The State of Cardiovascular Resources and Expertise in Echocardiography Nationwide: The Philippine Survey on Echocardiography (The PHIL-SCREEN Study)

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Abstract

INTRODUCTION: Maldistribution of echocardiographic expertise is a relevant issue in an archipelago such as the Philippines. We specifically looked at (1) the nationwide census of physician echocardiographers, cardiac sonographers, and cardiac laboratory managers; (2) their geographic distribution; and (3) background training and laboratory classification.

METHODS: Data from paper and online surveys conducted in 2015 and 2021 were consolidated alongside the existing society database. Surveys (Google Forms; Google, Mountain View, California) were disseminated through a variety of online, social media, and communication avenues and focused on three categories of respondents: (1) physician echocardiographers, (2) cardiac sonographers, and (3) laboratory managers. The main variables of interest included estimated census per category and geographical distribution. Secondary variables included training background and laboratory classification.

RESULTS: In 2021, there were 651 physician echocardiographers, 2487 cardiac sonographers, and 443 cardiac laboratory managers on record, with 86 readers, 405 sonographers, and 101 managers responding to the survey. The majority of the surveyed readers (41.2%), sonographers (48.3%), and laboratory managers (28.2%) were situated in the National Capital Region. Close to half of the readers were level III echocardiographers. The majority of the sonographers (46.7%) were nurses, followed by medical technologists (21.8%) and radiologic technologists (18.9%). Most laboratory managers were in nontraining hospitals (38.2%) or stand-alone facilities (20.9%). The minority were in hospitals with cardiology (18.2%) or internal medicine (22.7%) training programs.

CONCLUSION: Geographical maldistribution of echocardiographic resources is still evident, with the majority of human resources being concentrated in the metropolis. The majority of the sonographers have nursing as their training background, and many laboratory managers are situated in facilities with no established training programs.

KEYWORDS: echocardiography, laboratory, reader, resources, sonographer, survey

INTRODUCTION

The quality of health care in any community is largely dependent on the availability of resources, both human and logistical. This becomes more profound in archipelagic and low- to middle-income settings such as the Philippines where maldistribution of resources is a reality. More so, when matters concerning cardiovascular health are considered, these require timely access to quality care to improve clinical outcomes. Among the various facets of cardiovascular care, cardiac imaging through echocardiography is arguably one of the most relevant and of high impact, as it cuts across a wide spectrum of medical conditions and clinical disciplines.

Cardiovascular conditions remain to be the leading cause of morbidity and mortality not only locally[1,2] but also globally.[3] They also attract a great deal of attention as far as research and investigative efforts are concerned. Unfortunately, though, the bulk of the global cardiovascular research output is contributed by high-income countries.[4] At the local scene, however, no outputs have yet been published specifically reporting resource distribution as far as the field of echocardiography is concerned. It is because of this observation that the Philippine Society of Echocardiography (PSE), in coordination with the Philippine Heart Association (PHA) Council on Echocardiography, spearheaded the very first national survey in echocardiography in 2015 through a joint task force.[5] This was updated in 2021, in line with the society's efforts to determine gaps in care and improve the quality of echocardiographic services in the country.

We evaluated the profile and trends in human and logistical resources in echocardiography across the country. Specifically, we aimed to

(1) Estimate the nationwide census of physician echocardiographers, cardiac sonographers, and echocardiography laboratory managers;
(2) Determine the geographic distribution of physician echocardiographers, cardiac sonographers, and echocardiography laboratory managers using a sample population; and
(3) Profile the physician echocardiographers, cardiac sonographers, and echocardiography laboratory managers according to training and competency, procedural load, and range of services.

METHODS

Study Design and Setting

We looked into the existing records of PSE, which conducted national surveys (cross-sectional studies) of echocardiography at two separate time points (2015 and 2021), primarily looking at physician echocardiographers, cardiac sonographers, and laboratory managers to obtain information regarding geographical distribution, as well as procedural census. We also looked at the society database for accredited training programs in echocardiography. We utilized the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) cross-sectional reporting guidelines[6] as template for this study.

Eligibility Criteria

Each survey focused on three categories of respondents: (1) physician echocardiographers, (2) cardiac sonographers, and (3) laboratory managers. Physician echocardiographers include those who are involved in the performance, interpretation, or observation of various echocardiographic procedures. They were included in the survey if they were Filipino physicians reading either adult or pediatric echocardiograms. According to the Philippine Learning Framework for Specialty Fellows in Adult Cardiology, echocardiography is a core skill of the general cardiologist, who is expected to be competent enough to supervise and interpret this procedure upon graduation from training.[7] Cardiac sonographers include those paramedical professionals who perform ultrasound procedures focusing on the cardiovascular system,[8] which mainly refer to but may not be limited to adult and/or pediatric echocardiographic procedures, in technical compliance with established local or international guidelines.[9] Laboratory managers included either physician or paramedical professionals who carried an administrative or supervisory position at their laboratory during the time of the survey.

Data Sources and Measurement

The main variables of interest included the actual number as well as geographical distribution of physician echocardiographers, cardiac sonographers, and echocardiography laboratory managers. Secondary variables of interest included those concerned with expertise and experience of physicians and sonographers (eg, training background, membership and fellowship in specialty societies, procedural loads, learning strategies, etc) and profiling of laboratory managers (laboratory classification, staffing, caseloads, variety of procedures offered, etc). Variables of interest were obtained through the use of a variety of survey techniques. In 2015, the main method was an online survey using surveymonkey.com (SurveyMonkey, San Mateo, California). This was augmented with the release of paper surveys. In 2021, Google Docs (Google, Mountain View, California) served as the main platform for creation of the online questionnaire, hosted through a unique URL. This URL link was then sent to the target respondents. The online surveys were disseminated through the following strategies: general announcement on the official website as well as social media accounts (Facebook, Twitter, Viber community) of the society and direct email blast to target respondents, based on existing membership database of the society.

A unique Google Forms survey (Google, Mountain View, California; see Appendix) was crafted for each of the three target categories of respondents: physician echocardiographers, cardiac sonographers, and laboratory managers. Each survey form was color-coded and labeled to clearly signify the target population using a title and icon. Each survey collected personal and identifying information from the respondent regarding the following: full name, email address (personal or work email), contact number, name, and mailing address of the main area of practice (cardiac laboratory). Each survey was divided into sections lumping together related questions for easier and more efficient accomplishment of the survey. For surveys intended for physician echocardiographers and sonographers, the sections included contact information and place of practice, range of competency and caseloads, and continuing professional

development (CPD). For the survey on laboratory managers, the sections included contact information and place of practice, staffing and supervision, and laboratory capabilities and caseloads, Each survey contained 17 main questions, uniquely structured depending on the information needed and the most appropriate format applicable. The survey developers exerted effort to ensure that the majority of the questions provided clear and nonoverlapping options. Some came in the form of multiple-choice format, where only one answer was allowed; others were checkbox style, where many answers may be selected; the rest were either in drop-down format (when prespecified answers were made available), linear grid (multiple-choice style for multiple rows with a similar heading), and open-ended questions allowing short free-text answers. Each survey ended with two final questions—one open-ended question on how PSE could further help the respondent in his/her work, and the other a yes-or-no question regarding willingness to receive updates from the society through email. The surveys were pretested by the investigators on selected volunteer members of the organization to check for length, comprehensibility, and user-friendliness.

The use of the Google Forms allowed responses to be captured and then stored in a "cloud" database, which automatically sorts, scales, and scores such data using custom Excel (Microsoft Corp, Redmond, Washington) formulas. This strategy also allowed the investigators to review, track, and download the responses at any point in time. Once public access to the surveys was closed, the investigators viewed all responses individually and in summary format. The Google Forms also automatically presented data in visual bar graphs or pie charts for ease of review and convenience in data presentation. Such graphs were reconciled with actual numbers in situations where some responses may have been misclassified.

