

Keys to Successful Survey Research in Health Professions Education

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ABSTRACT

Background: Survey research is well suited to measuring the knowledge, behavior, and attitudes of study participants and has been widely used in medical education and pulmonary and critical care medicine research. Although the ease of survey administration via electronic platforms has led to an increased volume of survey publications, improving the quality of this work remains an important challenge.

Objective: To provide an overview of key steps for rigorous survey design and conduct.

Methods: Narrative review.

Results: Conducting survey research begins with a clearly defined research question pertaining to a specified population that is accessible for sampling. Survey investigators may choose to adapt relevant preexisting survey instruments, an approach with the potential for conducting more valid, generalizable, and comparable studies. If a new survey tool is used, more extensive piloting and psychometric analysis of the survey instruments may be needed to assess if they accurately measure the concepts of interest. When administering the survey, the use of appropriate methods for sample recruitment maximizes the chances of a high response rate in a generalizable study population. Finally, when writing up and disseminating survey research, careful attention to reporting guidelines can increase the clarity of survey reports and assist readers in interpreting the results and conclusions.

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Conclusion: With careful attention to study design and conduct, the quality of survey research can be improved and lead to higher impact and more generalizable studies in the fields of medical education and pulmonary and critical care medicine.

Keywords:

surveys; medical education; pulmonary and critical care

Survey research is an important component of social science research and can generate important information about knowledge, attitudes, and beliefs in populations of interest. Over the past two decades, the propagation of easy-to-use web-based tools to design and administer surveys has in part led to increases in survey-based research publications (1). In pulmonary and critical care medicine (PCCM), this has included studies addressing topics in medical education (2–5), the assessment of clinicians' attitudes toward critical care practices (6, 7), understanding the perspectives of patients living with pulmonary diseases (8, 9), and determining factors that can optimize critical care delivery (10, 11). Although the ubiquity of survey-based research in these areas could suggest that surveys are easy to conduct and publish, the quality and reporting of such studies remain challenges for the field (12–15). In this narrative review, we provide an overview of the rigorous design, conduct, interpretation, and reporting of survey research. Throughout, we provide salient examples for medical educators, clinicians, and researchers working in PCCM. In addition to providing guidance on key steps for rigorous survey conduct, we highlight important threats to validity and outline measures to mitigate them.

WHEN ARE SURVEY METHODS THE APPROPRIATE TOOL?

As with any research, the initial and most important step in designing a high-quality

survey study is to start with a well-defined research question (Table 1) (16, 17). The research question and hypotheses should be supported by a detailed literature review from which the theoretical justification for the concepts to be measured (i.e., survey constructs) can be based. After refining the research question, further study design decisions are tailored to answering this query (Table 1). To this end, clarity of thought and purpose around the overarching research question and hypotheses cannot be overemphasized. Iterative refinements of the research question(s) through discussions among the research group, subject matter experts, and population representatives are essential in pursuing meaningful survey research.

Research questions that maximize the benefits of survey methodology involve measuring concepts that can be accurately self-reported by participants, are often not observable by other means, and are amenable to quantitative analysis. When little is known about a complex phenomenon (e.g., what encourages/discourages intensivists from discussing long-term outcomes with patients [18]), survey methods may yield data that are too narrow to assess the myriad inputs that drive complex behavior or attitudes. In these cases, qualitative methods such as semistructured interviews, focus groups, and/or ethnographic observation may be more appropriate tools (19). Such informative work can generate a theoretical basis for creating subsequent surveys that are more likely to measure relevant constructs.

Table 1. Key steps in the rigorous conduct of survey research

Step/Concept	Further Details
1. Define the research question 1a. Generate study hypotheses	Ask a question of importance and interest to the study population, informed by literature review, expert opinion, and target population input.
2. Clearly define the target population	What population does this research pertain to? Delineating this group will drive survey design and sampling strategy.
3. Obtain ethical approval	Does this study need IRB approval? Survey research is often exempt but may not be if the topic is sensitive and/or conducted in a vulnerable population. Consultation and review with the local IRB are required.
4. Develop/adapt survey instrument 4a. Choose, define, and refine survey constructs 4b. Adapt existing instrument if available 4c. Design new survey if no appropriate instrument exists	What concepts (known as constructs) should be assessed? These should be based on a literature review, preexisting theory, subject-matter expert input, and input from the target population.
5. Piloting the survey as component of validation	Pilot the adapted or newly created survey to assess face and construct validity, identify issues with question interpretation, and collect preliminary data on distribution and interquestion correlation of responses.
6. Recruit study participants	Random sampling of participants from a sample frame (comprehensive list of the source population) can yield precise estimates that generalize to the desired target population. Sample-size calculation should drive recruitment targets. Use multiple methods to maximize response rate, which should be tracked.
7. Analyze data	Have a prespecified plan designed together with the study. Consult with a statistician to ensure best practices.
8. Disseminate results	Choose a journal with dedicated interest to the research question/population. Ensure that study reporting criteria (i.e., CROSS guidelines) are followed and reported.

Definition of abbreviations: CROSS = Consensus-Based Checklist for Reporting of Survey Studies; IRB = institutional review board.

A survey-appropriate question in medical education relating to PCCM was exemplified in a study by Steinbach and colleagues, who sought to assess how often PCCM fellowship programs included leadership

training for its trainees and also to measure the perceived importance of such training among fellowship directors (20). This question was identified after recognizing a need to prepare PCCM fellows for leadership

positions, a literature review that revealed that little was known about the current leadership training landscape, and the identification of clear and measurable concepts that could be answered by their study population (i.e., PCCM fellowship directors.)

DEFINING AND SAMPLING THE STUDY POPULATION

Survey research should seek to ask questions that are both important and interesting to members of a target population, and those that research them. In epidemiology, a target population is defined as the group that researchers seek to make inferences about and is specified by elements of persons, place, and time (21). For example, a researcher may be interested in the procedural experience of nonsurgical critical care fellows before the coronavirus disease 2019 (COVID-19) era. A reasonable target population in this case could be U.S.-based pulmonary and internal medicine critical care fellows training in 2019 (5). This population specification includes elements of persons (critical care fellows), place (U.S.-based), and time (training in 2019). Once the research question and target population are clearly specified, investigators must consider whether a representative sample (i.e., source population), can be recruited to participate in the survey (Table 1).

Survey sampling methods are designed to recruit a highly representative sample, known as the study population, in which accurately measured survey constructs yield results that generalize to the target population. The use of rigorous survey sampling methods help mitigate several key threats to the validity of survey research, including “coverage error” (Table 2), in which the recruited sample differs systematically from the target population, and “sampling error,” in which results obtained from the study population do not

generalize to the source population (the pool from which participants were recruited) (16). Although a detailed review of survey sampling is beyond the scope of this article, we point readers to several excellent resources (16, 22, 23), and in the following section we succinctly outline several important facets of these methods.

Random sampling (either simple random sampling or more complex forms with stratification) allows precise estimates of a measure of interest to be made from study populations that are small relative to the target population. In random sampling, each member of a source population has a known probability of being recruited into the study but is otherwise selected at random. This technique relies on having a clearly enumerated “sample frame”: lists that identify all members of a target population. For an example relevant to PCCM, a sample frame may be a resource such as a comprehensive membership list of the American Thoracic Society, through which the membership of this professional society can be studied via random sampling from this frame (24). Inferences made in this randomly selected population should generalize to the target population of interest. Much like in randomized controlled trials, differences in source and target populations should be random and balanced across a large enough study population to yield unbiased outcome measures. This is a powerful technique to reduce the risk of coverage error.

Other techniques, such as census sampling, in which all members of the target population are recruited to the survey, are rarely necessary. In general, census sampling increases the complexity and costs of survey recruitment and provides diminishing returns in terms of larger samples’ improving estimate precision (16, 17). However, census sampling may be used

Table 2. Threats to the validity of survey research and steps to mitigate them

Threat to Validity	Definition	Mitigating Steps
Coverage error	The population recruited (source population) is not representative of the target population.	Use random sampling with a comprehensive sample frame (comprehensive list of target population members). Use sample weighting to create a study population that resembles the target population.
Sampling error	Results from a sample do not generalize to the source population (from which participants recruited).	Use rigorous sampling methods with complete data frames. Prespecify appropriate study power and meet recruitment targets.
Measurement error	The survey question does not accurately measure the study constructs. <ul style="list-style-type: none"> • Researchers ask “leading” questions. • Participants inaccurately recall events. • Participants are hesitant to share information (particularly if sensitive in nature). 	Pilot survey to assess the validity of the questions/constructs, and assess participant–survey interaction. Address these issues in the design phase.
Nonresponse error	Nonrespondents differ from respondents in ways that influence study results.	Maximize response rate through appealing survey design, recruiting methods, and multiple options for survey administration. Track response rate and compare characteristics of respondents vs. nonrespondents (if available).

Concepts as defined by Dillman *et al.* (16).

when a target population is small and well enumerated (e.g., directors of PCCM programs) (25). Notably, in medical education research, there is often a well-enumerated target population. In part because of this, as well as the costs and complexity of random sampling methods, census sampling is commonly used and can be effective (26). Another sampling technique, nonprobability sampling, otherwise known as convenience sampling, can substantially decrease the cost and effort needed to define

a comprehensive sample frame. However, this can introduce a higher risk of coverage error, as the method yields imprecise information about who is and is not being asked to join the study. That being said, nonprobability samples have been used effectively, for example, in surveys recruiting participants from attendees at in-person professional society conferences to answer questions about their membership (27). When confronted with nonprobability samples, researchers and readers should be

aware of threats to generalizability, as it is likely that conference attendees differ in important ways from colleagues not attending these conferences with respect to available time, resources, or interest, to name a few (28).

In planning survey administration, a sample-size calculation should inform recruitment targets. These calculations should account for anticipated response rate and are a crucial piece of the study design. This ensures that the study has the statistical power to provide precise estimates that can be used to make accurate inferences about the source population (hence reducing sampling error). Power calculations should be based on the primary question/hypothesis of interest. Trade-offs between sample size and precision are a component of much of quantitative research, and decisions balancing these trade-offs should be tailored to the needs of the research question.

CREATING THE SURVEY INSTRUMENT

A key threat to validity across many types of survey research is “measurement error,” in which what researchers intend to measure is not represented in the results generated by the survey instruments (Table 2) (16). As such, identifying the right measurement instrument is extremely important (Table 1). To do this, researchers should clearly define and refine the constructs of interest. Preliminary qualitative work with focus groups or semistructured interviews with members of the target population can be particularly useful at this stage (15). There are several comprehensive resources for finding existing survey instruments and these are nicely compiled by several institutional libraries (29, 30). Paired with a careful literature review on the topic of interest, these resources serve as excellent starting places to search for relevant instruments.

When there is a relevant preexisting validated survey tool, the use and/or adaptation of this instrument should be carefully considered. Using previously validated tools can yield greater validity, generalizability, and generates results that may be comparable across studies and as such meaningfully add to a body of literature. Moreover, using or adapting previously validated questionnaires may require less time and material resources compared with designing a new survey instrument, which may require additional validation steps. Although many questionnaires exist, assessing whether prior validations of the instrument of interest were performed in a similar population to the one researchers intend to study is important, as results can be sensitive to differences in populations and contexts (31). Finally, it is recommended that researchers consider copyright availability and possible costs when selecting instruments. For a concise and rigorous example of survey instrument adaptation and further validation relevant to PCCM, *see* Burns and colleagues, who combined preexisting tools assessing measures of clinician burnout and adapted them for use in assessing moral distress and burnout in intensive care unit clinicians during the COVID-19 pandemic (32).

If researchers construct a new questionnaire, the goal is to develop a parsimonious set of questions that accurately and reliably measure the construct(s) of interest. Each question should be clearly written to result in uniform interpretation by respondents and promote interpretation that is consistent with study team intent (16). Questions should be inviting and relevant to encourage respondents to answer each question accurately. There are several high-quality resources that provide guidance for creating survey items (15–17, 33), including resources that specifically address the types of evaluation used in graduate and undergraduate

medical education (31). We recommend that interested readers explore these resources in depth.

Pilot testing is a critical piece of survey validation (Table 1). The goals of pilot testing include ensuring clarity of the survey instructions and questions, optimizing the survey experience for participants, ensuring the feasibility and completeness of data collection procedures, and generating preliminary data on validity and reliability (16, 17). During pilot testing, it can be helpful to have participants think aloud and provide verbal and/or written feedback about their interpretation of questions as well as assess their overall experience with the survey. This process enhances overall survey design, leading to more reproducible and informative results.

Examining the psychometric validity and reliability of a new or adapted survey instrument is an important component of rigorous survey research (34). Validity is defined as the degree to which survey questions measure the desired constructs, while reliability refers to consistency of results each time the survey is given in the same setting with similar subjects (i.e., test-retest consistency) (17). Assessing and optimizing validity and reliability provides an opportunity to minimize measurement error, in which systematic bias from inaccurate or unreliable assessments of the intended constructs is introduced (Table 2). The extent of validation will depend on the study question(s), the novelty of the survey tool, and the resources of the study team. It is important to recognize that psychometric data can be systematically collected during piloting and assessed quantitatively and qualitatively (34). Measures such as Cronbach's α quantify internal consistency, while construct validity can be assessed by comparing results from a new or adapted survey instrument to a preexisting "gold standard"

instrument if available (17). As a qualitative assessment, pilot participants can provide feedback on the survey design and describe their interpretation of the survey questions to ensure that the items are assessing the intended construct.

ADMINISTERING THE SURVEY

A key threat to bias in survey research that can be introduced during the administration phase is "nonresponse error" (Table 2), in which survey respondents differ in important ways from those who do not respond (16). As an example of nonresponse error in curricular assessment in medical education, learners who participate in surveys and/or offer constructive feedback often differ from those who do not participate. This can lead to biased results and subsequent curricular changes that are not responsive to some learner groups (35). Fortunately, there are survey design and administration methods that target maximizing response rate, therefore mitigating the threat of nonresponse error, and these are discussed in the following section.

The mode of survey administration (i.e., self-administered on a web-based platform, in-person interviews, phone based) will determine how survey questions are written, presented, and ultimately experienced by study participants. There are now several widely available web-based resources for disseminating surveys, including the widely used Research Electronic Data Capture and Qualtrics (<https://www.qualtrics.com>) platforms (36). If researchers decide on a web-based platform for a survey, the choice of which platform to use will be institution specific and dependent on study resources. Some advantages of these well-developed platforms include tools for overall quality control and data validation and survey-specific features including branching logic, which uses participant responses to earlier

questions to target/modify subsequent questions, maximizing the ease and relevance of the survey experience for survey takers. Although web-based platforms have become the dominant mode of survey administration, there may be instances in which face-to-face survey administration is advantageous. For example, in a study of patient experiences of chronic illness (including chronic obstructive pulmonary disease) in primary care practices, participants were recruited from waiting rooms (37). Medical education surveys also may benefit from recruitment in classroom settings and lend themselves to having participants fill out the surveys on site (38). In these cases, a paper survey may be an alternative to enhance the ease of participation. Regardless of survey platform, careful attention to how questions appear and how respondents interact with the survey form in its intended mode or modes is critical (16).

Attention to maximizing the response rate starts from the beginning of study design. A survey should be attractive to study participants in terms of overall interest in the study question, the relevance and face validity of survey questions, and the ease of completing the survey (16, 39, 40). Questions should directly relate to the research question, and those that are not needed for the analysis should not be included. In that regard, shorter surveys are generally more attractive to potential study participants and are associated with higher response rates (41). Researchers and staff members can also use several additional methods to maximize response rate, including incentives for participating (monetary or otherwise), the use of multiple spaced reminders for completion, and offering participants alternative modes of completion (e.g., if a participant is not filling out a web-based survey, the research team can offer to complete via

phone directly with research staff members) (16, 41).

Data on the number of participants contacted and number who participate (to calculate response rate) should be assessed whenever feasible. If ethically permissible and allowed by institutional review boards, data on the characteristics of nonrespondents should also be collected. These data can be used to help understand important differences between respondents and nonrespondents, which helps researchers and readers calibrate their interpretation of survey results (Table 2). Although no specific response rate ensures a lack of bias, often proposed thresholds indicating adequate response rate are $\geq 50\%$ and $\geq 70\%$, depending on the topic (17, 39).

ANALYZING SURVEY RESULTS

It is best practice to create a study design and analytic plan tailored to addressing the prespecified research objectives. Consulting with a biostatistician to ensure the appropriate use of analytic methods can aid in that goal. As the study begins, careful attention should be given to data quality through the use of rigorous data management methods, including electronic data capture and data validation (36, 40). Survey responses can take several different forms: binary (yes/no), a Likert scale (strongly agree, agree, neutral, disagree, or strongly disagree), visual scales, and free response, and each of these response types will necessitate different analytic approaches (15). For example, binary questions can be analyzed using simple counts and proportions, whereas surveys using an assessment such as a five-point Likert scale can be analyzed on the basis of a central tendency or binary cutoff, with each approach having benefits and drawbacks (17). If a free-text option for response is

given, a specific plan for analyzing those free-text responses (e.g., content analysis) should be specified. Last, many surveys, particularly those in medical education, may involve longitudinal assessment and/or pre-post designs (e.g., curricular assessment) (42, 43). In these cases, statistical techniques accounting for repeated measures within the same subjects or summary measures that measure differences over time should be used carefully and in consultation with experts in statistics.

Another issue that may arise in surveys using more complicated sampling schemes is the use of individual participant weights. In these surveys, subgroups are sampled with different probabilities, and then the overall sample is weighted to represent the distribution of these subgroups in the population of interest. Specific analytic tools for weighted-survey analysis are needed, and we recommend expert consultation should this be required. Last, as with any quantitative research, it is important to assess patterns of missing data and address with the appropriate methods for handling missingness as relevant (44). Several statistical programs (R; R Foundation for Statistical Computing, Stata; StataCorp LLC., SPSS; IBM Corp., SAS; SAS Institute) have packages that can assist with survey analysis, though as above, ensuring that this is guided by a research team member with the appropriate expertise is critical.

WRITING AND PUBLISHING A SURVEY STUDY

Once the survey and data analysis are completed, the research is ready for write-up and dissemination. Excellent guidance on the writing of scientific manuscripts, with a specific focus on PCCM researchers, exists elsewhere (45). For papers reporting survey research, it is

important (as with any research) to clearly delineate the many important choices made in the design of the study (i.e., clearly stating study question, describing the creation/piloting/validation of survey instrument, defining sampling strategy) as well as presenting a clear and concise description of results, including details on response rates. When presenting the interpretation of results, it is critical that researchers consider limitations in survey research methods and avoid overinterpreting results, such as trying to establish causality, when not appropriate.

The Enhancing the Quality and Transparency of Health Research Network maintains a repository of robust reporting guidelines that can be used to guide researchers in the ensuring the adequate conduct and reporting of their work (<https://www.equator-network.org>). These include the Consensus-Based Checklist for Reporting Survey Studies guidelines, which should be referenced during each phase of the survey research process (design, conduct, analysis, and reporting) to ensure that standards for rigor are being achieved (46). A journal submission will be enhanced by the inclusion of a supplemental table or document outlining how the reported research meets the items included on this checklist.

CONCLUSIONS

Rigorous survey research has the potential to be highly informative in areas of importance for medical education and other topics of interest to the PCCM community. Continued attention to the appropriate design, conduct, and analysis of such studies holds promise for increasing the rigor and impact of such studies.

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