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Veterinary echocardiographers' preferences for left atrial size assessment in dogs: the BENEFIT project☆

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Abstract *Introduction/objectives:* Veterinary echocardiographers' preferences for left atrial (LA) size assessment in dogs have never been systematically investigated. The primary aim of this international survey study was to investigate

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The preliminary data of the study were presented in abstract form at the 31st European College of Veterinary Internal Medicine-Companion Animals Online Congress on September 3, 2021.

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Cardiomyopathy

echocardiographers' preferences for LA size assessment in dogs. The secondary aim was to investigate echocardiographers' preferences for assessing LA size in subgroups based on geographic, demographic, and professional profiles.
Animals, materials, and methods: An online survey instrument was designed, verified, and distributed globally to the veterinary echocardiographers.
Results: A total of 670 echocardiographers from 54 countries on six continents completed the survey. Most echocardiographers (n = 621) used linear two-dimensional (2D)-based methods to assess LA size, 379 used subjective assessment, and 151 used M-mode-based methods. Most commonly, echocardiographers combined linear 2D-based methods with subjective assessment (n = 222), whereas 191 used linear 2D-based methods alone. Most echocardiographers (n = 436) using linear 2D-based methods preferred the right parasternal short-axis view and indexed the LA to the aorta. Approximately 30% (n = 191) of the echocardiographers who performed linear measurements from 2D echocardiograms shared the same preferences regarding dog position, acquisition view, indexing method, and identification of the time-point used for the measurement. The responses were comparably homogeneous across geographic location, training level, years of performing echocardiography, and type of practice.
Discussion/conclusion: Most veterinary echocardiographers assessed LA size in dogs using linear 2D echocardiography from a right parasternal short-axis view, and by indexing the LA to the aorta. The respondents' preferences were similar across geographic, demographic, and professional backgrounds.

Abbreviations

2D	2-dimensional
Ao	aorta
LA	left atrium, left atrial
MM	M-mode

Introduction/objectives

Assessment of left atrial (LA) size plays an important role in establishing diagnosis and prognosis, grading disease severity, and timing of treatment in dogs with cardiac disease [1—5]. Echocardiographers can evaluate LA size qualitatively (subjectively) and quantitatively (objectively) using one-dimensional (M-mode, MM), two-dimensional (2D), and three-dimensional echocardiographic techniques, and various methods have been suggested for this purpose [6—9]. Multiple factors may influence how veterinary echocardiographers assess LA size, including the modalities available in the ultrasonographic system, the level of experience and training features, and personal preference for using specific methods [10,11].

Expert groups have created and disseminated recommendations for standardizing the methodology used to quantify cardiac chambers in humans [12,13], but no similar recommendations currently exist in veterinary medicine. Investigators have proposed reference intervals for specific echocardiographic methods assessing LA size in dogs [8,9,14—19], which might, in part, reflect the variation in assessment between echocardiographers rather than between methods. A lack of consistency in assessments could negatively impact the assessment of disease severity and prognosis, as well as how published clinical study results and expert treatment guidelines are interpreted and implemented.

Prior to proposing actions to address these concerns, an essential first step is to quantitatively investigate the variability of echocardiographic assessment of LA size in dogs. The gloBal caninE and feliNE leFt atrIal sIze assessmenT (BENEFIT) project is an international research collaboration aimed at exploring how veterinary echocardiographers assess LA size in dogs and cats, which may provide useful information for future work to improve echocardiographic LA size assessment in dogs and cats. The American Society of Echocardiography and the European Association of Cardiovascular Imaging have surveyed echocardiographers to examine potential sources of inter-observer variability in echocardiographic assessments and to

identify potential discrepancies between recommendations and everyday clinical practice [20—24]. These studies aimed to identify differences and similarities in how echocardiographers and centers perform clinical imaging, in order to address challenges in complex areas and further improve guidelines and recommendations in the future [21,25,26]. Although it is widely acknowledged that veterinary echocardiographers use a variety of methods and have different preferences for assessing LA size in dogs, the extent of this variation has, to our knowledge, never been investigated systematically.

The primary aim of this prospective study was to investigate echocardiographers' preferences concerning LA size assessment in dogs, including echocardiographic techniques (MM, linear 2D, area-based, volume-based, and subjective assessment) and methods (positioning of the dog, acquisition views, indexing methods, and identification of the time-point used for the measurement). The secondary aim was to investigate echocardiographers' preferences for assessing LA size in subgroups based on geographic, demographic, and professional profiles.

Animals, materials and methods

An English-language survey instrument was constructed and validated using recognized principles [27—31], and it was deployed using an online platform[i]. The survey design process is depicted in Supplemental Table A. Respondents were instructed to participate only once, and the survey could only be accessed once, using the same device. All respondents participated anonymously. There was no incentive provided to respondents other than contributing to the development of knowledge. The period of collection of responses was September 18th to November 1st, 2020. Respondents were asked to answer questions based on their situation prior to the COVID-19 restrictions. Respondents who were no longer in clinical practice were asked to answer questions based on their past practice.

Study enrollment

Inclusion criteria: individuals who performed, or had previously performed, echocardiogram in dogs.

Exclusion criteria: individuals who did not meet the inclusion criteria and those who provided contradictory responses (e.g. respondents who stated, in an initial question, that they performed echocardiogram in dogs, or that they used a specific echocardiographic technique, but then stated the opposite in a subsequent question).

Survey instrument

The 134 survey questions were divided into three parts (Fig. 1). Respondents were directed to relevant subsequent questions according to their answers to the preceding questions; thus, they were not required to respond to all the questions. Most questions (129/134) were mandatory and were primarily formatted as multiple-choice questions comprising both single- and multiple-answer possibilities. Respondents could provide free-text answers if their option was missing from the listed response options. Five optional questions were open-ended. The questions in Parts 1 (12 questions) and 3 (16 questions) were for all respondents. Respondents who performed echocardiogram in both dogs and cats were directed to all questions in Part 2 (106 questions); respondents who only performed echocardiogram in dogs or cats were directed to the relevant questions in Part 2 (53 questions). The filter questions and illustrations were designed to reduce misconceptions regarding animal species and technique of use for each question. The survey question stems, associated answer alternatives, and illustrations are reported in Supplemental Document I.

