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Need for better and broader training in cardio-obstetrics: A national survey of cardiologists, cardiovascular team members, and cardiology fellows in training

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Journal of the American Heart Association

ORIGINAL RESEARCH

Need for Better and Broader Training in Cardio-Obstetrics: A National Survey of Cardiologists, Cardiovascular Team Members, and Cardiology Fellows in Training

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BACKGROUND: Team-based models of cardio-obstetrics care have been developed to address the increasing rate of maternal mortality from cardiovascular diseases. Cardiovascular clinician and trainee knowledge and comfort with this topic, and the extent of implementation of an interdisciplinary approach to cardio-obstetrics, are unknown.

METHODS AND RESULTS: We aimed to assess the current state of cardio-obstetrics knowledge, practices, and services provided by US cardiovascular clinicians and trainees. A survey developed in conjunction with the American College of Cardiology was circulated to a representative sample of cardiologists (N=311), cardiovascular team members (N=51), and fellows in training (N=139) from June 18, 2020, to July 29, 2020. Knowledge and attitudes about the provision of cardiovascular care to pregnant patients and the prevalence and composition of cardio-obstetrics teams were assessed. The widest knowledge gaps on the care of pregnant compared with nonpregnant patients were reported for medication safety (42%), acute coronary syndromes (39%), aortopathies (40%), and valvular heart disease (30%). Most respondents (76%) lack access to a dedicated cardio-obstetrics team, and only 29% of practicing cardiologists received cardio-obstetrics didactics during training. One third of fellows in training reported seeing pregnant women 0 to 1 time per year, and 12% of fellows in training report formal training in cardio-obstetrics.

CONCLUSIONS: Formalized training in cardio-obstetrics is uncommon, and limited access to multidisciplinary cardio-obstetrics teams and large knowledge gaps exist among cardiovascular clinicians. Augmentation of cardio-obstetrics education across career stages is needed to reduce these deficits. These survey results are an initial step toward developing a standard expectation for clinicians' training in cardio-obstetrics.

Key Words: cardio-obstetrics ■ continuing medical education ■ medical knowledge ■ pregnancy

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Cardiovascular disease (CVD) is not only the leading cause of death in the United States, but also the primary cause of pregnancy-related mortality.[1,2] Approximately two thirds of all maternal deaths are from CVD, and most of these are preventable.[1,3] Among industrialized countries, the United States has the highest rate of maternal mortality, and this alarming trend has continued to increase since the early 2000s.[4]

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Supplemental Material is available at https://www.ahajournals.org/doi/suppl/10.1161/JAHA.121.024229

For Sources of Funding and Disclosures, see page 9.

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CLINICAL PERSPECTIVE

What Is New?

- The growing burden of cardiovascular disease in adults, who are trying to become and who are pregnant, places them at risk for adverse pregnancy outcomes.
- Cardio-obstetrics knowledge and practice patterns of the cardiovascular workforce and fellows in training have not yet been described.

What Are the Clinical Implications?

- Cardiovascular clinicians receive little formal training and report large knowledge gaps in cardio-obstetrics.
- Along with the standardization and amplification of cardio-obstetrics team-based care, the survey results highlight the need to increase available educational opportunities for practicing clinicians and trainees.

Nonstandard Abbreviations and Acronyms

CVT	cardiovascular team
FIT	fellow in training

The urgent need for efforts to reduce maternal mortality has recently been highlighted by the US Surgeon General and the Department of Health and Human Services.[5,6]

The care of pregnant women with or at risk for CVD covers a wide clinical spectrum, including preconception counseling, management of CVD during pregnancy and postpartum, and counseling and preventative care for women with a history of adverse pregnancy outcomes who are at heightened risk for subsequent CVD.[7-14] To address the complexities of providing care to these pregnant women, comprehensive cardio-obstetrics team-based approaches have been developed at several centers.[15-17] Despite the field's existence for several decades and a growing evidence base to guide the care of patients,[10,11,12,13,14,18] the current state of cardio-obstetrics knowledge and practices of cardiologists, fellows in training (FITs), and cardiovascular team (CVT) members, as well as the prevalence and composition of formal cardio-obstetrics programs, is unknown. To answer these questions, we performed a cross-sectional survey with a deliberate sampling design to provide results that are representative of the US membership of the American College of Cardiology (ACC).

METHODS

Study Sample

This was a cross-sectional electronic survey sent via e-mail to a targeted, representative group of 5091 US ACC member clinicians, including adult and pediatric cardiologists, FITs, and CVT members (nurse practitioners, pharmacists, physician assistants, and registered nurses). The survey was conducted from June 18, 2020, to July 29, 2020, and a maximum of 3 reminders were sent. The surveyed clinicians were sampled through a random stratified sampling technique to be representative of the range of clinical settings, subspecialties, career stage, and geography encountered across the United States. This study was approved by the ACC institutional review board, and a waiver of written informed consent was granted. The authors declare that all supporting data are available within the article (and its online supplementary files).