Handling of Bias

Cognizant of the potential for sampling bias using a pure online survey, the task force that spearheaded the original survey in 2015 combined online with paper strategies. This was followed up in 2021 with dissemination of the new online survey through various online channels such as email, social messaging applications (individual and community Viber), and posts on the society's official social media platform (Facebook) and website, as well as offline push through phone or text messaging in 2021. Recall bias, where respondents erroneously provide answers based on their ability or inability to recall certain information in the past,[10] and response bias, where certain factors can lead to provision of answers that deviate from their true value,[11] were acknowledged as very possible issues in the survey. These biases were partly mitigated by ensuring anonymity of the respondents upon publication of survey results. Other strategies used to lessen bias include grouping of relevant questions, crafting of straightforward questions, and provision of clear and nonoverlapping options.

Study Size

The study size was arrived at based on preliminary estimation of the projected target population. Based on existing directories of societies and additional information obtained through other strategies, projected targets were obtained for each of the three respondent categories: physician echocardiographers, cardiac sonographer, and laboratory manager. For physician echocardiographers and cardiac sonographers, target numbers were based on the 2015 survey data and updated PSE membership directory. For the cardiac laboratory managers, data from the 2015 laboratory census were cross-referenced with the 2021 cardiac sonographer survey, to note any laboratories. A minimum of 10% of the target population (collectively and per category) was the desired response rate for the study.

Handling of Data and Variables

All responses underwent preliminary screening to check for redundant or unclassified entries. Such responses were also cross-referenced with the existing membership database of the society. For the physician echocardiographer and cardiac sonographer survey, each unique response was counted as one reader or one sonographer. For the laboratory manager survey, multiple entries by one respondent were still accepted provided that they pertained to distinct laboratories. This was quite possible, as some physicians serve as managers in multiple laboratories. To obtain data on census, we combined information obtained from the two online surveys conducted separately in 2015 and 2021, coupled with information gathered by individual members of the society as well as the existing directory or database of the society. Data are presented as absolute numbers. For data on survey response rate, the collective census data served as denominators for the responses in the 2021 survey. To report geographic distribution, the data set from the survey responses was analyzed according to the indicated location of practice, with data being presented as percentages of the surveyed sample. The survey was crafted in a way that responses to all questions were mandatory for completion of the survey. This was done to avoid getting responses with missing data.

Ethical Issues

Because the present study is considered a secondary review of existing data and records of the society, the study authors depended on whatever technical or ethical approvals exist at the time of conduct of the two surveys, if any. Upon review of the two surveys done separately in 2015 and 2021, no ethical approval was obtained. The study authors surmise that this was so in consideration of the minimal potential risk to survey participants, who voluntarily participated and signified electronic consent for use of data for research purposes. Moreover, the study authors think that the past two surveys did not fully satisfy any of the mandatory criteria for ethical approval of survey research.[12] Nevertheless, the authors believe data were collected in an ethical manner. Each online survey indicated a preliminary clause, assuring the respondent that although identifying data will be obtained for record-keeping and cross-referencing purposes, such data will eventually be anonymized in the final report. It also explicitly obtained consent for the use of data for research and advocacy efforts of the organization.

RESULTS

Surveyed Population

In the first survey (May 2015 to May 2016) using a hybrid strategy of online and paper surveys, initial mapping and

projections placed the potential respondents at 2713 (554 physician echocardiographers, 1716 cardiac sonographers and 443 laboratory managers). The overall response rate for the first survey in 2015 was 24.9% (31.8% of physician echocardiographers, 21.1% of cardiac sonographers, and 5.6% of laboratory managers). In the second survey (2021) using mainly an online strategy coupled with existing data from the first survey and updated membership directory of the society, potential respondents were estimated at 3677 (651 physician echocardiographers, 2487 cardiac sonographers, and at least 539 laboratory managers). There were 86 initial physician echocardiographer responses received from August 27 to October 13, 2021; 435 for cardiac sonographers from April 12 to September 4, 2021; and 110 for laboratory managers from March 30 to July 1, 2021. After screening out the redundant or duplicated responses (0 for physician echocardiographers, 30 for cardiac sonographers, and 9 for laboratory managers), the overall response rate for the second survey (Figure 1) was 15.2% (13.1% of physician echocardiographers, 16.3% of cardiac sonographers, and 18.7% of laboratory managers). Curiously, there was one respondent who migrated to another workplace within the survey period, as reflected by her two redundant entries (4 months apart).

Physician Echocardiographers

As of 2021, the estimated number of physicians reading echocardiograms was 651, based on the membership directory of PSE. This number was acknowledged to be underestimated, because not all readers were presumed to be bona fide members of the society. The increase in physician echocardiographers is surmised to be largely due to the increase in training programs producing general cardiologists as well as echocardiography specialists. The number of accredited cardiology training programs increased from 16 in 2015 to 22 in 2021. This likely contributed to the increase in physician echocardiographers. Meanwhile, dedicated echocardiography training programs markedly increased from 5 in 2015 to 14 in 2021 (11 adult, 2 cardiac sonographer, and 1 pediatric echocardiography programs), with the numbers based on programs duly recognized and accredited by PSE.

A total of 86 physician echocardiographers responded to the 2021 survey. In terms of physician distribution (n = 86), all geopolitical regions of the country were represented, with the National Capital Region (NCR) expectedly taking the lion's share at 41.2% in 2021, followed by Central Visayas at 12.8% and CALABARZON (Batangas, Cavite, Laguna, Quezon, and Rizal) at 10.5% (Table 1). Regions that logged in the smallest portion of the pie were Eastern Visayas and Northern Mindanao, all at 1.2%. No respondents came from MIMAROPA (Marinduque, Occidental Mindoro, Oriental Mindoro, Palawan, and Romblon) or overseas. The majority (80%) of surveyed physician echocardiographers were noted to maintain readership status in at least two laboratories, with one-fourth (26.7%) of respondents indicating more than five laboratories. This suggests that the limited human resource is unwittingly trying to keep up with the demand from increasing numbers of laboratories.

With respect to expertise and experience, 41% were in practice for 5 years or less. Fewer than half (44.7%) underwent a dedicated 1-year training program in echocardiography, whereas 29.4% received in-house training and exposure from a physician echocardiographer (Figure 2). More than half (54.1%) of the surveyed readers received fellowship status in PSE. The number of PSE fellows was noted to increase from 200 in 2015 to 362 (304 physicians and 58 sonographers) in 2021.

Of the 86 physician respondents, 89.5% indicated performing/interpreting adult transthoracic echocardiograms, whereas 18.6% mentioned pediatric transthoracic echocardiograms. Among the echocardiographic procedures, exercise echocardiography using arm ergometer was the least encountered, with only 3.5% of respondents having experience in interpreting such a procedure. This was offset by the observation that a substantial proportion of physician echocardiographers were performing/interpreting treadmill (65.1%) and pharmacologic (54.6%) stress

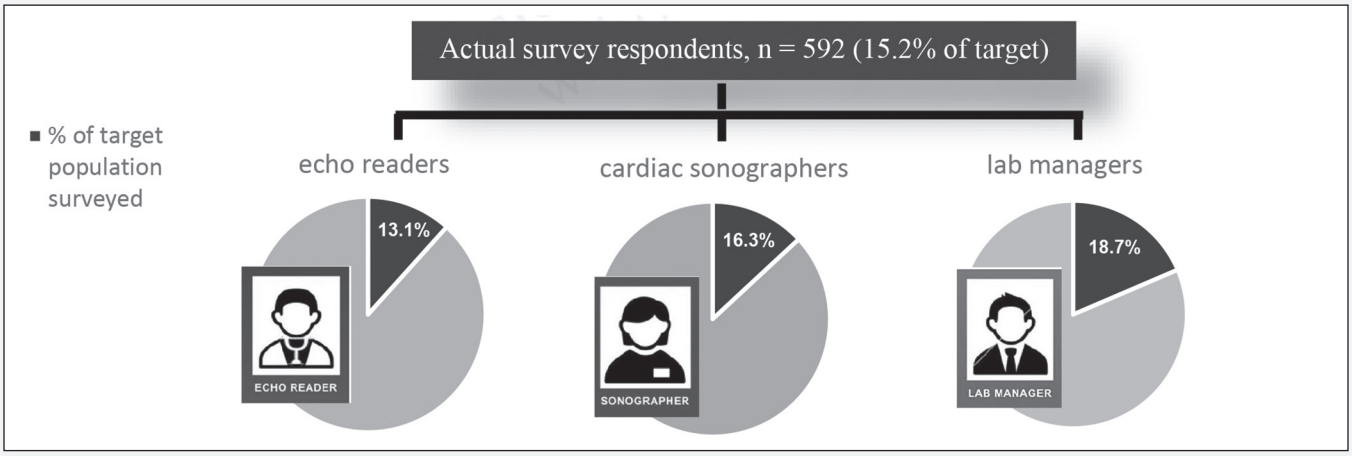

Figure 1. Survey response rates for each category of respondent during the 2021 Philippine Society of Echocardiography survey.