PART 1: general background of respondents. Questions related to respondents' geographic, demographic, and professional profiles in echocardiography.

PART 2: techniques/methods of echocardiographic assessment of left atrial size in dogs. Questions included in part 2.1 were related to the following echocardiographic techniques: (1) subjective assessment, (2) MM, (3) linear 2D, (4) area, and (5) volume. Respondents were asked to specify their most commonly used technique(s) for assessing LA size (multiple answers were possible) and were then directed to relevant questions regarding their technique(s) of choice to share details. Questions in part 2.2 were related to respondents' opinions of their technique(s)/method(s) of choice.

PART 3: self-assessment regarding echocardiographic preferences and training. Questions were related to the respondents' preferences regarding echocardiography, echocardiographic experiences, and their level of training.

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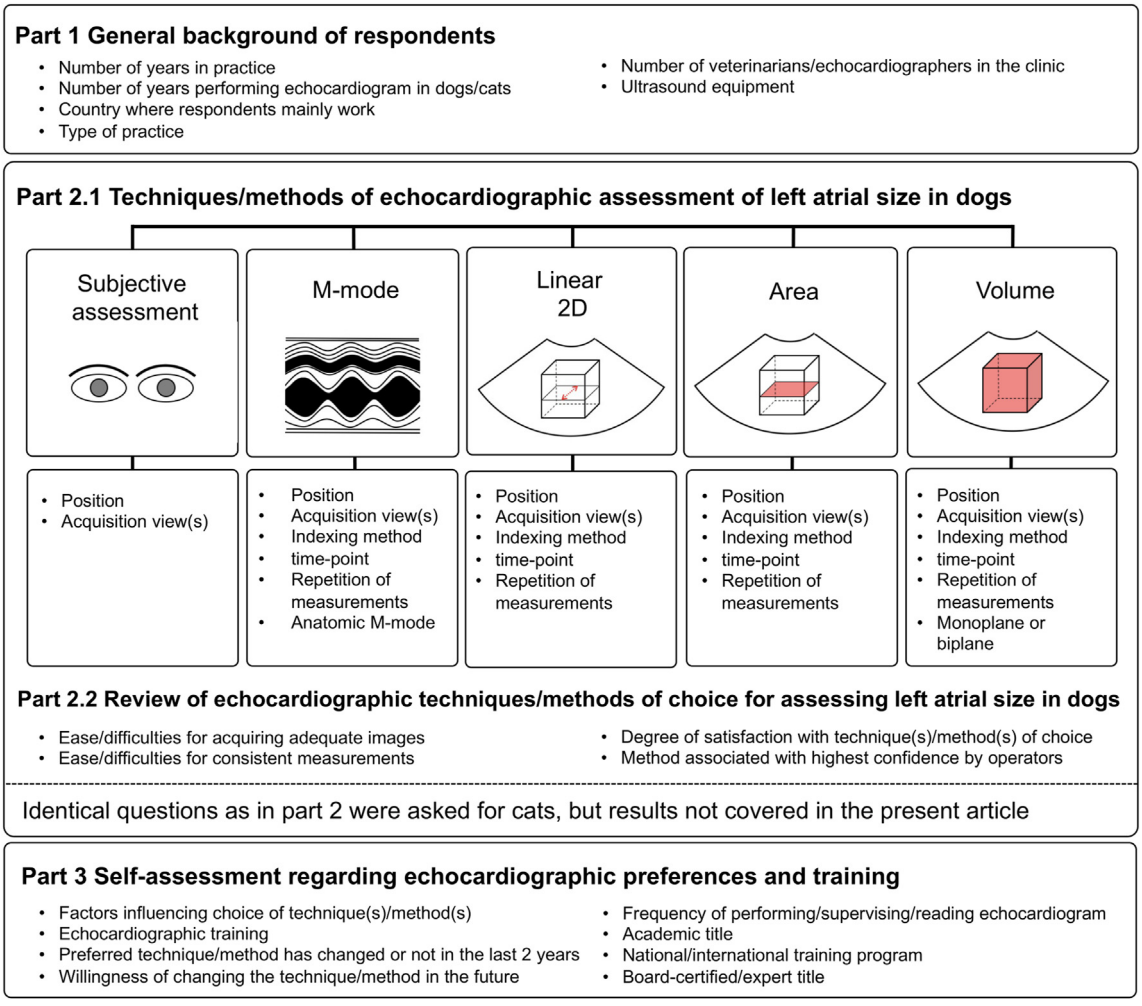

Figure 1 Survey construction and overview of questions. Illustrations correspond to the five different echocardiographic techniques evaluated in the survey. See Supplemental Document I for further details about the survey questions and answer alternatives. 2D: two-dimensional.

Pretest verification

A 3-phase pretest was performed in the survey design process (Supplemental Table A) using the modified Delphi method [32]:

Phase 1: a group of subject-matter experts (n = 9), consisting of board-certified cardiologists and researchers working in academia or private clinical practice, from Canada, Sweden, Taiwan, the Netherlands, and the United States, reviewed the survey instrument with the goal of identifying perceived flaws and limitations, and stating recommended changes. Revisions were made according to the comments received.

Phase 2: a reference group (n = 12), consisting of echocardiographers who regularly performed echocardiography in dogs and cats, but who were not working in academia and were not board-certified cardiologists, and who worked in various fields of veterinary medicine (cardiology, diagnostic imaging, emergency and critical care, and internal medicine) in different countries and territories (Australia, China, Hong Kong, Japan, Singapore, Sweden, the Netherlands, the United States, and Zambia), tested the survey. Most echocardiographers (9/12) in the reference group were non-native English speakers. Revisions were made according to the comments received. The subject-matter experts involved in Phase 1 were not eligible to participate in Phase 2.