Survey Design

Survey questions were developed and refined through an iterative process involving experts in cardio-obstetrics with oversight from an ACC staff member with expertise in survey design and implementation. The final instrument included 24 items, covering the following topics: care of pregnant/postpartum women; personal competency in managing heart disease in pregnant and nonpregnant patients; presence and composition at the respondent's institution of a dedicated cardio-obstetrics team; prior training/education in cardio-obstetrics; and desired educational needs and resources. There were slight modifications of survey questions administered to practicing clinicians (physicians and CVT members) and trainees (FITs); the full surveys are available in Data S1.

All analyses were performed using IBM SPSS Statistics for Windows (Version 25.0; Armonk, NY).

RESULTS

A total of 311 cardiologists, 139 FITs, and 51 CVT members completed the survey, for a response rate of 10%. The Table describes the demographics and characteristics of the respondents. The minority of cardiologists (26%) and FITs (37%) identify as women, compared with 84% of CVT members, and most of the respondents in all 3 groups were White race (50%–77%). Table S1 illustrates the representative nature of respondents compared with the overall ACC membership at the time of survey distribution.

Care of Pregnant and Postpartum Women

In 64% of institutions, the acute care of pregnant and recently postpartum women is staffed by the on-call consulting cardiologist, whereas in 29% it is by a select

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Table. Demographics and Characteristics of Survey Respondents

Variable	Cardiologists (N=311)	CVT members (N=51)	FITs (N=139)	
Female sex	26	84	37	
Race or ethnicity				
White	58	77	50	
Asian	25	10	31	
Black	4	2	7	
Hispanic	5	5	8	
Other/decline	8	6	7	
Practice characteristics			Trainee characteristics	
Time in practice, y			Year of training	
≤7	21	49	First-year clinical fellow	25
8–14	17	18	Second-year clinical fellow	30
15–21	19	16	Third-year clinical fellow	33
≥22	42	18	First-year research fellow	3
			Other	9
Practice setting			No. of fellows in program	
Cardiovascular group practice	49	47	1–10	25
Medical school	25	10	11–20	32
Government hospital	6	4	21–30	26
Nongovernmental hospital	7	24	31–40	11
Multispecialty group	7	8	41–50	4
Solo practice	5	0	>50	2
Insurance company/other	1	6	Planned area of specialization	
Region			Adult cardiology	29
South	41	41	Invasive/interventional	29
Northeast	24	28	Electrophysiology	13
Midwest	20	18	Heart failure	9
West	14	14	Imaging	9
Board certification			Other	5
Adult cardiology	91	NA	Adult congenital	3
Interventional cardiology	25	NA	Undecided	2
Electrophysiology	9	NA	Critical care	1
Pediatric cardiology	6	NA		
Heart failure/transplant	6	NA		
Adult congenital	4	NA		
Nuclear medicine	3	NA		
Surgery	<1	NA		

Data are given as percentage of respondents. CVT indicates cardiovascular team; FIT, fellow in training; and NA, not applicable.
Other includes individuals who self identify as Native American/Alaskan Native, Native Hawaiian/Other Pacific Islander, or Other.

group of individuals, with most of these institutions having 1 to 2 cardiologists with a special focus in cardio-obstetrics. Fewer than one third of clinicians reported that they evaluate a pregnant or lactating patient at least monthly. Most cardiologists (42%) and FITs (40%) see such patients only every 3 to 6 months, whereas 51% of CVT members are never involved in the care of a pregnant or postpartum woman (Figure 1). One third of FITs reported evaluating a pregnant woman 0 to 1 time per year. In rank order, the 5 most common reasons for consultation across all respondents were as follows: (1) hypertension, (2) arrhythmia history/management, (3) valvular heart disease, (4) heart failure, and (5) preeclampsia. Less common indications included simple and complex congenital heart disease, pulmonary hypertension, acute coronary syndromes and coronary artery disease, and connective tissue disorders.

Slightly more than half of cardiologists are very or extremely confident prescribing a cardiovascular medication to a pregnant (56%) or lactating patient (52%)