Table 1. Geographical Distribution of Physician Echocardiographers in the Philippines in 2021 (n = 86)

Philippine Region	No. of Respondent Physician Echocardiographers	% of Surveyed Population
NCR	35	40.7
Region 7: Central Visayas	11	12.8
Region 4A: CALABARZON	9	10.5
Region 6: Western Visayas	7	8.1
Region 12: SOCCSKSARGEN	5	5.8
Region 1: Ilocos	4	4.7
Region 3: Central Luzon	3	3.5
CAR	2	2.3
Region 9: Zamboanga Peninsula	2	2.3
Region 5: Bicol	2	2.3
Region 13: Caraga Region	2	2.3
Region 8: Eastern Visayas	1	1.2
Region 2: Cagayan Valley	1	1.2
Region 11: Davao	1	1.2
Region 10: Northern Mindanao	1	1.2
Region 4B: MIMAROPA/Southwestern Tagalog	0	0.0
Overseas	0	0.0
Total	86	100.0

CALABARZON=Batangas, Cavite, Laguna, Quezon, and Rizal; CAR=Cordillera Administrative Region; MIMAROPA=Marinduque, Occidental Mindoro, Oriental Mindoro, Palawan, and Romblon; NCR=National Capital Region; SOCCSKSARGEN=South Cotabato, Cotabato, Sultan Kudarat, Sarangani, and General Santos.

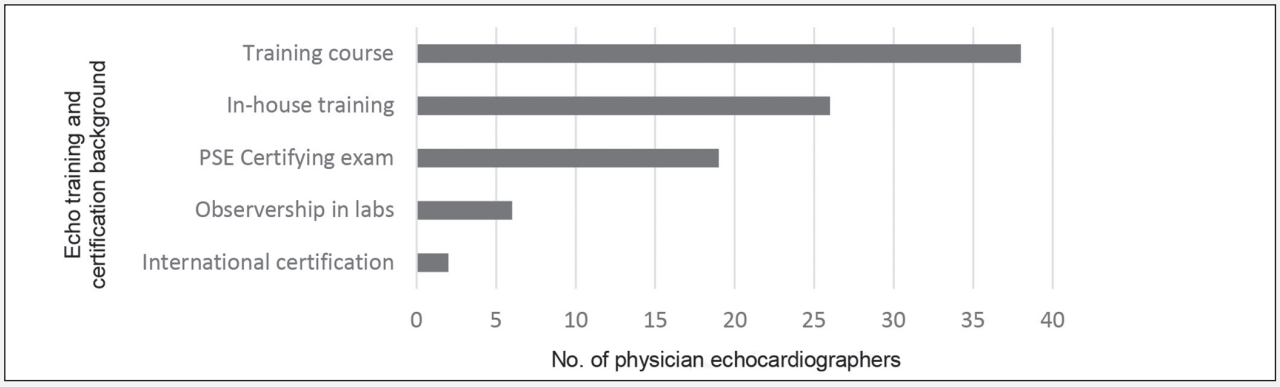

Figure 2. Echocardiography training and certification background of physician echocardiography readers in the Philippines in 2021 (n = 86).

echocardiograms. Transesophageal echocardiography (TEE) was performed and interpreted by 51.2% of physician respondents. Echocardiographic studies done perioperatively or periprocedurally were performed by 55.8% and 44.2% of respondents, respectively. The disparity in availability of various echocardiographic procedures may largely be due to the classification of the echocardiographic laboratory, with majority of readers (84.9%) interpreting studies done at hospital-based laboratories, where special and more advanced procedures are most likely available. The proportion of physicians performing/interpreting special echocardiographic procedures also seems to align with the observation that many of them (69.8%) encounter such procedures in training hospitals (those with local society-accredited training programs in internal medicine

and/or cardiology). On top of echocardiograms, a clear majority of respondents (n = 85) have indicated interpreting other cardiac procedures such as resting 12-lead electrocardiogram (97.6%), exercise electrocardiogram or treadmill exercise test (91.8%), Holter monitoring (85.9%), and ambulatory blood pressure monitoring (81.2%). Approximately one-fifth indicated involvement in performance/interpretation of vascular procedures such as venous thrombosis screening (22.4%), carotid duplex scanning (22.4%), and arterial or venous duplex scanning (21.2%).

All respondents engaged in at least one CPD activity related to echocardiography within the past 3 years from survey date. Almost half (48.2%) engaged in more than five activities, suggesting a high level of motivation for education and professional advancement. This corroborates the fact that a great proportion (91.8%) of the respondents were members of PSE. Interestingly, though, only 85.9% acknowledged being affiliated with the PHA, which is the minimum requirement for eligibility to read and interpret echocardiographic procedures. Only 4.7% indicated membership in international societies in cardiovascular ultrasound or echocardiography. When asked to indicate which clinical cases or imaging aspects they found most challenging as an echocardiographer, the majority indicated congenital heart diseases (69.4%), followed by technical issues/artifacts (45.9%), cardiac masses (29.4%), and ischemic or coronary artery diseases (20%) (Figure 3).

In an attempt to resolve such challenges in the practice of echocardiography, respondents mentioned attendance in PSE-led webinars and workshops as the main strategy (84.7%), followed by direct consultation with colleagues (76.5%) and accessing of other (non-PSE) online educational videos or resources (74.1%).

Cardiac Sonographers

Based on the PSE directory, the estimated number of cardiac sonographers was 2487 as of 2021. Similar to physician echocardiographers, this number is most likely underestimated as well, because not all cardiac sonographers were presumed to be affiliated with the society. This is corroborated by the observation that only 70.4% of the surveyed sonographers (n = 405) acknowledged membership in PSE. Using these estimates, we project that the actual number of cardiac sonographers in the country as of year 2021 could be more than 3000. The increase in sonographer membership from 1716 to 2487 is surmised to be due to the steady enrollment in existing cardiac sonographer training programs in the country, with two being recently accredited by PSE.

A total of 405 responses from cardiac sonographers were included in the analysis for the 2021 survey. In terms of sonographer distribution, all 16 geopolitical regions of the country were likewise represented, but the majority (48.1%) of the sonographers were noted to practice in NCR (Table 2). This was followed by CALABARZON (11.6%), Central Luzon (7.4%), and Central Visayas (5.4%). Regions that logged in the smallest portion of the pie were Bicol (1.2%), MIMAROPA/Southwestern Tagalog and Northern Mindanao (1%), SOCCSKSARGEN (0.7%), and Caraga (0.2%). Sixteen respondents (4%) indicated place of practice overseas. It is interesting to note as well that 143 respondents indicated NCR as their place or origin or residence, but that 195 specified actual practice in this region, implying that a proportion (26.7%) of sonographers in NCR actually originated outside the metropolis.