Phase 3: the survey was tested and amended again by nine subject-matter experts prior to the survey distribution.

Data collection

Veterinary echocardiographers were invited to participate in the study, which was distributed through

the following channels: (**1**) Chairpersons of national veterinary organizations and key-opinion leaders of veterinary internal medicine/cardiology associations in 34 countries; (**2**) American and European Colleges of Veterinary Internal Medicine, Cardiology ListServe, hosted by the Veterinary Information Network. The subscribers of ListServe include veterinarians globally who had voluntarily registered to receive ListServe emails because of their interest in veterinary cardiology and include all American and European College of Veterinary Internal Medicine cardiology diplomates and candidates, as well as other interested veterinarians; and (**3**) international cardiology virtual congresses. Reminders were sent out after 14 and 30 days in groups (**1**) and (**2**).

Statistical analysis

Descriptive analyses of the survey results were performed. The response counts and percentages were calculated.

Results

A total of 949 individuals provided responses, of which 702 (74.0%) completed the survey. Entries from 32 respondents were considered invalid and were excluded (Fig. 2). The results described below are from responses provided by the 670 respondents. Respondents (n = 3) from one country reported that

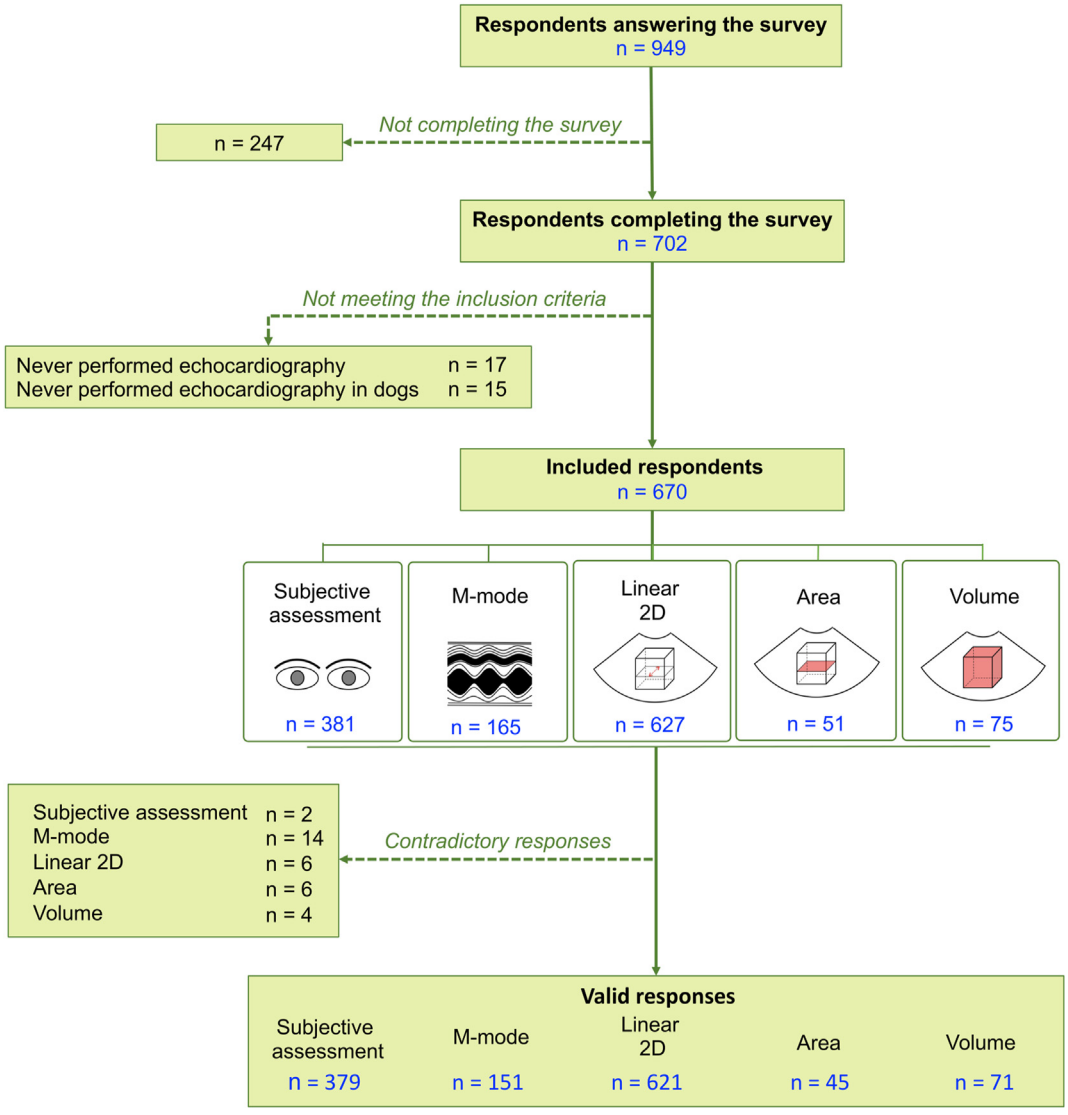

Figure 2 Flow chart demonstrating the process of extracting valid survey responses. Contradictory responses for an echocardiographic technique led to exclusion of survey responses for that particular technique, whereas the remaining responses from these respondents were retained. 2D: two-dimensional.

the survey link could not be opened without access to VPN in their country.

Geographic, demographic, and professional profile

Echocardiographers providing responses worked in 54 countries on six continents (Fig. 3 and Supplemental Table B). The demographic and professional profiles of the respondents are presented in Supplemental Figure I. Most echocardiographers (n = 644/670, 96.1%) reported that they performed echocardiograms regularly in the 12 months preceding the survey (or portion of 12 months excluding COVID-19 restrictions, as relevant). In general, respondents with longer experience in echocardiography performed and supervised/taught more echocardiographic examinations and read more echocardiograms per week compared to respondents with fewer years of experience (Supplemental Figure IB). Twenty-four % (n = 164/670) had been trained in an international specialty training program (e.g. ACVIM/ECVIM/Asian College of Veterinary Internal Medicine, AiCVIM), 22.5% (n = 151/670) in a national specialty training program, and 2.7% (n = 18/670) in both a national and international specialty training program. Respondents had mostly learned to perform echocardiograms from echocardiography courses (n = 428/670, 63.9%) and/or were self-taught (n = 302/670, 45.1%). Approximately half of the respondents (n = 317/670, 47.3%) were the only echocardiographers who regularly practiced echocardiography at their workplace.

Preferences for echocardiographic approach for LA size assessment in dogs

The respondents most commonly used the linear 2D technique (n = 621/670, 92.7%) when assessing LA size, followed by the subjective assessment (n = 379/670, 56.6%), and the MM technique (n = 151/670, 22.5%) (Fig. 4A). Most commonly, respondents combined the linear 2D technique with subjective assessment (n = 222/670, 33.1%), followed by the linear 2D technique alone (n = 191/670, 28.5%), or by combining the MM technique, linear 2D, and subjective assessment (n = 68/670, 10.1%) (Fig. 4B). Most respondents (n = 512/670, 76.4%) trusted the linear 2D technique the most when assessing LA size.

Quantitative assessment

Linear two-dimensional

Most of the 621 respondents (n = 470/621, 75.7%) who assessed LA size using a linear 2D technique preferred to acquire images with dogs positioned in right lateral recumbency and using the right parasternal short-axis view (Fig. 5). Similarly, most respondents preferred indexing the LA dimension to the aortic (Ao) dimension, using 2D echocardiographic guidance for timing the

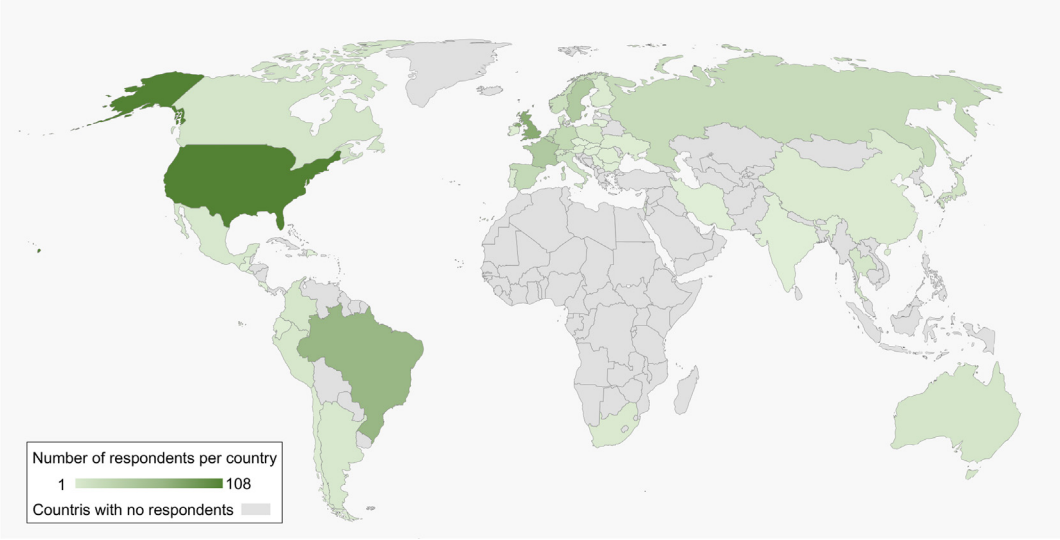

Figure 3 Geographic distribution of 670 veterinary echocardiographers spanning 54 countries. Detailed information of geographic location of the respondents are reported in Supplemental Table B.