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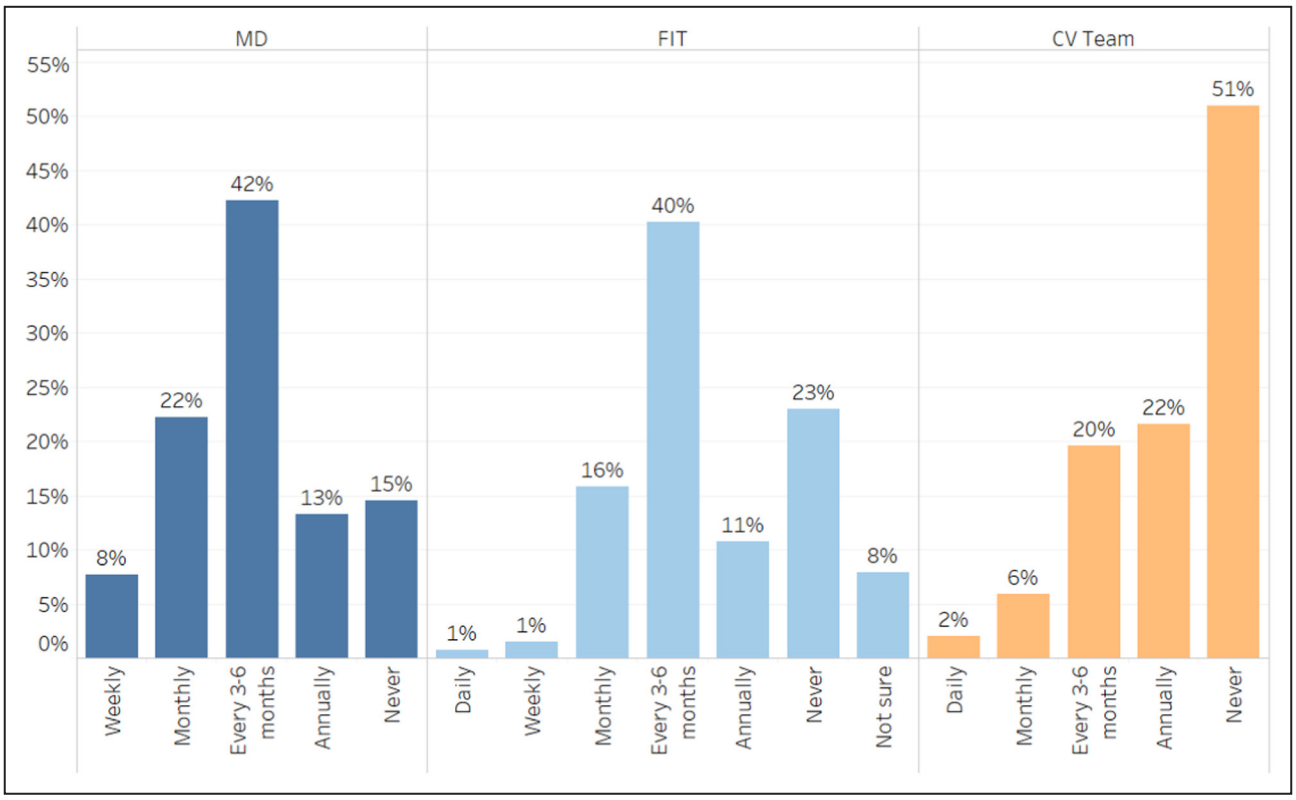

Figure 1. Reported frequency of evaluation of a pregnant or lactating patient by survey group.
Reported frequency of evaluation of a pregnant or lactating patient for the 3 surveyed groups: cardiologists (MDs), fellows in training (FITs), cardiovascular team (CV Team) members.

and managing CVD in pregnancy (52%). FITs and CVT members are much less confident in these general areas (Figure 2). We further queried for clinicians' comfort level managing a variety of cardiovascular conditions in pregnant and nonpregnant patients, and for each topic, a gap in comfort level was calculated as the difference between the level of comfort caring for a pregnant versus a nonpregnant patient with the same condition (Figure 3 and Figures S1 and S2). Compared with FITs and CVT members, cardiologists reported