One-third (158 [39%]) of sonographer respondents indicated main practice in a cardiac laboratory situated in a training hospital with a PHA-accredited cardiology training program. The rest of the sonographers were distributed in the following laboratory categories: Philippine College of Physicians (PCP) training hospital laboratory (69 or 17%), nontraining hospital (100 [24.7%]), and stand-alone clinical laboratory (78 [19.2%]). The majority (62.7%) of surveyed sonographers practiced in only one laboratory, whereas 16.8% maintained practice in two laboratories. A substantial proportion of sonographers (20.5%)

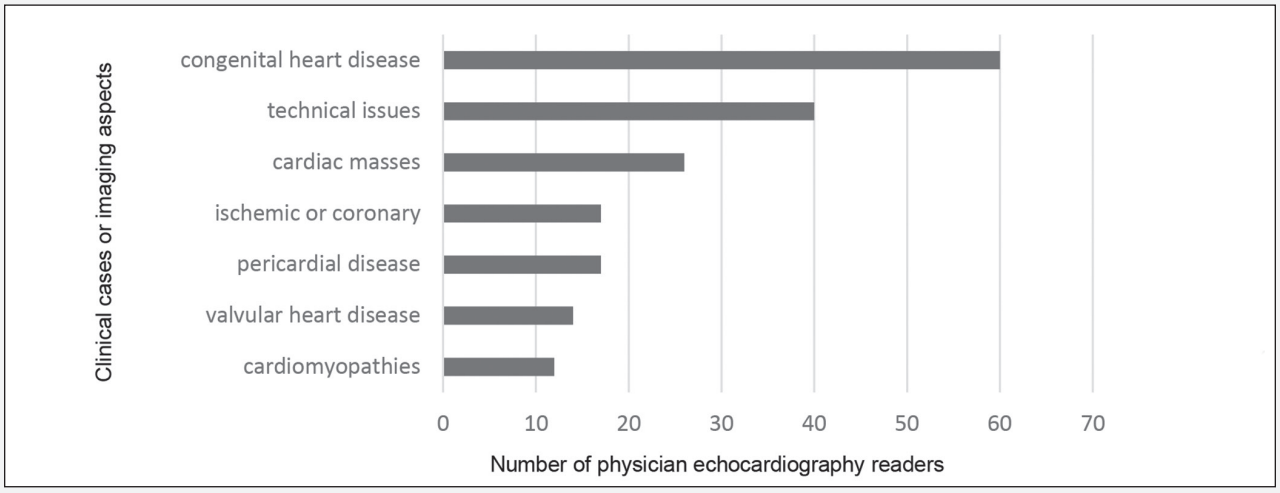

Figure 3. Clinical cases or imaging aspects deemed to be most challenging for the physician echocardiography readers in the Philippines in 2021 (n = 86).

Table 2. Geographical Distribution of Cardiac Sonographers in the Philippines in 2021 (n = 405)

Philippine Region	No. of Respondent Laboratory Managers	% of Surveyed Population
NCR	195	48.1%
Region 4A: CALABARZON	47	11.6%
Region 3: Central Luzon	30	7.4%
Region 7: Central Visayas	22	5.4%
CAR	17	4.2%
Region 6: Western Visayas	16	4.0%
Overseas	16	4.0%
Region 9: Zamboanga Peninsula	12	3.0%
Region 1: Ilocos	11	2.7%
Region 8: Eastern Visayas	8	2.0%
Region 2: Cagayan Valley	8	2.0%
Region 11: Davao	6	1.5%
Region 5: Bicol	5	1.2%
Region 4B: MIMAROPA/Southwestern Tagalog	4	1.0%
Region 10: Northern Mindanao	4	1.0%
Region 12: SOCCSKSARGEN	3	0.7%
Region 13: Caraga Region	1	0.2%
Total	405	100.0%

CALABARZON=Batangas, Cavite, Laguna, Quezon, and Rizal; CAR=Cordillera Administrative Region; MIMAROPA=Marinduque, Occidental Mindoro, Oriental Mindoro, Palawan, and Romblon; NCR=National Capital Region; SOCCSKSARGEN=South Cotabato, Cotabato, Sultan Kudarat, Sarangani, and General Santos.

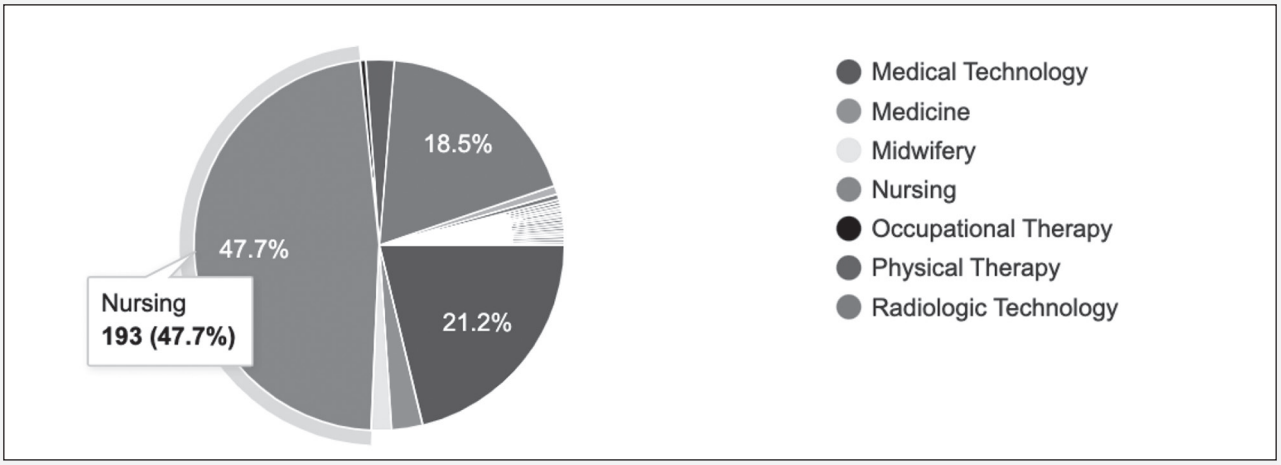

Figure 4. Distribution of cardiac sonographers in the Philippines in 2021 according to training background (n = 405).

mentioned shuffling work between at least three laboratories, with 5.9% indicating practice in at least five facilities. In terms of staffing, 14.6% indicated that they served as the lone cardiac sonographer in their main laboratory of practice.

In terms of postbaccalaureate training background, almost half (47.7%) of the respondents indicated nursing profession (Figure 4). Medical technology was a far second at 21.2%, followed by radiologic technology at 18.5%. The remainder included

medicine (2.7%), physical therapy (2.5%), midwifery (1.7%), occupational therapy (0.7%), pharmacy (0.5%), and respiratory therapy (0.2%).

With respect to years of experience as a sonographer, 0% indicated less than 1 year; 31.6%, 1 to 3 years; and 68.4%, more than 3 years. More than a quarter (26.7%) have been in practice for at least 10 years, with one indicating more than 30 years. Only a little more than half of those surveyed (228 [56.3%]) completed a cardiac sonographer training course, which usually involves at least 3 months of dedicated training in echocardiography. This is considered the minimum requirement for the practice of cardiac sonography in the country. This seems to be offset partially by the various strategies used by sonographers to augment their knowledge and skills, which include completion of the seasonal and mainly didactic-style PSE cardiac sonographer course (25.7%), in-house training with a level 3 echocardiographer for more than 3 years (31.1%), and observership in other cardiac laboratories presumably with no level 3 echocardiographers (17%). Only one-tenth (9.9%) of those surveyed indicated successfully passing the PSE certifying examinations for cardiac sonographers, which is a requisite for fellowship status in the society, something that was attained by the same percentage (9.9%) of surveyed sonographers. A small proportion (4.4%) mentioned being certified by international societies or credentialing organizations in echocardiography (eg, American Registry for Diagnostic Medical Sonography, National Board of Echocardiography, American Society of Echocardiography; Figure 5).

Transthoracic two-dimensional (2D) echocardiography is the bread-and-butter procedure of cardiac sonographers in the country. Interestingly, though, 17 respondents (4%) mentioned only observing but not performing this essential procedure, and 34 (8.4%) admitted not even encountering this procedure at all. The various special procedures were performed by the surveyed sonographers: exercise stress echo—treadmill (63%) and pharmacologic stress echocardiography (43%).

Only a handful have hands-on experience with the alternative modalities for stress echocardiography such as the bicycle (11.6%) and arm ergometer (3.5%). Close to half of respondent sonographers have performed contrast echocardiography using agitated saline (47.4%), whereas 17% indicated being able to perform this procedure using agents for left ventricular opacification. Close to one-third (27.4%) have experience performing perioperative echocardiography presumably through TEE, with 24.9% specifically indicating echocardiograms done for guidance of invasive or transcatheter procedures. More than a quarter (25.7%) indicated being able to assist in adult TEE. A number of sonographers (166 [41%]) have indicated experience in pediatric transthoracic echocardiography, presumably as an observer or as a knobologist assisting the pediatric cardiologist who usually serves as the main operator. A few have assisted in pediatric TEE (10.6%) and fetal echocardiography (10.4%).

Of the 405 sonographers surveyed, 2 (0.5%) have not utilized Color Doppler, whereas 37 (9.1%) have either observed only or not encountered tissue Doppler (Figure 6). As far as advanced echocardiography modalities are concerned, the respondents indicated actual use of speckle-tracking echocardiography or strain imaging (45.2%), three-/four-dimensional (3D/4D) transthoracic echocardiography (31.9%), 3D/4D TEE (32.4%), handheld ultrasound (27.7%), and vortex or vector flow mapping (9.4%).

Aside from their main role as sonographer for echocardiographic procedures, the respondents mentioned performing or supervising other cardiovascular diagnostic tests such as resting electrocardiography (90.1%), exercise electrocardiography (treadmill exercise test) (73.1%), Holter monitoring (72.1%), and ambulatory blood pressure monitoring (62.7%). Close to one-third of cardiac sonographers also performed vascular studies such as deep venous thrombosis screening (24.2%), carotid duplex scanning (29.1%), and arterial and/or venous duplex scanning (28.9%). An equivalent proportion (17.8%) of the surveyed sonographers logged in 5

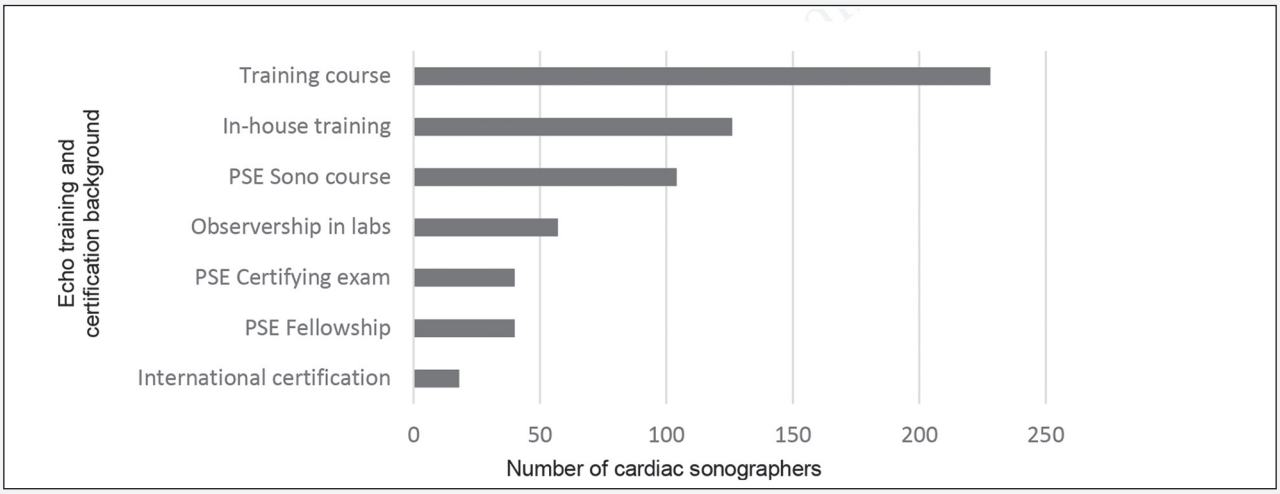

Figure 5. Echocardiography training and certification background of cardiac sonographers in the Philippines in 2021 (n = 405).

or 10 electrocardiography-related procedures per day. A small portion of respondents (3%) mentioned a personal daily census of at least 20 electrocardiography-related procedures.

The majority of the sonographer respondents (97.5%) engaged in at least one CPD activity related to echocardiography within the past 3 years from survey date. Almost one-fourth (24.4%) engaged in more than five CPD activities. More than two-thirds (70.4%) were members of PSE. On the flip side, this meant that a substantial proportion of practicing sonographers still remain untapped by and unaffiliated with the national society in echocardiography. A very small proportion (3.2%) of sonographers indicated membership in international societies in cardiovascular ultrasound or echocardiography. Clinical cases or imaging aspects deemed most challenging were almost identical to those tagged by physicians, with the majority (74.3%) indicating congenital heart diseases, followed by technical issues or artifacts (49.9%), valvular heart disease (33.6%), cardiac masses (30.4%), cardiomyopathies or myocardial diseases (26.9%), ischemic or coronary artery diseases (25.4%), and pericardial diseases (20.5%; Figure 7).

Direct consultation with laboratory colleagues (sonographer or physician) was the most common method (82.2%) used to resolve challenges in the course of cardiac sonography. Accessing online educational videos outside of PSE was the second most popular strategy (70.4%), followed by attendance in PSE-led webinars and workshops (60.5%) and literature search using textbooks or journals (55.1%). Close to half also mentioned the use of PSE-managed or curated online or social media accounts (47.2%). When asked how PSE could further help them in performing their work better and in improving the quality of echocardiography services in the country, the resounding response was the conduct of more educational activities in the form of seminars, webinars, and training programs.

Cardiac Laboratories and Laboratory Managers

In the 2015–2016 national survey, a total of 443 laboratory managers responded. This number increased to 539 as of 2021, because of the addition of 96 cardiac laboratories during the interim between the two surveys (16 from NCR, 0 from CAR, 5 from Ilocos Region, 4 from Cagayan Valley, 15 from Central Luzon, 19 from CALABARZON, 4 from MIMAROPA/ Southwestern Tagalog, 0 from Bicol, 3 from Western Visayas, 9 from Central Visayas, 6 from Eastern Visayas, 4 from Zamboanga Peninsula, 2 from Northern Mindanao, 5 from Davao, 1 from CARAGA, 1 from SOCCSKSARGEN, 0

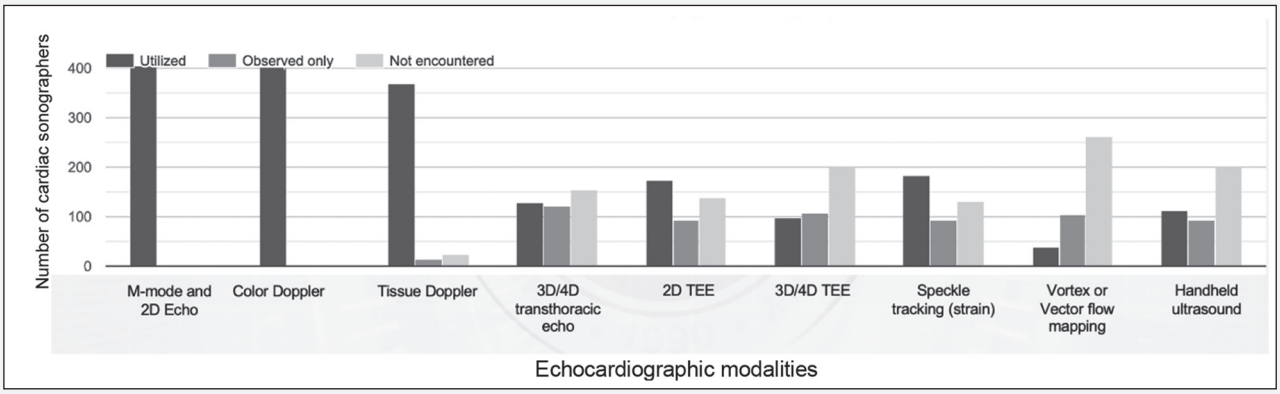

Figure 6. Echocardiographic modalities encountered by cardiac sonographers in the Philippines in 2021 (n = 405).

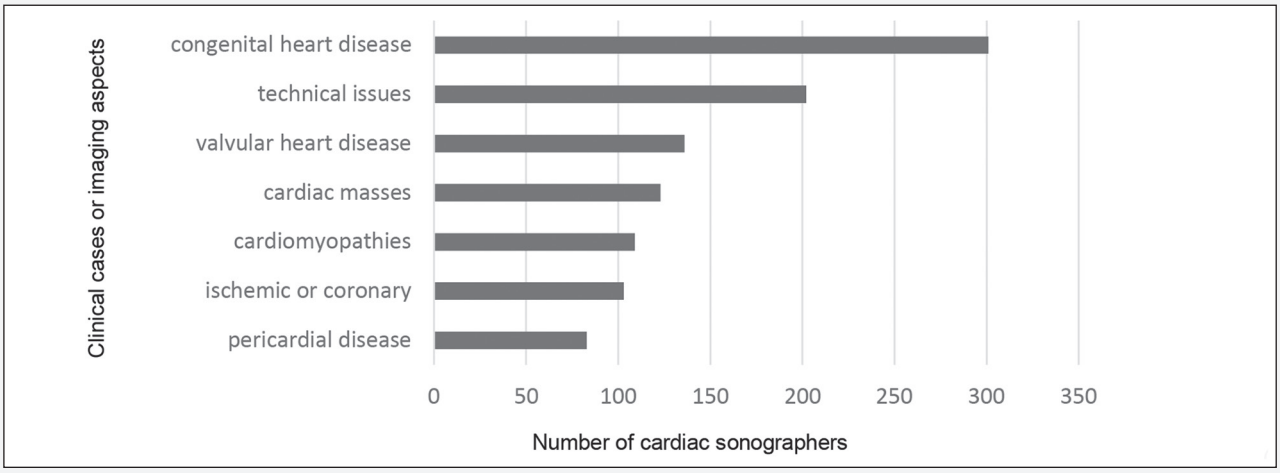

Figure 7. Clinical cases or imaging aspects deemed to be most challenging for the cardiac sonographers in the Philippines in 2021 (n = 405).

Table 3. Geographical Distribution of Cardiac Laboratories in the Philippines in 2021 (n = 101)

Philippine Region	No. of Respondent Laboratory Managers	% of Surveyed Population
NCR	29	28.7%
Region 4A: CALABARZON	18	17.8%
Region 3: Central Luzon	16	15.8%
CAR	6	5.9%
Region 1: Ilocos	5	5.0%
Region 7: Central Visayas	5	5.0%
Region 9: Zamboanga Peninsula	4	4.0%
Region 13: Caraga Region	4	4.0%
Region 8: Eastern Visayas	3	3.0%
Region 4B: MIMAROPA/Southwestern Tagalog	2	2.0%
Region 5: Bicol	2	2.0%
Region 10: Northern Mindanao	2	2.0%
Region 11: Davao	2	2.0%
Region 12: SOCCSKSARGEN	2	2.0%
Region 2: Cagayan Valley	1	1.0%
Region 6: Western Visayas	0	0.0%
Overseas	0	0.0%
Total	101	100.0%

CALABARZON=Batangas, Cavite, Laguna, Quezon, and Rizal; CAR=Cordillera Administrative Region; MIMAROPA=Marinduque, Occidental Mindoro, Oriental Mindoro, Palawan, and Romblon; NCR=National Capital Region=SOCCSKSARGEN, South Cotabato, Cotabato, Sultan Kudarat, Sarangani, and General Santos.

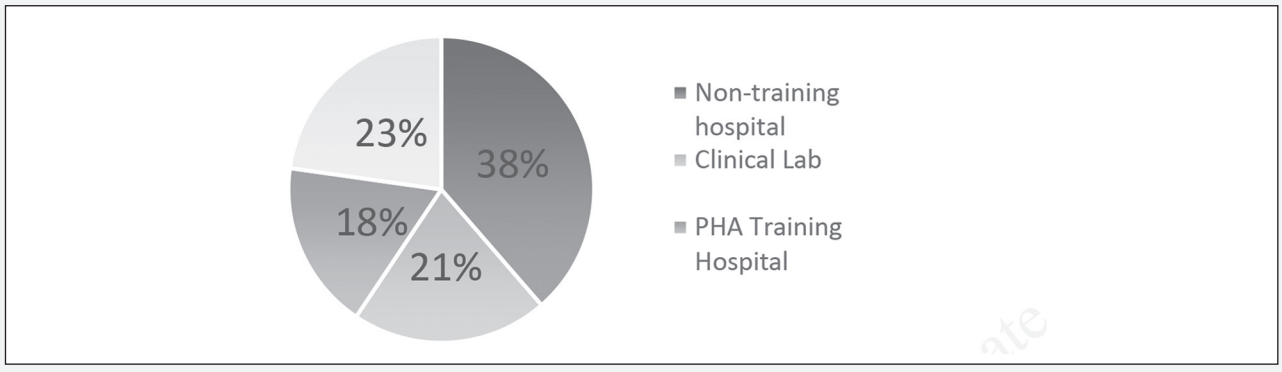

Figure 8. Classification of cardiac laboratories in the Philippines in 2021 (n = 101).

from BARMM, 2 from overseas). The 2021 survey received responses from 101 laboratory managers, most of whom (28.7%) were supervising laboratories in NCR. All regions in the country were represented in the survey, except for Western Visayas, which did not have a laboratory manager respondent (Table 3). None was received as well from overseas.

The majority of the laboratories were situated in nontraining settings, with 38.6% in nontraining hospitals and 20.8% in stand-alone clinical laboratories. Less than a fifth (17.8%) were classified as laboratories in hospitals with PHA-accredited cardiology training programs, whereas 22.8% were in hospitals with PCP-accredited internal medicine training programs (Figure 8). A great majority (78.2%) of the laboratories were operating for more than 5 years from the time of survey, whereas the rest were operating for 1 to 5 years (19.8%) and less than a year (2%).

According to the PSE Core Curriculum Guidelines, an echocardiography laboratory in the country must ideally have a level III echocardiographer (with dedicated 1-year training in echocardiography on top of general cardiology) as its physician head or manager.[13] According to the 2021 survey, 16.8% of the laboratories surveyed did not have a level III echocardiographer in its roster. A third of the laboratories (32.7%) had at least three physicians in its staff with level III expertise, the minimum requirement to set up a formal training program in echocardiography. A third of the laboratories had only one level III echocardiographer (30.7%), and more than five echocardiographers had level I or II status (29.7%). Many laboratories had at least one pediatric cardiologist level III (68.3%) or level I/II (40.6%) as reader. A substantial proportion of laboratories (73.3%) had at least one vascular specialist, with 9.9% having at least three vascular experts. Almost all (93.1%) had at least one sonographer skilled to perform both echocardiography and vascular studies. In terms of certified staff, 6.9% and 40.6% stated not having any sonographers certified to perform echocardiographic studies and vascular studies, respectively. Most laboratories have either one (27.7%) or two (22.8%) additional nonsonographer staff to assist in or perform nonechocardiography laboratory functions. Interestingly, 16.8% did not have nonsonographer staff, suggesting that some sonographers were likely performing multiple roles at their laboratory. A third (30.1%) also specified the absence of support staff such as clerk, secretary, or utility aide.

With respect to laboratory census and caseloads, 37.6% of respondents indicated having more than 100 adult transthoracic studies per month, whereas 18.8% had 30 studies or fewer. Some laboratories (8.9%) indicated putting out as low as no to four studies per month. For the monthly census of special procedures, 15.8% logged in one to four TEE studies, with one laboratory registering more than 50 TEE studies in a month, likely classified as a teaching/training facility. Most laboratories logged in 11 to 30 treadmill stress echocardiograms (20.8%) and 1 to 4 pharmacologic stress echocardiograms (13.9%) per month. More than a third of laboratories performed an average of 1 to 4 contrast echocardiography procedures via agitated saline (31.7%), 1 to 4 perioperative echocardiograms (10.9%), 1 to 4 periprocedural echocardiograms (10.9%), 5 to 10 pediatric transthoracic echocardiography (18.9%) and TEE (4%), and 1 to 4 fetal echocardiograms (21.8%). Laboratory managers were asked about annual procedural census with respect to adult echocardiography, pediatric echocardiography, and vascular studies, comparing the years 2017 to 2020. For adult echocardiography, numbers seemed to be quite comparable for 2017 to 2019, but there was an obvious drop in the number of laboratories putting out more than 1000 studies per year in 2020. In 2019, 23.8% logged in a yearly census of at least 3000. This went down to 13.9% in 2020. For pediatric echocardiography, 10.9% registered at least 1000 studies in 2019 and 6.9% in 2020. For vascular studies, 17.8% registered at least 1000 studies in 2019 and 11.9% in 2020. The consistent drop in census is surmised to coincide with the onset of the COVID-19 pandemic.

As far as laboratory capabilities are concerned, all respondents indicated the availability of M-mode, 2D echocardiography, and color Doppler modalities in their facilities (Figure 9). Tissue Doppler, a necessary modality for comprehensive evaluation of left ventricular diastolic function, was available in only 85.1% of laboratories. Some laboratories specified the availability of the following additional modalities: 2D TEE (40.6%), speckle tracking or strain imaging (33.7%), 3D/4D transthoracic echocardiography (23.8%), 3D/4D TEE (15.8%), handheld ultrasound (10.9%), and vortex imaging or vector flow mapping (4%).

As part of quality assessment of the laboratory, the availability of a variety of resources was inquired in the survey. Almost all the laboratories indicated having a log of procedures (98%), a guide to normal measurements (96%), manual of operations (95%), echocardiography textbooks (94.1%), regular preventive

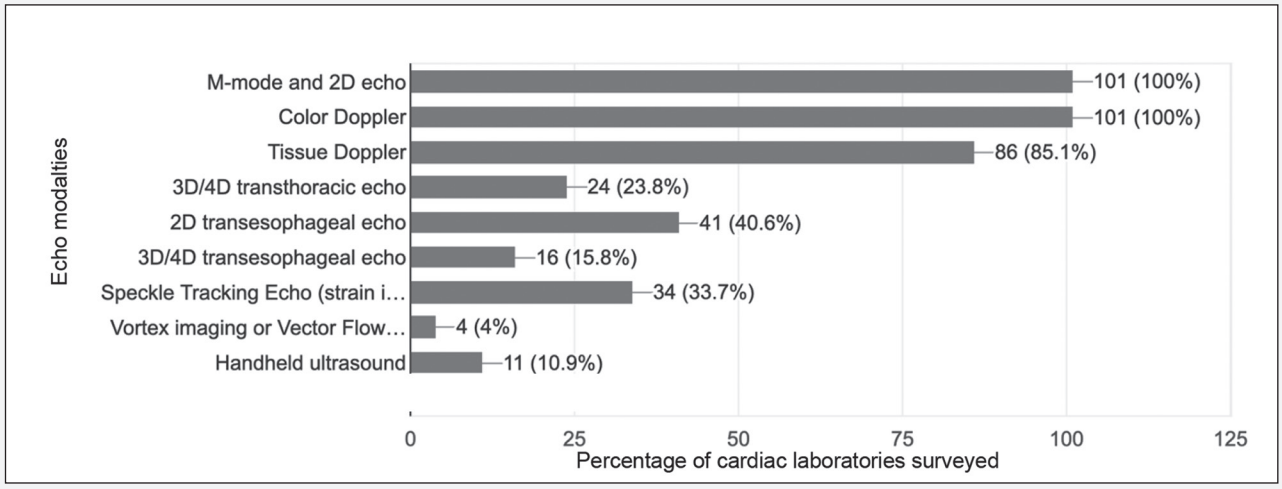

Figure 9. Percentage of cardiac laboratories in the Philippines in 2021 with echocardiographic modalities available (n = 101).

maintenance (95%), and standard template for reporting (94.1%). Some laboratories (13.9%) did not explicitly state the presence of any quality management protocols. Moreover, 36.6% did not have DICOM-compatible storage methods, and 32.7% did not have an emergency cart (defibrillator, Advanced Cardiovascular Life Support equipment).

DISCUSSION

Key Results

Consolidated data from the two separate surveys augmented with auxiliary information from stand-alone directories demonstrated that, as of year 2021, the Philippines had at least 651 physician echocardiographers, 2487 cardiac sonographers, and 537 cardiac laboratories. These numbers represent increases from the 2015 data across all three respondent categories (17.% increase for physician echocardiographers, 44.9% increase for cardiac sonographers, and 21.7% increase for cardiac laboratories). Based on the 2021 data, the majority of the physician echocardiographers (41.2%), cardiac sonographers (48.3%), and cardiac laboratories (28.2%) were situated in NCR. All regions in the country were represented in the survey across all respondent categories, except for Western Visayas, which did not have a laboratory manager respondent.

As far as profiling is concerned, fewer than half (41%) of physician echocardiographers were in practice for 5 years or less, and only 44.7% underwent a dedicated 1-year training program in echocardiography (level III echocardiographers). Despite these statistics, a great proportion (91.8%) of the respondents signified membership in PSE, with 54.1% of the surveyed readers being accorded fellowship status. The non–level III readers likely acquired such status through alternative but recognized pathways in the society. Meanwhile, almost half (46.7%) of the surveyed sonographers were nurses by training background, followed by medical technologists at 21.8% and radiologic technologists at 18.9%. Almost a third (31.3%) of the surveyed sonographers were in the early phase of their career, being in practice for 3 years or less. More importantly, only 56.6% indicated completing a 3-month dedicated training, which is an ideal requisite for the practice of cardiac sonography in the country, according to PSE.[13] More than a tenth (11.7%) admitted not performing the transthoracic echocardiogram, which is the bread-and-butter procedure of cardiac sonographers in the country. The majority of the sonographers (70.8%) log in anywhere from 5 to 10 electrocardiography-related procedures per day. For cardiac laboratories, the majority of the laboratories were situated in nontraining settings, with 38.2% in nontraining hospitals and 20.9% in stand-alone clinical laboratories. Less than a fifth (18.2%) were classified as laboratories in hospitals with PHA-accredited cardiology training programs, whereas 22.7% were in hospitals with PCP-accredited internal medicine training programs.

Valuable insights were gained from the survey regarding the clinical cases or imaging issues that challenged both physician echocardiographers and cardiac sonographers. Both groups identified congenital heart disease and technical aspects of imaging as the top two most challenging issues. In many respects, these two issues overlap, as patients with congenital heart disease have complex anatomies and can expectedly create difficulties with respect to acoustic window and image quality. This realization is vital most especially for the cardiac sonographer, whose primary role is to obtain high-quality ultrasound images and hemodynamic Doppler information of the heart using a variety of echocardiographic modalities.[8]

LIMITATIONS

As in any survey, the authors of the present study acknowledge a number of limitations. First, the census of physician echocardiographers, cardiac sonographers, and cardiac laboratories is considered a rough estimate only, as the main basis for this was the responses from the first survey in 2015 augmented by new information from the society directory. This inherently limits the reach of the survey to respondents who are either affiliated with the society or who have access to its various online and social media accounts. Second, the use of a pure online strategy in the most recent survey of 2021 may unwittingly exclude respondents in far-flung regions, which may have either unstable to nonexistent access to the internet. Third, the rollout of the online survey in 2021 was not standardized across the respondent categories, as the said surveys were opened at different time periods (March 2021 for laboratory managers, April 2021 for cardiac sonographers, and August 2021 for physician echocardiographers). This inevitably led to variable response turnouts, with surveys having variable time ranges for receipt of responses (4 months for laboratory managers, 5 months for cardiac sonographers, and 1.5 months for physician echocardiographers). Lastly, some survey questions relied on the respondents' ability to recall information, such as estimates daily procedural load for sonographers or yearly census for laboratories.

RECOMMENDATIONS

The following recommendations are proposed to address these limitations for any succeeding survey: (1) tap the various local government units in data gathering or consider tie-ups with the national government to capture echocardiographic data in established nationwide health surveys (eg, National Health and Nutrition Examination Survey); (2) consider alternative survey methods (house-to-house paper survey, phone survey) for selected regions; (3) either consider stratified random sampling according to geopolitical region or exert efforts to attain the minimum response rate per region; and (4) standardize the date and duration of survey rollout across respondent categories. As for policy recommendations, the authors suggest the following: (1) intensified efforts to incentivize practice in the provinces especially in underserved regions of the country; (2) local society support for creation of new training programs in the said regions outside the metropolis; (3) recognition of the cardiac sonographer position by concerned national and legislative bodies as a legitimate and stand-alone field worthy of salary and tenure commensurate to the level of expertise and unique skill involved in the said field; and (4) innovations to maximize telehealth solutions and enhanced interinstitutional collaboration to address gaps in expertise and service.

INTERPRETATION

Overall, the study illustrated the hypothesized maldistribution of human resources and expertise in the country through a surveyed fragment of the intended population. Although the said survey methods inherently carried some imperfections in terms of technique and reach, the findings represent the very first attempt in the country to document and profile the nationwide volume and distribution of resources and expertise with respect to echocardiography. Such baseline data will prove useful in helping key stakeholders to not only identify real-world gaps in terms of human as well as logistical resources, but also, more importantly, devise effective and lasting solutions to address such gaps, with the ultimate goal of delivering high-quality and equitable care to improve clinical outcomes.

GENERALIZABILITY

Cognizant of the limitations of an online survey, particularly with respect to how certain regions are not as well-represented as others, the authors recommend exercising caution in generalizing the findings. At the bare minimum, the distribution of human resources across the country as captured by the surveys is only deemed as a rough estimate and partial glimpse of the larger picture and may not necessarily faithfully reflect the true census and distribution.

ACKNOWLEDGMENT

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CONFLICT OF INTEREST

None.

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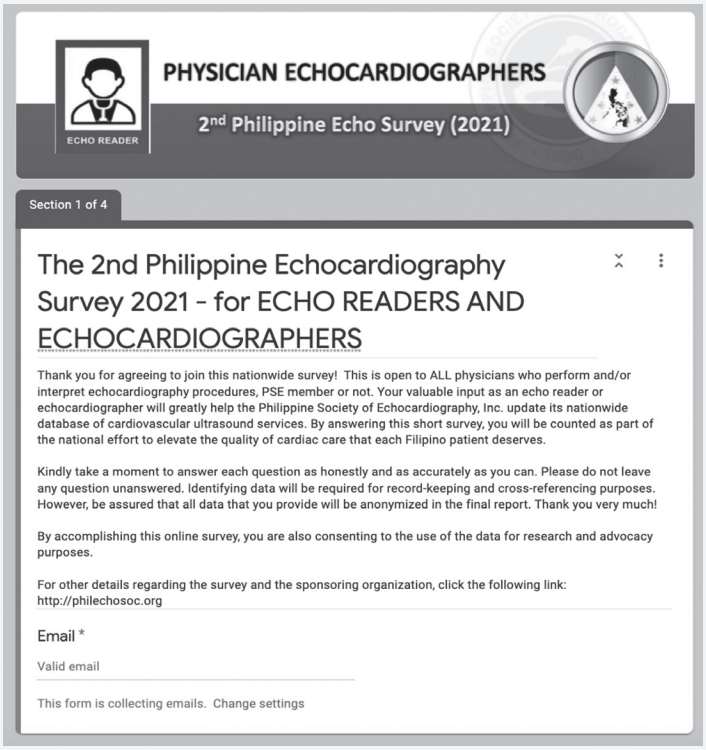
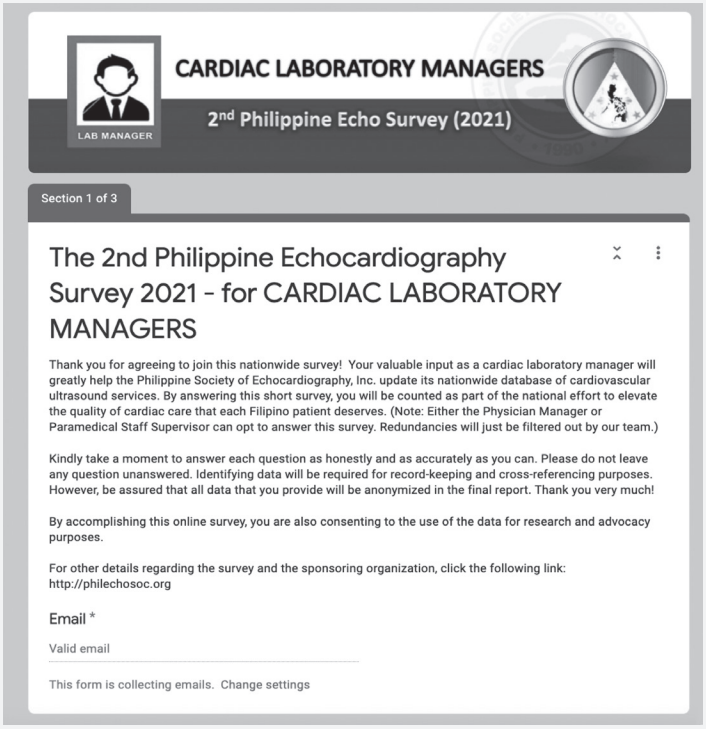
APPENDIX

Survey Forms for Echo Readers, Cardiac Sonographers and Cardiac Laboratory Managers.



Link to access the online survey form: https://docs.google.com/forms/d/e/1FAIpQLSdmycXxdmxbKXfEol4oX3f5QmH61bsJx17C4iOVWVCMXzFUIQ/viewform?usp=sf_link.



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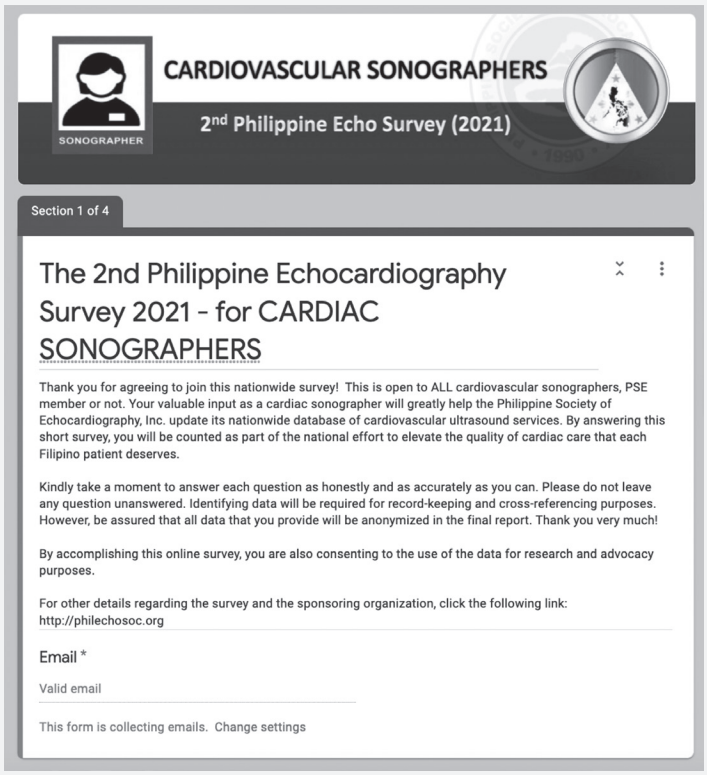

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