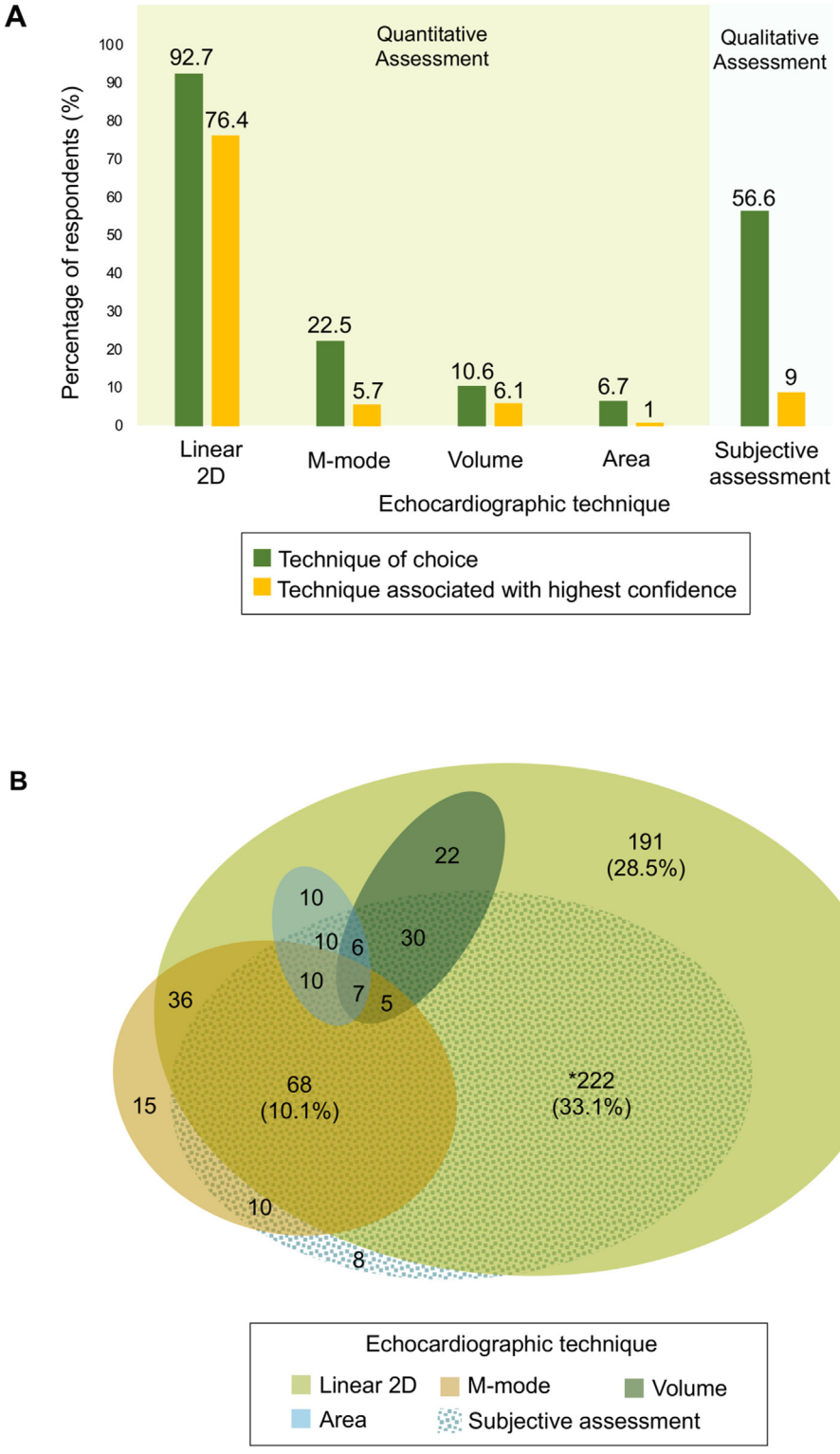

Figure 4 An overview of the veterinary echocardiographers' preferences for left atrial size assessment in dogs (n = 670), showing **(A)** the most commonly used (multiple-choice) and trusted (single-choice) echocardiographic technique for the purpose, and **(B)** the different approaches for assessing the left atrial size. Respondents that used other echocardiographic techniques (n = 17) and other combinations (n = 3) were not included in (B). The size of the areas in (B) are approximately in proportion to the actual number of the responses for each technique, and the numbers represent the number of the responses for each method and the combination of techniques. *222 echocardiographers combined linear technique and subjective assessment when assessing LA size in dogs.

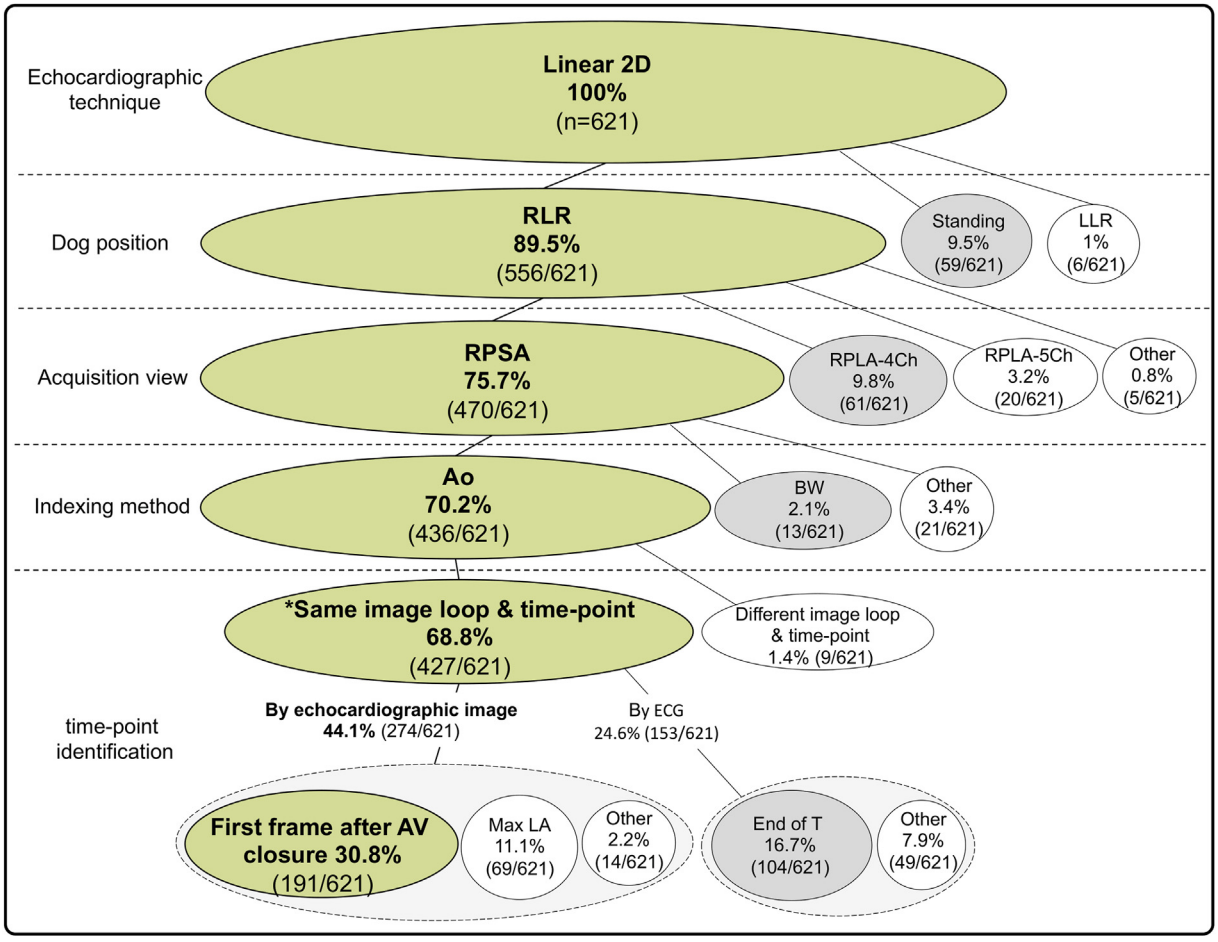

Figure 5 Linear 2D preferences for assessment of the left atrial size in dogs based on responses from 621 veterinary echocardiographers. Questions regarding dog position, acquisition view, indexing method and time-point identification for measurements had single discrete options for responding. The answers with the most (green) and second most (gray) responses in each layer are marked. The branch was only extended from the answers with most responses in the previous question. Answer alternatives receiving less than 2% of the responses for the linear 2D method were grouped as 'other'. 2D: two-dimensional; Ao: aorta; AV: aortic valve; BW: body weight; LLR: left lateral recumbency; RLR: right lateral recumbency; RPSA: right parasternal short-axis view; RPLA-4Ch: right parasternal long-axis four chamber view; RPLA-5Ch: right parasternal long-axis five chamber view. *The respondents used the same image loop (acquisition view) and time-point for both Ao and LA dimensions for LA size assessment.

measurement by identifying the first frame after aortic valve closure. Of the respondents using the linear 2D technique, 30.8% (n = 191/621) had identical preferences regarding the position of the dog during the examination, acquisition view, indexing method, and identification of the time-point used for the measurements. Approximately two-thirds of these respondents (n = 422/621, 68.0%) acquired replicate measurements over several cardiac cycles and averaged these.

M-mode

Most of the 151 respondents (n = 69/151, 45.7%) who assessed LA size using a MM technique preferred acquiring images with dogs positioned in right lateral recumbency, using the right parasternal short-axis view (Supplemental Figure II). Half of these respondents (n = 76/151, 50.3%) used anatomic MM. Most respondents preferred indexing the LA dimension to the Ao dimension, using echocardiographic guidance for timing the measurement of these two structures. To measure the Ao dimension, most respondents identified the time-point on the MM showing two Ao cusps. To measure the LA dimension, most respondents identified the time-point on the MM showing the maximal LA size. Few respondents using MM (n = 8/151, 5.3%) had identical preferences regarding positioning of the dog, acquisition view, indexing method, and identification of time-point used for the measurements. Approximately two-thirds of these respondents (n = 100/151,

66.2%) acquired replicate measurements over several cardiac cycles and averaged these.

Volume

Most of the 71 respondents (n = 26/71, 36.6%) who measured LA size using the biplane Simpson's modified method of discs preferred to acquire images with dogs positioned in left lateral recumbency and using the left apical four-chamber and two-chamber views (Supplemental Figure III). Similarly, most respondents preferred indexing LA volume to body weight, using 2D echocardiographic guidance for timing the measurement by identifying the last frame before mitral valve opening. Of these respondents, 43.7% (n = 31/71) acquired replicate measurements over several cardiac cycles and averaged these.

Area

Most of the 45 respondents (n = 16/45, 35.6%) who assessed LA areas preferred to acquire images with dogs positioned in right lateral recumbency and using the right parasternal short-axis view (Supplemental Figure IV). Similarly, most respondents preferred indexing the LA area to the Ao area, using 2D echocardiographic guidance for timing the measurement by identifying the image showing the maximal LA area. Forty-nine percent (n = 22/45) of these respondents acquired replicate measurements over several cardiac cycles and averaged these.

Qualitative assessment

Subjective assessment

Most of the 379 respondents (n = 358/379, 94.5%) who assessed LA size subjectively also assessed it quantitatively (Fig. 4B). Most examined images with dogs were positioned in right lateral recumbency and imaged the LA from both right parasternal short-axis views (n = 277/379, 73.1%) and right parasternal long-axis four-chamber views (n = 265/379, 69.9%) (Supplemental Figure V).

Factors influencing choice of echocardiographic technique/method and respondents' willingness to change methods

Respondents reported being substantially influenced by clinical studies/guidelines/textbooks, echocardiography courses, and supervisors in their preferences for LA size assessment (Fig. 6).

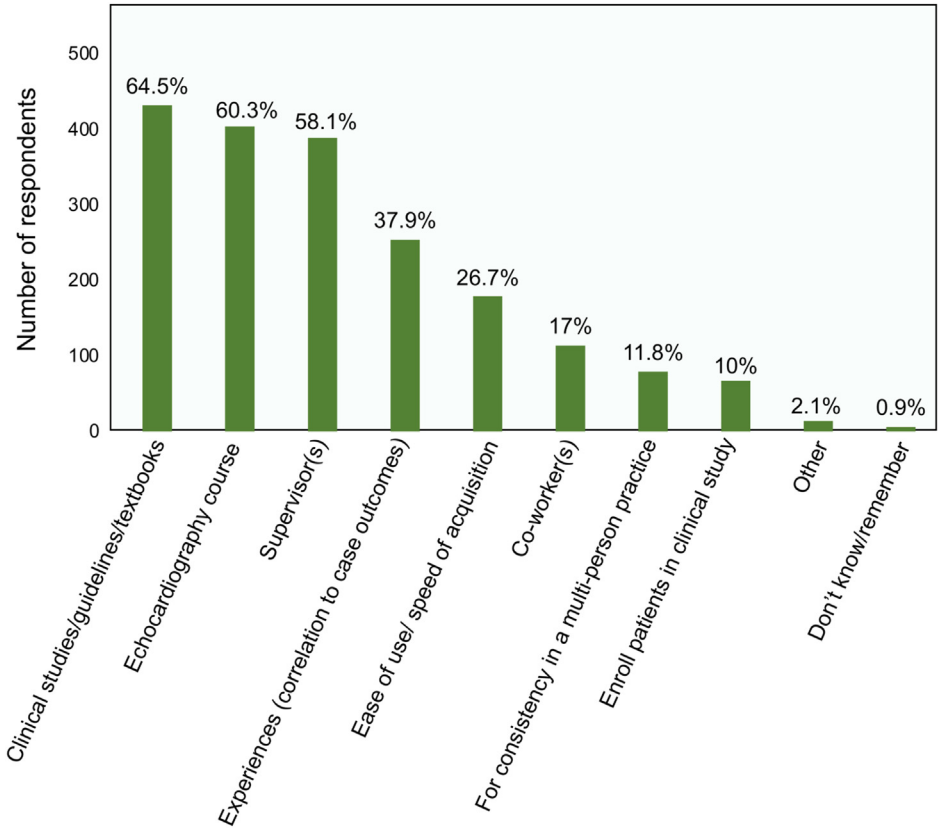

Figure 6 Factors that had impacted the 670 veterinary echocardiographers' preferences for left atrial size assessment in dogs.