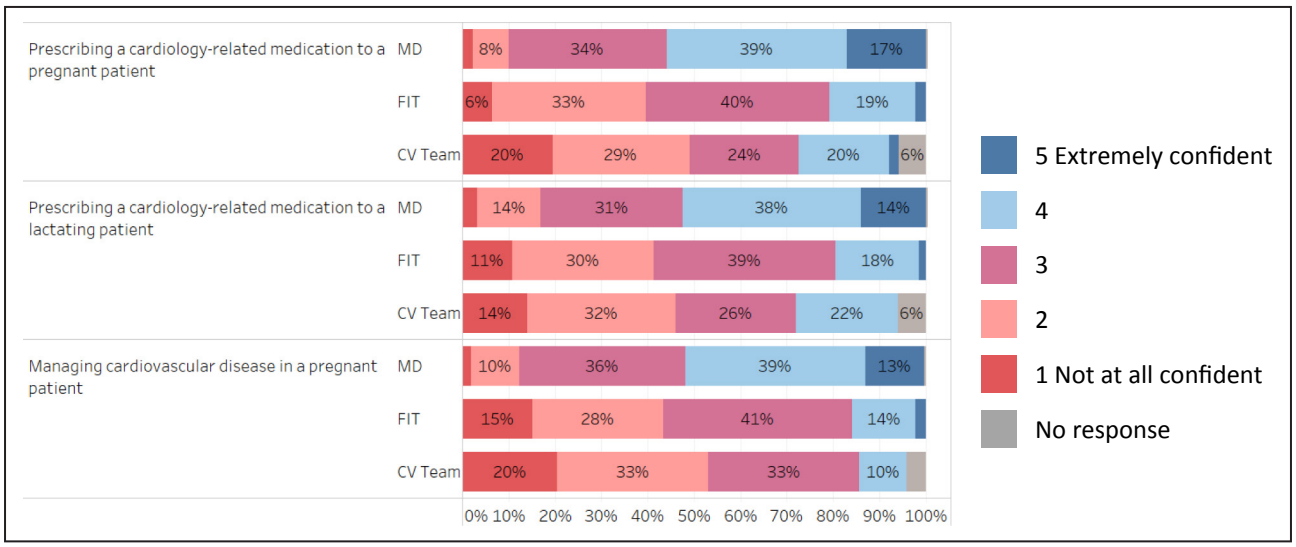

Figure 2. Self-reported confidence in treating pregnant or lactating patients by survey group.
Self-reported confidence in treating pregnant or lactating patients for the 3 surveyed groups: cardiologists (MDs), fellows in training (FIT), cardiovascular team (CV Team) members.

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	MD	FIT	CV Team
Acute coronary syndromes during pregnancy	39%	67%	71%
Peripartum cardiomyopathy	18%	44%	57%
Chronic coronary artery disease during pregnancy	30%	51%	66%
Complex congenital heart disease	15%	11%	8%
Hypertension management during pregnancy	21%	38%	58%
Management of aortopathies during pregnancy and delivery	40%	55%	43%
Management of arrhythmias during pregnancy	33%	49%	58%
Management of prosthetic valves and anticoagulation in pregnancy	38%	46%	65%
Medication safety in lactation and pregnancy	42%	52%	68%
Multimodality imaging in pregnancy	30%	51%	39%
Performing a physical exam and interpreting cardiovascular physiology during pregnancy	24%	66%	53%
Recommending contraception to women with CVD	5%	21%	12%
Simple congenital heart disease	24%	31%	16%
Valvular disease in pregnancy	30%	69%	49%

Figure 3. Gaps in comfort level for the treatment of cardiovascular disease (CVD) in pregnant vs nonpregnant adults.
Larger gap percentage indicates greater level of discomfort treating pregnant patients compared with nonpregnant patients with a similar condition. CV Team indicates cardiovascular team; FIT, fellow in training; and MD, physician MD.

higher confidence levels for treating all cardiovascular conditions and the lowest gaps in comfort between treating pregnant and nonpregnant patients with the same condition. Cardiologists reported the lowest levels of confidence recommending contraception to women with CVD and treating complex congenital heart disease in both pregnant and nonpregnant patients. Similar trends were seen for FITs and CVT members.

Existing Cardio-Obstetrics Teams

Most cardiology physician (76%) and CVT member (63%) practices do not have a dedicated cardio-obstetrics team. Consistent with this finding, only 10% of cardiologists and 2% of CVT member respondents are a part of the cardio-obstetrics team in their practice setting. Of the 71 respondents with knowledge of a cardio-obstetrics team at their facility, 54% practice at a medical school, 37% are part of a cardiovascular or multispecialty group, 6% are at a nongovernment and 3% at a government hospital, and only 1% are in solo practice. The composition of these teams is shown in Figure 4. For the timing of their involvement in the cardio-obstetrics team, more than half of cardiologists (64%) are involved in prepregnancy/preconception, with a greater percentage involved during pregnancy (93%), delivery planning (84%), and similar level of involvement during delivery hospitalization

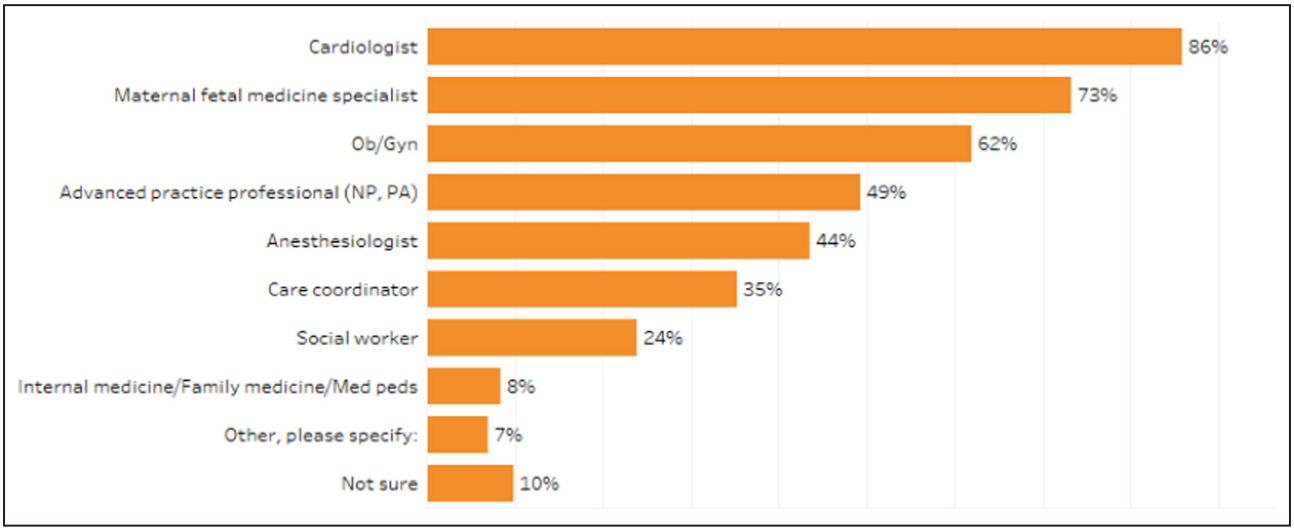

Figure 4. Composition of the cardio-obstetrics teams.
Composition of the cardio-obstetrics teams reported by respondents whose institutions/practices have a cardio-obstetrics team. NP indicates nurse practitioner; OB/Gyn, obstetrician gynecologist; and PA, physician assistant.

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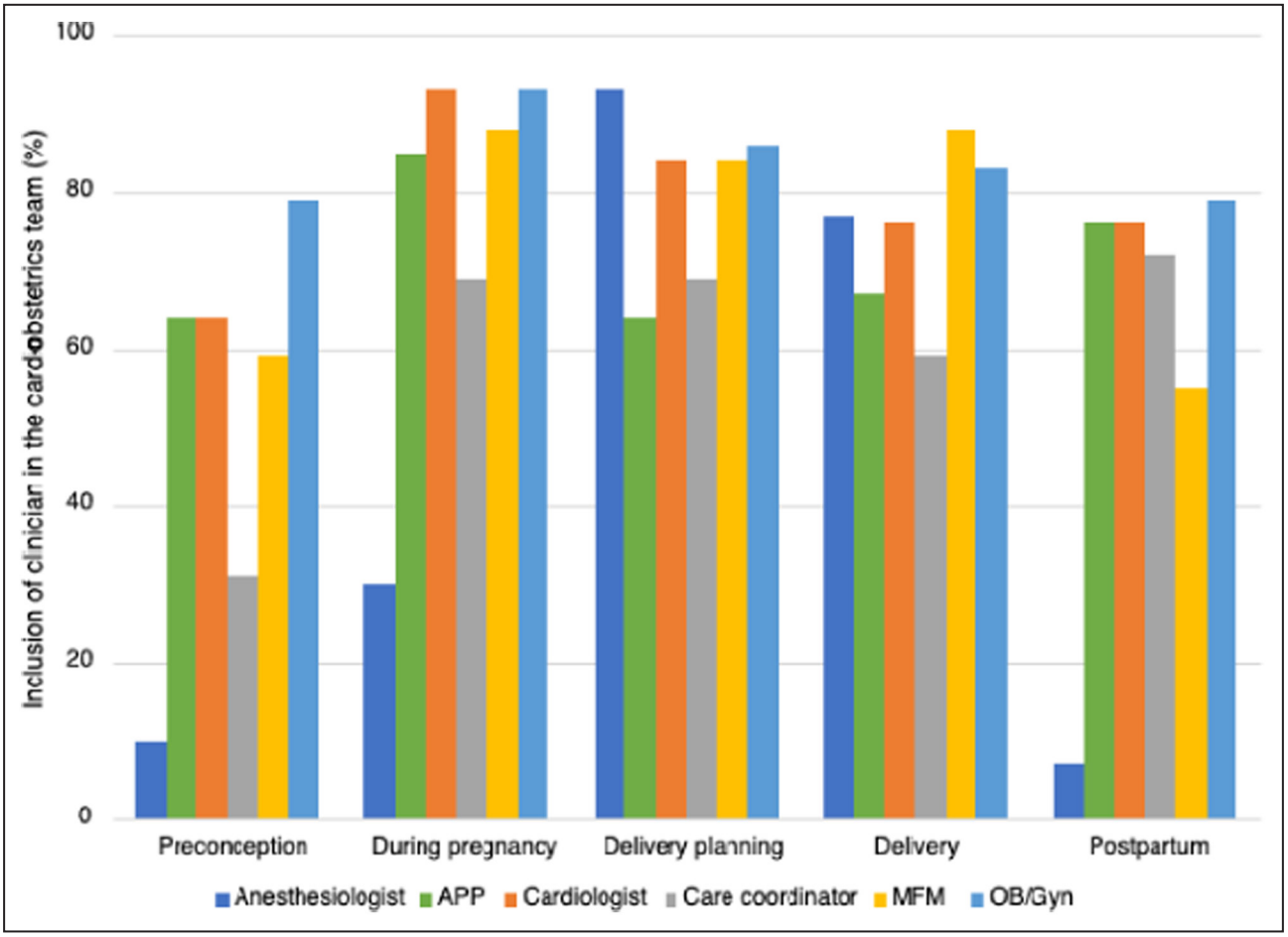

Figure 5. Composition of cardio-obstetrics teams as reported across the span of pregnancy from preconception through the postpartum period, by clinician type.
APP indicates advanced practice professional; MFM, maternal fetal medicine specialist; and OB/Gyn, obstetrician gynecologist.

and postdischarge (76%) (Figure 5). Before conception, obstetricians (79%), cardiologists (64%), and advanced practice professionals (64%), followed by maternal fetal medicine specialists (59%), are the most frequently included members of the cardio-obstetrics team. During pregnancy, 93% of cardio-obstetrics teams contain a cardiologist and an obstetrician, 88% also involve a maternal fetal medicine specialist, and most include a social worker (75%) and/or care coordinator (65%). Anesthesiologists are predominantly involved in delivery planning (93%) and during the delivery hospitalization (77%). After discharge, most cardio-obstetrics teams are composed of obstetricians (79%), advanced practice professionals (76%), cardiologists (76%), social workers (75%), and care coordinators (70%).

Past and Present Training in Cardio-Obstetrics

Of the practicing clinicians surveyed, 66% of cardiologists and 94% of CVT members received no formal cardio-obstetrics didactics during their training. For the 29% of cardiologists who reported some formalized training, 85% have been in practice <14 years and only 13% believed their clinical exposure to pregnant women with CVD while training was adequate. Current FITs also report limited training and didactic experience in cardio-obstetrics. Slightly more than half of FITs (55%) had attended a lecture/conference on cardio-obstetrics in the past year, with 86% of that group reporting 1 to 5 hours and 9% reporting 6 to 10 hours over the course of a year dedicated to cardio-obstetrics didactic learning. Of the FIT responders, more than three quarters (83%) report they do not have a cardio-obstetrics training module in their training program. The 12% (n=16) of FITs who do have formal training tend to be at larger-sized programs (≥20 fellows), and of the programs with a formal module, only 13% require participation in the rotation.

The vast majority, 92% of respondents, thought positively about the inclusion of cardio-obstetrics in the ACC repertoire of educational products. Midcareer cardiologists and CVT members were most likely to

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believe this is an extremely important offering. Almost half (46%) of FITs believe it is important for training in cardio-obstetrics to be included in the Core Cardiovascular Training Statement requirements.

DISCUSSION

The findings of this survey suggest that although 30% of cardiologists evaluate a pregnant patient at least monthly and 86% at least annually, a large proportion of the cardiology workforce feels uncomfortable providing care to these patients. Key findings include the following: (1) most respondents (76%) lack access to a dedicated cardio-obstetrics team; (2) only 29% of practicing cardiologists received cardio-obstetrics didactics during training; and (3) 83% of current FITs report no formal cardio-obstetrics training in their fellowship program. The results also highlight a large self-perceived deficit in the clinical knowledge and competency base for both cardiovascular clinicians in practice and those in training across the spectrum of cardio-obstetrics topics. This shortfall is seen in conjunction with reports of limited formal training in cardio-obstetrics by physicians in practice and training as well as CVT members. Our study is the first to assess and highlight the challenges in the cardio-obstetrics knowledge base and the competencies of a diverse cardiovascular workforce. Although the team-based field of cardio-obstetrics has developed to provide specialized care to women with and at risk for CVD in pregnancy, most practices and thus patients do not have access to such a team. When present, there is marked variability in the cardio-obstetrics teams' makeup and involvement of team members at different time points from preconception through delivery and postdischarge. These inconsistencies are particularly important given the recommendations for preconception counseling for women with underlying CVD and the growing recognition that the postpartum period is a high-risk time for cardiovascular morbidity and mortality.[10,11,12,18,19]

Practicing Cardiologists

For all topic areas investigated, practicing cardiologists reported the highest level of comfort managing both nonpregnant and pregnant patients, and with the exception of congenital heart disease, cardiologists also reported the smallest gap in comfort level between treating a pregnant and nonpregnant patient with the same condition. Although 56% of practicing cardiologists reported they were very or extremely confident in prescribing a medication to pregnant women, the largest gaps in cardiologists' comfort level caring for pregnant compared with nonpregnant patients pertain to medication safety in pregnancy and lactation, followed by the management of aortopathies and acute coronary syndromes during pregnancy and delivery. The gap in comfort level was smallest for the provision of contraception, which arose from a global low level of confidence with the topic for all women with CVD, rather than a high level of comfort recommending contraception to women with CVD who are pregnant or postpartum.

CVT Members

In general, CVT members reported similar patterns of self-perceived strengths and weaknesses by topic area as practicing cardiologists, but with a higher relative gap in comfort for any given topic. CVT members have the potential to make important contributions to the cardio-obstetrics care team, particularly during the fourth trimester when cardiovascular complications are common and long-term risk modification and counseling is essential.[10,11,12,13,14,19,20] Future opportunities for the use of CVT members as part of the cardio-obstetrics team include telehealth and remote vital sign monitoring. With proven efficacy, validity, and improved patient satisfaction, CVT telehealth visits and remote monitoring lead to increased compliance with recommendations and follow-up for all demographics of women.[21-24]

Fellows in Training

Similar to CVT members, most FITs do not feel comfortable treating pregnant/lactating patients. One of the largest gaps was seen in valvular heart disease for FITs, with 88% feeling extremely/somewhat comfortable managing this condition in the nonpregnant patient, whereas only 19% felt the same in pregnant patients, a gap of 69%. A total of 90% of FITs felt extremely/somewhat comfortable managing hypertension in the nonpregnant patient, whereas only 52% felt the same in pregnant patients, even though hypertension is the most common cardiac condition for consultation. These findings are particularly relevant given that left-sided valvular stenosis is one of the highest-risk cardiovascular conditions in pregnancy, and the prevalence of hypertensive disorders is increasing among pregnant women and is associated with significant morbidity and mortality.[2,25-27] Furthermore, only 2% of FITs felt extremely confident in prescribing a cardiovascular medication to a pregnant or lactating patient, an essential skill for prompt and effective treatment of cardiovascular disorders in pregnant and lactating women.

Opportunities for Educational Initiatives

Along with standardization and amplification of cardio-obstetrics team-based care, the survey results highlight

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a large need to increase the available educational opportunities for practicing clinicians and FITs. Maternal mortality reviews have identified that issues related to clinical care, including a failure to promptly diagnose and deliver effective treatment, are often the largest contributors to maternal cardiovascular deaths.[1] Increased broad knowledge of cardio-obstetrics topics within the specialty of cardiology in addition to the education of other groups of clinicians, such as those providing emergency medicine and primary care who are often the first to evaluate these women, are needed. The survey responses indicate that these educational efforts would be well received.

These findings clearly demonstrate multiple gaps in current (and prior) training standards, offering potential opportunities for growth for cardiovascular FITs.[19,28] In addition to enhancing and expanding their didactic curriculum, trainees could benefit from increased exposure to this patient population. Current self-reported exposure of FITs to pregnant or lactating women is low, with 11% evaluating a pregnant or lactating patient annually and 23% never over the course of their fellowship to date. This historical and ongoing shortfall likely contributes to the gaps reported by practicing clinicians as well as FITs; there is clearly a higher level of comfort for managing heart disease in the nonpregnant patient compared with the pregnant patient for all groups. Ensuring exposure to this complex patient population and adequate interdisciplinary didactic training for all cardiovascular trainees will be important for reducing knowledge gaps and improving maternal outcomes.

Similar opportunities exist to improve upon current CVT member training. Current nurse practitioner/physician assistant programs are mostly divided by Family Practice (which encompasses obstetrics and postpartum care) and Acute Care Practice (cardiovascular specialties), creating few chances during graduate-level education to marry the 2 topics, but innovative combination programs at cardio-obstetrics centers of excellence could be developed. For practicing CVT clinicians (nurse practitioners/physician assistants/registered nurses), training varies greatly based on the clinical setting; and although a Practice Transition Accreditation Program pathway currently does not exist, one could be constructed to merge the currently isolated obstetrics and cardiology curricula into dedicated cardio-obstetrics training.

Although the field of cardio-obstetrics has existed for several decades, survey respondents report a paucity of formalized programs at their institutions, with most existing in affiliation with a medical school. Although data supporting a maternal morbidity and mortality benefit for women with CVD who are cared for by a cardio-obstetrics team are limited, they suggest better outcomes for patients cared for by an integrated, multidisciplinary program compared with national data for the usual care.[15] Although the general care of pregnant and postpartum women is an essential skillset, it is unnecessary for every practice setting to have a dedicated cardio-obstetrics team. Referral-based access to an expert collaborative cardio-obstetrics team should be available for all women when needed, following the model used for patients with complex congenital heart disease. To match the current and projected population of cardio-obstetrics patients, the cardio-obstetrics team model must also expand in a way that is proven to reduce maternal morbidity and mortality. Cardio-obstetrics core competencies and best practices must be developed to monitor outcomes and track programs' effectiveness.[18] This survey's documentation of the variability in cardio-obstetrics teams represents an important first step forward, but more work is needed to develop and test models of care that provide benefit and can be easily replicated and expand knowledge around best practices.

There are some limitations of our findings that should be noted. The survey instruments used for this undertaking have not been validated. Although only 10% of the approached individuals completed the survey, the survey was specifically designed to be nationally representative and reflective of the ACC's member base. Unfortunately, data on nonrespondents' cardio-obstetrics knowledge and training are not available for comparison with responders, although we hypothesize that individuals who completed the survey may have been more confident or interested in the subject, thus potentially skewing the results to be biased toward overestimating exposure and training in cardio-obstetrics.

Despite the increasing wave of cardiovascular maternal morbidity and mortality, there is a significant gap in knowledge and confidence among cardiovascular clinicians and trainees pertaining to the care of pregnant and postpartum women with CVD. Although all surveyed groups recognize cardio-obstetrics as a vital area of our field and are interested in education on the topic, most cardiologists, FITs, and CVT members do not feel confident managing CVD in pregnant or lactating women. Few centers currently have formalized multidisciplinary cardio-obstetrics teams, and training for cardiovascular fellows is inadequate, providing us with a legacy of suboptimally trained clinicians. This survey substantiates the need for developing new standards for training and educating members of the cardiology workforce to optimize the care provided to pregnant and lactating women with CVD, and to facilitate the expansion of dedicated cardio-obstetrics centers.[16] These efforts will improve the care we provide to women with CVD who are planning or experiencing pregnancy and help reverse the alarming increase in rates of maternal morbidity and mortality experienced in this country.

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ARTICLE INFORMATION

Received October 6, 2021; accepted March 18, 2022.

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Acknowledgments

The authors would like to thank Anne Rzeszut from the American College of Cardiology for her assistance with survey design, implementation, and analysis.

Sources of Funding

Dr Bello receives funding from National Institutes of Health/National Heart, Lung, and Blood Institute: K23 HL136853 and R01HL153382.

Disclosures

Dr Park receives grant funding from Abbott. The remaining authors have no disclosures to report.

Supplemental Material

Data S1
Table S1
Figures S1–S2

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Data Supplement: The Need for Better and Broader Training in Cardio-Obstetrics—

A National Survey of Cardiologists, Cardiovascular Team Members, and Cardiology Fellows in Training

Supplemental Data.

1. Survey questions for physicians and CV team members
2. Survey questions for Fellows in Training.

Supplemental Figure 1. Comfort level of cardiologists, FITs, and CV team members in the management of cardiovascular disorders in non-pregnant patients.

Supplemental Figure 2. Comfort level of cardiologists, FITs, and CV team members in the management of cardiovascular disorders in pregnant patients.

Supplemental Table 1. Demographic comparison between survey respondents and the American College of Cardiology membership at the time of survey distribution.

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Supplemental Data.

1. Survey questions for cardiologists and CV team members

Welcome to the Cardio-Obstetrics Survey!

On behalf of the American College of Cardiology, thank you again for your participation in this important research. This study is a comprehensive effort to characterize those individuals involved in the care of women with and at risk for heart disease before, during, and after pregnancy. Goals are to characterize the backgrounds, practice patterns, training backgrounds and challenges of clinicians, and to define current institutional resources and processes. All answers will only be reported in aggregate with no individual or institutional information. This survey should take approximately 5-7 minutes to complete.

When you complete all of the questions be sure to select the "Submit" button.
If you need to exit the survey before you are finished, please select the "Save" button. Your responses will be saved and you can resume taking the survey from the point at which you stopped.

Thank you very much for your time and insights.

1. To begin, do you currently practice medicine:
   - o Full-time (40 or more hours per week of clinical/administrative/research work)
   - o Part-time (39 or fewer hours per week of clinical/administrative/research work)
   - o Employed, but do not practice medicine (THANK AND TERMINATE)
   - o Retired (THANK AND TERMINATE)
   - o Other, please explain _____

2. How many years have you been in practice?
   - o In training
   - o 1-7 years
   - o 8-14 years
   - o 15-21 years
   - o More than 21 years

3. Who takes care of pregnant and postpartum women with heart disease at your institution?
   - o Whoever is called for the consult
   - o 1 or 2 cardiologists routinely take care of all of these women
   - o We have more than 2 cardiologists who routinely take care of these women

4. Does your facility have a dedicated cardio-obstetrics team and, if so, are you a part of that team?
   - o Yes – I am part of the team
   - o Yes – I am *not* part of the team
   - o No
   - o Not sure

4a. IF YES to 4, What individuals are on the cardio-obstetrics team at your facility? Please select all that apply.
   - ☐ Ob/Gyn
   - ☐ Maternal fetal medicine specialist
   - ☐ Anesthesiologist
   - ☐ Internal medicine/Family medicine/Med peds
   - ☐ Cardiologist
   - ☐ Social worker
   - ☐ Care coordinator
   - ☐ Advanced practice professional (NP, PA)
   - ☐ Other, please specify: _____
   - ☐ Not sure

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4b. IF ANY CHOICE OTHER THAN “not sure” to 4a, At what point are the cardio-obstetrics team members involved in patient care? Select all that apply.

	INSERT INDIVIDUAL FROM Q4A	INSERT INDIVIDUAL FROM Q4A
Pre-pregnancy/Preconception	☐	☐
During pregnancy	☐	☐
Delivery planning	☐	☐
Delivery hospitalization	☐	☐
Post-discharge care	☐	☐
Not sure	☐	☐

5. How often do you take a reproductive history from a new female patient?

- o Always
- o Sometimes
- o Never
- o Depends, please describe: _____
- o Not applicable
- o Decline to answer

5a. IF ALWAYS/SOMETIMES, Which of the following conditions do you investigate? Please select all that apply.

- ☐ Gestational hypertension
- ☐ Preeclampsia/Eclampsia
- ☐ Gestational diabetes
- ☐ Preterm birth
- ☐ Small for gestational age
- ☐ Polycystic ovary syndrome
- ☐ History of assisted reproductive technology/in vitro fertilization
- ☐ Age of first menses
- ☐ Contraceptive methods used
- ☐ Age of menopause
- ☐ History or current use of hormone replacement therapy
- ☐ Other, please describe:
- ