Journal of the Society for Cardiovascular Angiography & Interventions 3 (2024) 101287

JSCAI

The official journal of the Society for Cardiovascular Angiography & Interventions

Standards and Guidelines

SCAI Manual of Standard Operating Procedures for Performing Scientific Surveys

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ABSTRACT

The Society for Cardiovascular Angiography & Interventions (SCAI) endeavors to serve the interventional cardiology community, including both clinicians and patients. The SCAI Scientific Oversight Committee is charged with annually reviewing the scientific needs of the membership at large, including survey-based research of the practice patterns and perspectives of SCAI members and stakeholders. This document is intended as a reference by the survey proponents, document writing groups, external collaborators, SCAI representatives, peer reviewers, and anyone seeking information about the SCAI surveys program. The aims of this SCAI document are to: (1) provide a framework for members to develop survey requests that are relevant, feasible, and align with the Society's missions and goals; (2) promote transparency and clarity for the process of performing a survey through SCAI; (3) establish the criteria for evaluating survey requests and provide input on reliable and meaningful design, data collection, and best practices; and (4) facilitate collaboration and communication between the survey committee and members of SCAI to maximize the impact of the findings to the interventional community at large.

Introduction

Survey research collects data from research participants through survey instruments and quantifies the information gathered from respondents regarding opinions, behaviors, and patterns of practice. The advantages of collecting data through surveys include low cost and ability to understand patterns of practice in a variety of areas. Survey methodology has been employed in several disciplines in medicine and public health with broad applications in disease prevalence in epidemiologic studies, health behaviors and disease prevention programs, patient-reported outcomes and assessment of quality of life, economic evaluations of clinical programs, and obtaining feedback from health care professionals about effectiveness and adverse events of therapies. There is a critical need for a valid and reliable approach to these research instruments to obtain meaningful and actionable results.

The Society for Cardiovascular Angiography & Interventions (SCAI) aims to serve the interventional cardiology community at large, including physicians, nurses, medical staff, technologists, and patients. For SCAI, surveys are essential research tools that can: capture information on interventional cardiology practice; address the needs of SCAI members, including as it relates to relationships with hospitals, payors, and government; improve quality of care; promote public health; and advocate for disease prevention and management. In addition, data obtained from a national and/or international representative sample can be used to identify risks and complications from cardiovascular

Abbreviations: SOC, scientific oversight committee.

Keywords: manual; standard operating procedures; surveys.

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https://doi.org/10.1016/j.jscai.2023.101287
Available online 7 February 2024

interventions and develop programs to address those risks. Examples of surveys include those obtained during the COVID-19 pandemic on the perceived risks of myocardial infarction and stroke for patients[1,2] and the impact on interventional cardiology trainees and on cardiac catheterization laboratory practices.[3] Other examples include risks of cardiac catheterization (eg, acute kidney injury),[4] practice patterns in managing multivessel disease,[5] practice and training for structural and valvular heart disease,[6] and transfemoral approach for angiography and intervention.[7] Finally, SCAI has published several surveys regarding the occupational health risks for interventional cardiologists.[8,9] Surveys can be used to guide decision making in health policy and provide a platform for SCAI to engage with its members and provide meaningful improvements that address emerging trends and challenges in practice.

The SCAI Scientific Oversight Committee (SOC) is charged with developing, overseeing, and promoting all aspects of SCAI's scientific and research endeavors. The SOC Survey Subcommittee is charged with defining priority areas for surveys relevant to the practice of interventional cardiology and vetting proposed surveys to ensure that they meet SCAI's quality standards (Central Illustration). Several prior surveys have had significant impact on the contemporary practice of interventional cardiology.[1–9] This document aims to: (1) provide a framework for members to submit survey requests that are relevant, feasible, and align with the society's missions and goals; (2) promote transparency and clarity for the process of performing a survey through SCAI; (3) establish the criteria for evaluating survey requests and provide input on reliable and meaningful design, data collection, and best practices; and (4) facilitate collaboration and communications between the Survey Subcommittee and members of SCAI to maximize the impact of the findings to the interventional community.