Echocardiographers' preferences were comparably similar across the groups based on geographic location, level of training, years performing echocardiography and type of practice, as shown in Supplemental Figures VI, VII, Table C, and D. Most respondents stated that they were willing to change the method of assessing LA size in the future (Supplemental Table C).

Discussion

To our knowledge, this study represents the first, and currently the only, large-scale investigation examining how veterinary echocardiographers with a variety of training backgrounds evaluate LA size. The present survey instrument, constructed using scientifically tested methods with rigorous validation, sampling from academia and practice, and from 54 countries, generated a large volume of data that showed veterinary echocardiographers' preferences concerning LA size assessment in dogs. Most veterinary echocardiographers assessed LA size in dogs using linear 2D echocardiography from a right parasternal short-axis view and indexing the LA to the Ao. However, despite the apparent agreement for this imaging plane, only approximately one-third of those who used a linear 2D technique shared the same preferences regarding dog position, acquisition view, indexing method, and identification of the time-point used for measurement. Additionally, most echocardiographers combined their objective assessment with a subjective estimate of LA size. We found that the respondents' preferences were similar across geographic, demographic, and professional backgrounds.

More than 90% of echocardiographers assessed LA size in dogs using a linear 2D technique with or without another technique. Most echocardiographers who used a linear 2D technique assessed LA size from a right parasternal short-axis view and indexed the LA dimension to the Ao. Only 13% of the respondents used a right parasternal long-axis view, regardless of dog positioning. This view was more frequently used by echocardiographers working in North America and/or academia and by respondents with more than 20 years of echocardiographic experience and/or being international specialists. The overwhelming preference for estimating the LA:Ao ratio from a right parasternal short-axis view may be related to a wealth of published studies in which this method has been used [2–5,33,34], along with the ease of acquiring an image that includes both the Ao and the LA in the same view. The Ao short-axis dimension has been widely used for normalizing LA size, presumably because few diseases in dogs change the Ao size, and because it is not influenced by body condition score [14]. The American College of Veterinary Internal Medicine consensus guidelines for staging and treating myxomatous mitral valve disease, which is the most prevalent heart disease in dogs, recommend using the right parasternal short-axis method [35,36]. Such recommendations likely influenced the preference of echocardiographers. The method has, furthermore, been reported to be more sensitive at detecting LA enlargement than MM-based estimates [15], and it has, in several studies, been demonstrated to be one of only a few variables that consistently shows a high prognostic value in dogs with heart diseases [1–4]. Even though the lateral LA wall may, in some cases, be more readily identified in the right parasternal long-axis view, comparably few respondents used this method.

Approximately one-third of the respondents using a linear 2D technique reported relying solely on this technique when assessing LA size in dogs, again presumably reflecting a high confidence in linear 2D-based methods, whereas the other two-thirds preferred to combine various techniques, most commonly with subjective assessment. Respondents identified subjective assessment as the second most trusted technique according to the results in the self-assessment part of the study. However, most respondents trusted quantitative measurements more. More than half of the respondents assessed the LA subjectively, but almost none reported using this technique alone. Even though subjective assessment appeared to be a popular approach for evaluating LA size, its utility and performance in the hands of veterinary echocardiographers is currently unknown. Respondents trained in international specialty programs subjectively assessed LA size more frequently than respondents with other backgrounds. A possible explanation for this finding might be that the echocardiographers who have undergone international specialty training in cardiology have received extensive practical supervised training, and, thus, have gained more experience leading to greater confidence in their subjective assessment. In addition, 55% (n = 72/132) of the respondents working in North America were international specialists, which might explain why respondents working in this location favored subjective assessment more than those working in other continents.

Approximately 30% (n = 191/621) of the echocardiographers who used a linear 2D technique shared the same preferences regarding dog position, acquisition view, indexing method and identification of time-point used for the measurement.

Although echocardiographers mostly preferred linear 2D-based methods for assessing LA size in dogs, the specific preferences varied: those who preferred calculating the LA:Ao ratio from a right parasternal short-axis view (n = 436/621, 70.2%) had comparably homogeneous preferences for dog positioning (right lateral). Imaging the dogs in a standing position was more frequently performed by echocardiographers working in Europe and South America compared to those working in other continents. Approximately 80% (n = 364/436) of the respondents who calculated LA:Ao from a short-axis view measured the LA dimension in a similar time phase (ventricular end-systole/early diastole and end of T wave, namely at the maximal LA size), but their preferences for identification of time-point varied substantially. Approximately 45% (n = 191/436) performed the measurement at the first frame after Ao valve closure, which is in agreement with initial studies describing the method [15,16]. One potential explanation for why the rest identified the time-point for measuring the LA dimension differently might be that the active ventricular myocardial motion in systole and early-diastole can sometimes blur the outline of the cardiac structures, including the aortic cusps [19,37]. Another possibility of the observed variation in time-point identification for LA size assessment may be due to non-uniform descriptions and variable recommendations for echocardiographic methods in textbooks [6—9], published literature, and echocardiography courses. Comparably, few respondents prioritized the right parasternal long-axis view for assessing LA size, making it difficult to draw any conclusions about their preference for this technique.

Although approximately one-quarter of respondents used a MM technique for assessing LA size in dogs, few trusted the technique the most. Similarly, few respondents stated that they assessed LA size solely with this technique. No clear pattern was identified when characterizing the respondents who used MM, except that the technique was more frequently used by echocardiographers working in North America, compared to those in other continents, and by echocardiographers not working in academia. The use of MM-based methods for assessing LA size is rarely described in recent literature, which contrasts with the number of echocardiographers who still commonly use this technique. Despite several inherent limitations of this technique [14,15,38,39], possible explanations for its popularity could be high temporal and image resolutions, which are of value for border detection and timing, thereby facilitating appropriate cursor placement when measuring the chamber [40,41], training, and personal habits.

Few respondents reported using volume- or area-based methods to quantitatively assess LA size in dogs. The low numbers made it difficult to draw strong conclusions about these respondents. A comparably high proportion of echocardiographers had confidence in volume-based methods, but a small proportion expressed confidence in area-based methods. Those who used volumetric methods most commonly used Simpson's modified method of discs applied to 2D biplane images for assessing LA size, similar to findings from an echocardiographic survey on cardiac chamber quantification in people [21]. Based on the results of the present study, the three-dimensional technique is not currently widely used for LA volume assessment in dogs. The finding that comparably few echocardiographers assessed LA size using volume- or area-based methods may be explained by the later introduction of these methods in veterinary medicine, the need for specialized equipment with the required software, and that they are more time-consuming and laborious compared to the MM and linear 2D methods. Furthermore, the use of volumetric assessment is presumably also limited by a shortage of reliable reference intervals, and currently, it is unknown which method most accurately estimates the true LA size. Furthermore, the published large clinical trials [3,33,42,43] have hitherto not included volumetric assessment as a major inclusion criterion or primary outcome variable. The absence of methods for estimating LA volume in these trials may have influenced the results of the current study. Finally, no clinical study has shown that more complex 2D and three-dimensional methods are better prognosticators of clinical outcomes than simple linear estimates of LA enlargement [44].

Respondents reported being substantially influenced by clinical studies/guidelines/textbooks, echocardiography courses and supervisors in their preferences for assessing LA size, and most respondents had learned to perform echocardiograms at echocardiography courses and/or were self-taught. This is not surprising, as most respondents were not cardiologists or radiologists who would have had formal extended training. Only approximately one quarter of the respondents stated that ease of use or speed of acquisition influenced their preferences for certain methods. Nearly half of the respondents reported that they were the only person practicing echocardiography regularly at their workplace. These findings highlight the importance of training, continuing education, and guidelines/recommendations for

veterinary echocardiographers and people aspiring to start performing echocardiograms.

Well-designed survey instruments provide a rigorous approach to research with scientifically tested methods to ensure a high-quality process and outcome [31,45,46]. Appropriately designed survey studies in echocardiography can, accordingly, have the potential to identify differences and similarities in veterinary clinical imaging and serve as a valuable base for future work in the area. The method of this study mirrors the approach recently chosen by the European Association of Cardiovascular Imaging for a similar purpose [25].

A limitation of this study was that the results are based on self-reported responses that could not be verified independently. The subjectivity of the respondents' interpretations of certain terms, such as 'regularly performed echocardiograms,' could have introduced inter-respondent variability. The data analyzed and reported were based on all valid responses, and no lower limit of participants for each category of geographic, demographic, or professional profile was set. Another limitation was that, similar to many other published survey studies, no inferential statistics were included because these types of studies are inherently associated with several steps of selection bias and other limitations, making statistical analysis less appropriate [21,47]. The online survey was structured in English, which might have impacted the interpretation and understanding of some of the questions and answer alternatives for non-native English respondents. However, to ensure as little language confusion as possible, we invited 12 echocardiographers (three native and nine non-native English speakers) working in different countries/fields to validate the survey content prior to broad distribution during the study design. We performed several rounds of pretest by echocardiographers of various backgrounds in the 3-phase verification to ensure the quality and validity of the survey data. Only respondents who had access to the internet could participate in the survey, and some respondents reported that access to the survey link was denied in their countries. As the number of respondents in each country could also be affected by how the local chairpersons or key-opinion leaders promoted the survey, the respondents from each country might not have been in proportion to the real number of echocardiographers in a specific country. A further limitation with this study is that the definition of international and national specialist might vary between different countries. In the survey, the specialty-relevant questions and alternatives were phrased attentively, with annotations if possible, and free-text answers were allowed to overcome this issue.

The present study aimed to identify the veterinary echocardiographers' most prioritized echocardiographic method in daily practice for assessing LA size in dogs, and many questions had single, discrete options for responding. Thus, the study could not capture every possible choice if respondents preferred more than one option for response alternatives, or had a nuanced response. Adding more questions could have addressed this limitation, but at the expense of greater length and thus, respondent fatigue [48]. Therefore, the investigators acknowledged this limitation with the understanding that alternatives were not necessarily superior.

Conclusions

Veterinary echocardiographers most commonly used and trusted linear 2D-based methods to assess LA size in dogs. Most preferred to use the right parasternal short-axis view indexed to the Ao in combination with subjective assessment for the purpose. Although these broad preferences were comparably homogeneous across echocardiographers, fewer than one third shared the exact same combination of preferences regarding position of the dog during the examination, acquisition view, indexing method, and identification of time-point used for the measurements. Echocardiographers reported that clinical studies/guidelines/textbooks, echocardiography courses and supervisors exerted the most influence on their preferences for assessing LA size. The respondents' preferences were similar across geographic, demographic, and professional backgrounds. Findings of the present study could have important implications for future work aimed at optimizing and uniforming the assessment of LA size among veterinary echocardiographers.

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Conflict of Interest Statement

The authors do not have any conflicts of interest to disclose.

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Supplementary data

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