analyses studies were found suitable for this research. The main features of the reviewed studies were examined. More studies were published in 2021 than in any other publication year; the current research presents up-to-date data. In terms of the index, most of the studies were included in SCI-expanded indexed journals. This

Table 4. *Comparison of results of AMSTAR quality scores according to the characteristics of the included studies published in veterinary journals of the Clarivate group between 2016 and 2021*

Study Characteristics	SR (n=84)			MA (n=44)			SR/MA (n=79)			Total (n=207)		
	n (%)	Median (min-max)	P-value	n (%)	Median (min-max)	P-value	n (%)	Median (min-max)	P-value	n (%)	Median (min-max)	P-value
Publication year												
2016-2019	41 (48.8)	6 (3-9)	0.779	25 (56.8)	7 (1-10)	0.458	31 (39.2)	9 (5-11)	0.131	97 (46.9)	8 (1-11)	0.102
2020-2021	43 (51.2)	7 (2-11)		19 (43.2)	7 (1-11)		48 (60.8)	9.5 (4-11)		110 (53.1)	8 (1-11)	
Journal Impact Factor												
< 2.67	39 (47.0)	7 (2-9)	0.521	24 (55.8)	7(1-10)	0.361	25 (32.1)	9 (4-11)	0.599	88 (43.1)	7 (1-11)	0.018
2.67 and more	44 (53.0)	7 (2-11)		19 (44.2)	7 (2-11)		53 (67.1)	9 (5-11)		116 (56.9)	8 (2-11)	
Number of studies												
< 28	34 (40.5)	7 (2-9)	0.289	31 (70.5)	7 (1-11)	0.959	38 (48.1)	9.5 (5-11)	0.187	103(49.8)	8 (1-11)	0.268
28 and more	50 (59.5)	6 (2-11)		13 (29.5)	7 (3-9)		41 (51.9)	9 (4-11)		104 (50.2)	8 (2-11)	
Funding support												
Yes information	42 (50.0)	6 (2-11)	0.337	22 (50.0)	7 (1-10)	0.813	27 (34.2)	9 (4-11)	0.962	91 (44.0)	7 (1-11)	0.097
No information	42 (50.0)	7 (2-9)		22 50.0)	7 (1-11)		52 (65.8)	9 (5-11)		116 (56.0)	8 (1-11)	
The research period of included studies												
< 21 years	44 (52.4)	7 (3-9)	0.221	22 (50.0)	7 (1-10)	0.794	33 (41.8)	9 (5-11)	0.368	99 (47.8)	7(1-11)	0.051
21 years and more	40 (47.6)	7 (2-11)		22 (50.0)	6 (1-11)		46 (58.2)	9 (4-11)		108 (52.2)	8 (1-11)	
Number of authors												
< 5	40 (47.6)	7.5 (2-9)	0.028	22 (50.0)	8 (1-11)	0.009	28 (35.4)	9 (4-11)	0.356	90 (43.5)	8 (1-11)	0.451
Five and more	44 (52.4)	6 (2-11)		22 (50.0)	5 (1-10)		51 (64.6)	9 (5-11)		117 (56.5)	7 (1-11)	
Total score	84	7 (2-11)[b]	-	44	7 (1-11)[b]	-	79	9 (4-11)[a]	-	207	8 (1-11)	<0.001*

*SR: Systematic Review, MA: Meta-analysis, SR/MA: Systematic review and meta-analysis; *Kruskal Wallis test result*
Different letters on the row indicate the difference between study types for the total AMSTAR score

means that most of the studies were published in high-quality journals.

Researchers prefer different tools in studies to methodologically evaluate the quality of systematic reviews and meta-analyses. While Buczinski et al.[20] used AMSTAR and PRISMA, Toews [21] used only seven items of PRISMA related to literature search reporting features. Vriezen et al.[11] used only AMSTAR 2 (an enhanced version of AMSTAR consisting of 16 items) to assess the studies' quality. There are studies in which the AMSTAR tool was used outside the field of veterinary medicine [7,9,22]. In these studies, different tools were used together with AMSTAR. AMSTAR is widely used as a valuable tool to evaluate the quality of systematic reviews and meta-analyses conducted in any academic field and is an open tool that can be used without special consent. Since this tool's calculation and interpretation of methodological quality scores are more transparent and understandable, AMSTAR was preferred in this study.

In this study, according to the evaluation results obtained with the AMSTAR tool for SR, it has been observed that the number of studies that meet item 9 ("Were the methods used to combine the findings of studies appropriate?") and item 10 ("Was the likelihood of publication bias assessed?") were low *(Table 3)*. The studies that provided information on items 9 and 10 were 8.3% and 2.4%, respectively. These low numbers indicate that the statistical methods for combining and evaluating the individual study results for heterogeneity and publication bias tests were not performed or reported insufficiently in the SR examined. Contrarily, it was determined that the items related to the comprehensive literature search (item 3), the status of publication used as an inclusion criterion (item 4), and the list of studies provided (item 5) were reported in most of the SR examined. The large number of studies providing these items indicates that the authors tend to provide explanatory information, especially on literature review, inclusion criteria, and a list of included (and excluded) studies. For MA studies, the number of studies that met item 2 ("Was there a duplicate study selection and data extraction?") and item 8 ("Was the scientific quality of the included studies used appropriately in formulating conclusions?") were low. To ensure item 2,

there should be at least two independent data extractors, and a consensus procedure for disagreements should be in place. However, it was found that there was only one evaluator in most of the examined MA or that consensus procedure information was not reported for two or more evaluators. Similarly, the results of the methodological rigor and scientific quality considered in the analysis and the review's conclusions required for item 8 were poorly reported in MA. The number of MA that met items about literature search (item 3) and conflict of interest (item 11) was high. For SR/MA, it was observed that most of the items examined were reported often. The item related to the literature search (item 3) was even provided in the SR/MA. It means that at least two electronic sources were searched, and the information reported in all SR/MA included years, keywords, and databases. The least met item in the SR/MA was item 7 (63.3%), where information about the scientific quality of the included studies assessed and documented is reported. SR/MA mainly provides the relevant AMSTAR items, suggesting that writing these studies is better.

In the 207 studies reviewed, we observed that the item related to publication bias (item 10) was reported the least (36.7%), and the item related to literature search (item 3) was declared the most (92.3%). Insufficient reporting of item 10 revealed in the general evaluation was also seen in SR. The low number of studies that meet item 10 indicates that using graphical representations or statistical tests to evaluate publication bias is low, especially in SR. The reporting rates of the item related to the comprehensive literature search (item 3) were high for SR, MA, and SR/MA, as well as in the general evaluation. Of the 79 SR/MA reviewed, 11 (13.9%) fully provided all AMSTAR items. This result was seen in only one SR (1.2%) and one MA (2.3%). Of all the evaluated studies, 6.3% scored total points on the AMSTAR tool.

The AMSTAR quality scores significantly differed between the studies for SR only and MA only, based on the author number being fewer than five or more. All studies (n=207) showed a significant difference in AMSTAR scores between the journal's low or high-impact factors. The higher AMSTAR score of journals with a high impact factor compared to journals with a low impact factor may indicate that SR/MA studies are better reported in these journals. While the quality of 64.6% of the SR/MA was high, 69.0% of the SR only and 47.7% of the MA only were moderate. For the 207 articles, the overall quality was moderate with AMSTAR *(Fig. 1)*.

When the studies that methodologically evaluated the quality of systematic reviews and meta-analyses are examined, these studies seem to focus on whether the items of the quality assessment tool were generally met. Data are commonly expressed in these studies as frequencies (n) and percentages (%). Quality scores have been calculated only in a limited number of studies conducted. When the features' results were examined in the current study, the scores obtained for SR/MA did not differ statistically between the specified groups. This result means that the quality scores of the SR/MA examined do not vary based on the study characteristics.

Systematic reviews and meta-analyses are powerful and essential tools used in veterinary medicine to summarize available information, predict treatment effects more precisely, and make evidence-based decisions [5]. Accurate, transparent, and complete reporting of the systematic reviews and meta-analyses is essential and increases the methodological quality. The number of studies that evaluate the quality of systematic reviews and meta-analyses in veterinary medicine is limited. Vriezen et al.[11] assessed the quality of systematic reviews and meta-analyses examining preventive antibiotics designed to prevent disease in farm animals. In another study, Buczinski et al.[20] evaluated the quality of systematic reviews and meta-analyses available for bovine and equine veterinarians. In addition, Toews [21] examined the quality of meta-analysis studies published in veterinary journals between 2011 and 2015. Sargeant et al.[23] have similarly examined the completeness of reporting in published systematic animal health reviews with some PRISMA items.

The current study examined the quality of systematic reviews and meta-analyses published in veterinary journals. As a main result of this study, we found that the SR/MA in veterinary journals were generally of moderate quality; however, some information was reported insufficiently. These deficiencies vary according to the type of study. It was determined that the information about publication bias in SR and the evaluation of the scientific quality of the included studies in MA and SR/MA were underreported. Writing and publishing systematic reviews and meta-analysis studies with critical methodological deficiencies or flaws may cause researchers to misunderstand and misinterpret these studies. An excellent systematic review and meta-analysis should include a comprehensive and critical discussion of the results and be reported fully and transparently. Studies that methodologically evaluate the quality of systematic reviews and meta-analyses will increase the quality of these studies in veterinary medicine. Additionally, this study may help to raise awareness of the AMSTAR tool and highlight deficiencies in the current conduct and reporting of systematic reviews and meta-analyses. Thus, such studies may guide researchers and veterinary healthcare professionals in clinical decision-making.

In conclusion, the reporting quality of the studies was good, but generally, there was insufficient information

on assessing publication bias. It is essential to report systematic reviews and meta-analyses thoroughly and transparently to improve the quality. It is recommended to use the relevant procedures and evaluation tools in performing this type of study. This comprehensive research evaluates SR, MA, and SR/MA studies on animal health in veterinary medicine, both individually and as a whole, according to their types, with the AMSTAR assessment tool. What distinguishes this study from other similar studies is that it examines systematic review and meta-analysis studies on all animal subjects, not just a specific animal group. In addition, not only frequency values were obtained for the findings obtained with the tool used to determine the quality of the studies, but also a quality score was calculated and the studies were classified according to these scores.

Availability of Data and Materials

The data that support the findings of this study can be available from the corresponding author upon reasonable request (E. Uzabacı).

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Competing Interests

The authors declared no conflict of interest.

Ethical Approval

The data for this research were collected from online databases, so this study does not require any ethical permission.

Author Contributions

EU: Conception and design; EU, FEC: Acquisition of data; EU, FEC: Analysis and interpretation of data; EU: Writing the manuscript; EU, FEC: Final approval of the article.

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