Best practices for survey methodology

Who should be surveyed: The target population

Although traditional SCAI surveys have been directed toward SCAI members, the scope of who could be surveyed in SCAI surveys could be broader and include catheterization laboratory nonphysician staff, technicians and allied personnel, administrators, and patients. For some SCAI surveys, the target audience may be extended to other stakeholders, such as other disciplines, and may be deployed in coordination with other societies or institutions. All proposed surveys including surveys from internal (SCAI committee and council-derived concepts) and external (general members, industry, other societies, etc) contributors should be submitted to the Survey Subcommittee via its Staff Liaison for review and approval. An intake questionnaire (Supplemental File) must be completed so that the Survey Subcommittee can assess the aims and scope of any request, identify additional stakeholders or collaborators for review, and determine how the proposed survey should be prioritized.

Determining the goals and objective of the survey

SCAI members interested in creating a survey should draft questionnaire-based instruments in a document that clearly highlights the objective and goals of the survey.

Question structure

A good SCAI survey starts with a clear question that has broad impact on clinical practice, safety and effectiveness of therapeutics, or other relevant areas of cardiovascular interventions.[10] Careful planning when developing the research question is needed to focus on the overarching aim of the survey proposal. The survey may be composed of closed-ended and open-ended questions to gather either quantitative or qualitative data. Having a clearly stated research question and objective will allow appropriate discussions on the mode of survey administration, wording of each question, the choices of response formats and presentation, and techniques to enhance completion rates.[11] When considering these factors, the authors should consider the target population of the study and the available resources within the SCAI organization. Leveraging SCAI's membership database and online survey tools provides fast distribution, access to a large international population of interventional cardiologists, relatively low costs, and the ability to minimize interviewer biases. Although this is a convenient

Central Illustration.
SCAI survey standard operating procedures. SCAI, Society for Cardiovascular Angiography & Interventions; SOC, Scientific Oversight Committee.

Table 1. Definitions and examples in interventional cardiology of different types of validity in survey research.

Type of validity	Definition	Examples
Face validity	How well the survey tool measures what it intends to measure	A simulation training model and how well it resembles catheter manipulation in practice
Content validity	How comprehensive the survey tool covers the issue and exclude unrelated topics	A questionnaire designed to assess the knowledge of an interventional cardiologist on different types of drug eluting stents in practice
Criteria-related validity	How well a new tool compares with the gold standard. Subtypes of criterion-related validity are concurrent validity and predictive validity.	—
Concurrent validity	Both research surveys are conducted at the same time	Comparing a new survey to assess for competency in a procedure concurrently with the gold standard, eg, using peer evaluation. If the new survey correlates well with peer evaluation, the new instrument have concurrent validity
Predictive validity	The new test predicts future results from the gold standard	Using the survey instrument to predict whether the operator would score high on PCI quality metrics are later shown to have high PCI quality metrics in practice
Construct validity	How the instrument measures an abstract concept and requires strong content validity and defined context	An instrument used to assess the quality of life of patients with CAD. The questionnaire is designed to measure different aspects of quality of life such as physical functioning, emotional aspect, and social functioning

CAD, coronary artery disease; PCI, percutaneous coronary intervention.

method for survey research, concerns regarding confidentiality of survey respondents, type of software program used for data distribution and collection, low response rate, targeting cardiovascular professionals primarily limited to interventional cardiologists, and required web connectivity are issues that have been raised.[10]

The language used to create the research question should be clear and understandable to a wide audience of participants, avoiding abbreviations, acronyms, interventional cardiology jargon, and overly technical terms. The use of long and complex sentences may impair readability, as can the use of incomplete or ambiguous sentences. Occasionally, an additional sentence may be required to clarify the meaning and relevance of the question being asked. The answers in the research tool should be clear and interpretable to the target audience.[12] The use of closed-ended questions is encouraged because these provide a standardized response that can be quantified and analyzed systematically. However, the prudent use of open-ended questions may provide accuracy and granularity.[12] A long list of response options can lead to fatigue among survey participants and dilution of responses. The use of "other" with an accompanying text box can provide means to limit extensive response options while keeping the important choices in the stem of the question. Finally, the time needed to complete the survey influences the completion rate. Surveys that take more than 10 minutes to complete should be avoided; limiting the number of questions enhances the completion rate. The ability to return to the survey questionnaire to complete it at a later time by the participants may improve completion rates, and this can be achieved using more contemporary survey software packages.

Type of questions

The questions included in SCAI surveys are generally grouped by theme to increase readability. Within these groups, each question is categorized according to the type of response. The list of answer choices can be binary (eg, Are you a current SCAI member? Yes/no), nominal (eg, What is your subspecialty? Coronary, structural, peripheral, adult congenital, and pediatric congenital), ordinal (eg, How often do you use transradial access for coronary angiography? None of the time, some of the time, most of the time, and all time), or continuous (eg, annual procedure volume). For nominal lists, the answers should not overlap and should provide exclusive means to obtain the best information from respondents. Care should be taken to avoid vague terms such as "fair," which can have a different meaning to different respondents. Additionally, the term "not applicable" may sometimes be needed as the absence of this choice might force a respondent to provide an answer that may not be correct. To minimize respondent fatigue, the list does not need to be exhaustive, and the use of "other" with a text box should be encouraged. When ordinal responses are used, the list takes the form of an order or rank like a Likert scale.[13] The list of ordinal responses should also be reasonable and not exhaustive. For continuous variables, defining the range of answers is important to identify and exclude nonsensical responses or errors in entry.

Reliability and validity of surveys

The reliability of the survey instrument refers to its ability to capture consistent information over time.[13] A survey is considered reliable when administered to the same participants at different times and then yields the same answers, minimizing "measurement error." The validity of the surveys, on the other hand, is the degree to which a survey measures what it intends to capture.[13] Four types of validity are often discussed including content, face, criterion, and construct validity. A discussion on reliability and validity of survey methods are discussed in Table 1.[12]

Review of the survey proposals

The SOC Survey Subcommittee will review submitted survey applications and vote on whether to approve each request for SCAI resources. Voting will be conducted during subcommittee meetings and, when needed, through electronic polling of committee members. When evaluating proposals, the SOC will consider the following criteria as goals for successful submission: (1) relevance to SCAI's mission and goals; (2) objectivity and effort to avoid biases; (3) transparency of the survey authors' potential conflicts of interest; (4) involvement of expertise from SCAI committees or councils on the writing committee to provide input on the survey instrument and survey products (manuscripts and reports); and (5) consistency in survey and question format across submissions. For example, consistently including standard questions to characterize respondents when repeating previously deployed questions, ensure that longitudinal analyses can be performed, and provide valuable information; (6) appropriate study design to ensure respondents' confidentiality where the respondent's identity including their affiliation is blinded to investigators; and (7) inclusion of all SCAI members as potential survey respondents. Proposals receiving more than 80% of affirmative votes from the Survey Subcommittee will be approved. The number of proposals approved each year will be determined by the Survey Subcommittee and SCAI staff. Depending on the topics to be addressed, the Survey Subcommittee may refer a proposed survey to a relevant council and/or committee for additional expert review and input (eg, Ischemic Heart Disease Council or Education Committee). The reviewing committees/council may augment

Survey Subcommittee perspectives on relevance, timeliness, or other aspects of a proposed survey and offer a recommendation as to whether SCAI should support or not. The Survey Subcommittee may appoint additional representatives to serve as coinvestigators on the survey project to ensure adequate SCAI input, oversight, and co-ownership of the data. SCAI may support surveys in different manners, ranging from providing marketing services (email blast, web posting, and social media promotion), to survey development (formulation of questions), survey hosting, and deployment in an online survey tool. All surveys originating from third party individuals or organizations require SCAI as a cosponsor and a SCAI member as a coinvestigator. The Survey Subcommittee reserves the right to review or streamline survey proposals submitted in a calendar year.

Requirements for SCAI support of surveys

Data collected from each survey will be required to be shared and distributed with SCAI in a confidential and embargoed manner. This means that the data cannot be shared with anyone else until it has been published and that distribution of study data and results will be at SCAI's discretion. SCAI will use the data to help improve understanding of the topic of the survey and may develop clinical guidelines and other resources. Upon completion of the work, support from SCAI must be acknowledged in any publication of data related to surveys. At least 1 and, preferably, 2 SCAI representatives (ideally from the Survey Subcommittee and the most appropriate SCAI council/committee based on the survey topic) must be integrated into the planning and review of the survey. These representatives will help ensure that the survey is designed and conducted in a way that is consistent with SCAI's standards and will also provide feedback on the results of the survey. The SCAI representatives who are involved in the planning and review of the survey must be coauthors on any manuscripts that are published as a result of the survey. This ensures that they have a stake in the publication and that their contributions are properly recognized. After the work is completed, manuscripts resulting from SCAI-sponsored surveys must be reviewed by members of the Survey Subcommittee or their invited designees. This ensures that the manuscripts meet the high standards of the SOC. Possible outlet of the survey results include (1) SCAI-sponsored manuscript; (2) results may be posted on SCAI website; (3) results may presented in a slide set in a SCAI-sponsored presentation; (4) results are used to create an informal or a formal SCAI position statement document; and (5) results published as an author-initiated manuscript (non–SCAI-endorsed manuscript). When these outlets are considered, appropriate approval and oversight from SCAI should be obtained regarding the writing group members, and inclusion of SCAI committee members into the manuscript, and the author's relationships with industry should be documented.

For author-initiated manuscripts, *JSCAI* is recommended as the first choice for manuscript submission. Before submitting to *JSCAI*, the manuscript must be peer-reviewed and approved by the Survey Subcommittee. This vetting process is separate from *JSCAI* peer review and does not guarantee publication. Manuscripts detailing the survey results should include some of the general best practices in reporting the results of the survey, as follows: (1) emphasize the significance of the topic to the interventional cardiology community; (2) outline the methodology used in the survey; (3) highlight the representation of SCAI members in the sample; (4) discuss the generalizability and limitations of the survey tool, which can provide insights into the credibility of the data that are being presented; (5) elaborate on how the data should be interpreted and suggest downstream action plans and appropriate next steps; and (6) address limitations of survey tools and of the study specifically. This general best practices in reporting survey results sets a precedent for high quality future surveys in interventional cardiology.[14] Any survey considered for publication should adhere to robust research principles and offer clear insights into the research questions posed.[14]

All survey proposals should include a plan to maximize respondents and address content edits if required. All SCAI-sponsored surveys can only be disseminated through SCAI-approved portals and all other forms of dissemination need to be approved by SCAI. SCAI reserves the right to terminate, withdraw a survey and/or share publicly its findings. All SCAI-sponsored surveys are proprietary to SCAI and unapproved reproduction in part or full will be considered unlawful.

Survey bias

No survey is completely free of potential bias; when considering surveys, it is important to highlight potential sources of errors in survey research. Definition of each type of bias in survey research is summarized in Table 2.[13,15–17]

Selection bias in survey methods occurs when responders who are selected to take the survey are systematically different from those who did not take the survey, resulting in a sample that is not representative of the target audience.[13] Three types of selection bias are commonly observed in practice including sampling bias, self-selection bias, and no response bias. By default, SCAI surveys are generally targeted or deployed to SCAI members, who may be more engaged in research, education, quality improvement, or advocacy within the interventional cardiology community and may differ from other interventional cardiologists who are not as engaged in the work of their professional society. This introduces sampling bias. Furthermore, SCAI surveys aim to represent the interventional cardiology community but are not representative of all interventional operators in the world. Thus, there is a built-in selection bias when interpreting the results of these surveys. Additional sampling bias can be introduced by design if the questionnaire aims to address a subsegment of SCAI membership. For example, a survey designed to examine transradial access training in interventional cardiology fellowship may have results that are biased against more senior operators who trained before this was an accepted practice. Self-selection bias can be introduced when survey responders self-select to participate and may have different demographics or motivation to participate than those who do not respond.

No response is a major source of bias in survey research and can introduce significant variability in the interpretation of the data.[7] This is particularly important for interventional cardiologists who lead very busy clinical practices with little time devoted to research activities. When the responders and nonresponders differ significantly, the results of the survey can bias the outcomes toward the responders. For example, if the survey is concerned about medical malpractice cases in interventional cardiology, those who experienced a medical malpractice case are less likely to report it. However, nonresponse rate can also be due to inadequate time at computer, busy schedule in the cardiac catheterization laboratory, or excessively burdensome survey instrument with long complex questions and time to complete exceeding 10 minutes. These design issues can be addressed in the research methods when writing the survey instrument. Story and Tait[10] highlight a way of addressing nonresponder bias by comparing the demographics of the study population with those of the target population. If differences exist between the study and target populations, a discussion on nonresponse bias should ensue and include the potential reasons for the lower-than-expected response rate for each instrument.

The way the questions are written may introduce another form of bias and affect the responses in surveys.[17,18] This form of bias is called measurement bias, which can be introduced by the format of the question, wording, the order of in which the responses are presented, and mode in which the survey is being administered.[19] Using words such as "highly innovative" or "clinically useful" may skew the results positively, whereas

Table 2. Types, interventional cardiology examples, and impact of bias in survey research.

Type of bias	Description	Example/impact in interventional cardiology
Selection bias	Occurs when participants in the survey are not representative of the larger population	• Surveying only younger interventional cardiologists about a new procedure might miss insights from more experienced practitioners • For example, a survey obtained from junior interventional cardiologists about the use of a new stent design might reflect the experience of those who were only recently trained, and not those who have been practicing for many years • This could lead to the conclusion that the stent design is more effective than it actually is because the more junior interventional cardiologists may have seen less failure rates or complications, compared with more senior ones
Measurement bias	Systematic differences in the way data are collected, often due to the phrasing, medium, or format of questions	• When asking interventional cardiologist about their satisfaction with a new device the use of words "highly innovative" in the question stem can result in positive responses • Example, "How satisfied are you with the highly innovative new device in practice?" is more likely to get positive responses than a survey that asks, "How satisfied are you with the new stent design?" • This is because the leading term highly innovative suggests that the stent design is a good thing, and respondents may be more likely to agree with that statement
Nonresponse bias	Arises when selected participants do not respond, and these nonrespondents differ in ways from those who did respond	• If older interventional cardiologist, who are less adept with online instruments, do not respond to a postprocedural survey, results might not reflect reality • For example, a survey of interventional cardiologists who were asked about transradial catheterization might only have a response rate of 50% • This means that half of the participants who were selected to participate did not respond • If the nonresponders are more likely to have had complications because they are more experienced with femoral than radial angiography, then the results of the survey might underestimate the true rate of utilization
Social desirability bias	Respondents provide answers they believe will be viewed favorably by others	• An interventional cardiologist might overreport the number of successful procedures they have conducted owing to peer expectations • For example, an operator might be more likely to say that they have a high success rate with a new procedure if they think that their peers will view them more favorably if they do
Recall bias	Occurs in surveys requiring participants to recall past events or experiences. Some may forget, or certain events might be more memorable for some groups	• A cardiologist might misremember the exact rate of utilization of a certain procedure when surveyed months later • For example, an operator might not recall how the rate of using certain procedures, the exact timeline, or outcomes; their estimate might be inaccurate
Confirmation bias	Surveyors structure the survey, consciously or unconsciously, based on preconceived beliefs or hypotheses	• If a researcher believes a specific device is more effective, they might create questions that inadvertently favor that device • For example, a researcher who believes that a new device is more effective than the standard treatment might create questions that are worded in a way that makes it easier for respondents to say that they prefer the new therapy
Acquiescence bias	Refers to the tendency for respondents to agree with any statement, regardless of its content	• When asked, "Would you agree that newer catheter designs are superior?", some interventional cardiologists might agree without critically analyzing the statement • For example, a cardiologist might be more likely to agree with a statement about the superiority of newer catheter designs even if they do not have any personal experience with them • In few instances, giving a neutral middle response might resolve this issue
Anchoring bias	Presenting a certain number or value before asking respondents to estimate a value can make them anchor their response around the presented value	• If informed that "most cardiologists encounter 10 complications a year," a respondent might estimate their own complication rate around that figure. • For example, an interventional cardiologist might be asked to estimate how many complications they have encountered in the past year. If they are first told that the average number of complications encountered by cardiologists is 10, they might be more likely to estimate that they encountered 10 complications as well
Order effects	The sequence in which questions or options are presented can influence responses	• If a list of complications starts with the most severe ones, respondents might report experiencing those more frequently because they are on the top of their mind

the use of words "high risk" or "complications" may result in negative response rates. Similarly, the use of vague words may result in vague answers. For example, how often do you wear a lead cap during long procedures? In this example, the survey should attempt to clarify what counts as a "long" procedure. Responses of "regularly" vs "occasionally" may result uninterpretable answers, but when the answers are improved to "[ ] daily, [ ] only chronic total occlusion percutaneous coronary intervention days, or [ ] only in retrograde CTO percutaneous coronary intervention cases," the inference can be improved greatly.

Social desirability bias is important in interventional cardiology. It is the tendency of the responders to underreport undesirable outcomes. The reasons for such bias can be to describe a practice pattern that pleases an audience or based on the motivation to maintain a positive self-image to the larger audience and avoid embarrassment and repercussions from disclosing undesirable information.[17] Examples of this type of bias include complications related to cardiovascular interventions. When asking "Did you ever have a retroperitoneal bleeding leading to surgery, blood transfusion, or hospital mortality

with transfemoral access for coronary angiography" Yes [ ] No [ ], operators may tend to answer differently, particularly if the response is not anonymized. Similarly, recall bias secondary to distant event may alter the results of the survey when compared with survey reflecting recent events. Confirmation bias may result in inaccurate results when the questions are worded in a way to favor prior beliefs from the investigator. For example, if you survey an older population of interventional cardiologists, they are more likely to have experienced a major complication than a younger population, or if you survey a group performing low risk cases, they may get a lower number of respondents having femoral complications because they are not using large bore access. Other types of biases with illustrative examples are discussed briefly in Table 2.[15]

Statistical analysis

Proper study design includes a statistical analysis plan. A sound statistical plan ensures that the results are analyzed in a way that is reliable, accurate, and valid. The methods should specify how the survey sample will be obtained and whether the conclusions inferred from the results represent their target population. The methods to analyze the data should be outlined in a way that can ensure reliability of the analysis and the consistency of results if the same survey was used to capture longitudinal data over time. For example, having a consistent and reliable analytic plan will ensure that if SCAI redeploys a previous survey, survey data are able to be compared over time.[7,8] Finally, a reliable statistical plan ensures that the interpretation of the data is meaningful, and they are set to answer the research question they intended to ask.

The statistical plan starts with descriptive data analysis, a critical step used to understand the data, identify patterns, and develop hypothesis based on underlying statistics. Measures of central tendency describing the means, medians, and modes can help describe the data along with the spread or dispersion of the data measured by variance or standard deviation. Data can be summarized using tables, graphics, and charts. Tables are generally used to describe the frequency (%) and mean (SD) of the categorical or continuous variable, respectively. Graphics can visualize the data and show distribution of each variable in relation to another variable and identify outliers that may be influential on more advanced analytic methods. Overall, descriptive data analytics helps identify patterns and develop hypotheses that help make better decisions to subsequent inferential statistics.

Inferential statistics allow the investigators to draw conclusions from the data collected as part of the survey instrument. Unlike descriptive statistics, inferential statistics can build predictions or associations using hypothesis testing, confidence interval, and regression techniques to determine the likelihood of certain outcomes. When putting together the statistical plan for a survey project that involves inferential statistics, determination of the appropriate sample size to make reliable inferences should be determined. Power analysis can be used to determine the optimal sample size to measure certain outcomes within a desired confidence limit. For a specific relationship under investigation, the hypothesis should be specified prior to conducting the research at hand. Comparisons between groups can be performed using *t* tests or ANOVA, and correlations and generalized linear regression techniques can be used to assess relationships between variables. Multivariable regression and factor analysis can be utilized if the sample is large enough to address the association of multiple variables including confounding. Finally, assessment of assumptions of some of these models are needed and require an underlying knowledge of applied statistics. Thus, the use of a collaborator with statistical training is encouraged. At the conclusion, investigators will be able to generalize their survey findings.

There are several common pitfalls related to statistical analysis of survey data. Such pitfalls include the overreliance on *P* values to assess for association, ignoring confounding or mediation, using wrong statistical tests, and failure to consider underlying assumptions for statistical testing. Many surveys have missing data which can lead to nonresponse bias (see Table 2 for examples). Data analysis should be performed using software packages, such as R, Stata, or SAS, which ensure reproducibility and transparency. Finally, there is a risk of drawing misleading or incorrect conclusions from survey data, and enlisting the expertise of a statistician or clinician-scientist with quantitative training can ensure that issues related to choosing the correct statistical test, evaluating underlying statistical assumptions, and interpretation of such tests is properly addressed.

In summary, surveys are invaluable in capturing key data on interventional cardiology trends and practices. The journey from survey development to submission and evaluation can be complex. However, this guide aims to simplify the pathway by ensuring that submitted proposals meet the highest standards and facilitating their dissemination via publication in *JSCAI*. These principles set the benchmark for SCAI-endorsed or SCAI-affiliated surveys. Our ultimate goal is to create and promote well-constructed, scientifically sound surveys that delve into the perspectives of interventional cardiology professionals, patients, and general practices, providing stakeholders with actionable, reliable data for informed decision making.

Declaration of competing interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding sources

This work was not supported by funding agencies in the public, commercial, or not-for-profit sectors.

Supplementary material

To access the supplementary material accompanying this article, visit the online version of the *Journal of the Society for Cardiovascular Angiography & Interventions* at 10.1016/j.jscai.2023.101287.

References

1. Grines CL. SCAI consumer survey comparing fear of COVID-19 versus heart attack or stroke (first publish date: September 4, 2020). *Catheter Cardiovasc Interv*. 2021; 97(2):193–194. https://doi.org/10.1002/ccd.29419
2. Shah S, Castro-Dominguez Y, Gupta T, et al. Impact of the COVID-19 pandemic on interventional cardiology training in the United States. *Catheter Cardiovasc Interv*. 2020;96(5):997–1005. https://doi.org/10.1002/ccd.29198
3. Yong CM, Ang L, Welt FGP, et al. Cardiac procedural deferral during the coronavirus (COVID-19) pandemic. *Catheter Cardiovasc Interv*. 2020;96(5): 1080–1086. https://doi.org/10.1002/ccd.29262
4. Prasad A, Sohn A, Morales J, et al. Contemporary practice patterns related to the risk of acute kidney injury in the catheterization laboratory: results from a survey of Society of Cardiovascular Angiography and Intervention (SCAI) cardiologists. *Catheter Cardiovasc Interv*. 2017;89(3):383–392. https://doi.org/10.1002/ccd.26628
5. Tamis-Holland JE, Puvanalingam A, Cigarroa J. Physician practice patterns in managing severe multivessel disease in acute myocardial infarction. *Catheter Cardiovasc Interv*. 2022;99(3):956–959. https://doi.org/10.1002/ccd.30004
6. Herrmann HC, Baxter S, Ruiz CE, Feldman TE, Hijazi ZM. Results of the Society of Cardiac Angiography and Interventions survey of physicians and training directors on procedures for structural and valvular heart disease. *Catheter Cardiovasc Interv*. 2010;76(4):E106–E110. https://doi.org/10.1002/ccd.22703
7. Damluji AA, Nelson DW, Valgimigli M, et al. Transfemoral approach for coronary angiography and intervention: a collaboration of international cardiovascular societies. *J Am Coll Cardiol Intv*. 2017;10(22):2269–2279. https://doi.org/10.1016/j.jcin.2017.08.035

8. Klein LW, Miller DL, Balter S, et al. Occupational health hazards in the interventional laboratory: time for a safer environment. Catheter Cardiovasc Interv. Published online January 4, 2018. https://doi.org/10.1002/ccd.21772
9. Klein LW, Tra Y, Garratt KN, et al. Occupational health hazards of interventional cardiologists in the current decade: results of the 2014 SCAI membership survey. *Catheter Cardiovasc Interv*. 2015;86(5):913–924. https://doi.org/10.1002/ccd.25927
10. Story DA, Tait AR. Survey research. *Anesthesiology*. 2019;130(2):192–202. https://doi.org/10.1097/aln.0000000000002436
11. McColl E, Jacoby A, Thomas L, et al. Design and use of questionnaires: a review of best practice applicable to surveys of health service staff and patients. *Health Technol Assess*. 2001;5(31):1–256. https://doi.org/10.3310/hta5310
12. Slattery EL, Voelker CCJ, Nussenbaum B, Rich JT, Paniello RC, Neely JG. A practical guide to surveys and questionnaires. *Otolaryngol Head Neck Surg*. 2011;144(6):831–837. https://doi.org/10.1177/0194599811399724
13. Fink A. *The Survey Handbook*. Sage; 2003.
14. Fink A. *How to Manage, Analyze and Interpret Survey Data*. SAGE; 2003.
15. Choi BC, Pak AW. A catalog of biases in questionnaires. *Prev Chronic Dis*. 2005;2(1):A13.
16. Westland JC. Information loss and bias in likert survey responses. *PLoS One*. 2022;17(7):e0271949. https://doi.org/10.1371/journal.pone.0271949
17. Sedgwick P. Questionnaire surveys: sources of bias. *BMJ*. 2013;347:f5265. https://doi.org/10.1136/bmj.f5265
18. Schaeffer NC, Dykema J. Advances in the science of asking questions. *Ann Rev Sociol*. 2020;46(1):37–60. https://doi.org/10.1146/annurev-soc-121919-054544
19. Timmons S, McGinnity F, Belton C, Barjaková M, Lunn P. It depends on how you ask: measuring bias in population surveys of compliance with COVID-19 public health guidance. *J Epidemiol Community Health*. Published online October 16, 2020. https://doi.org/10.1136/jech-2020-215256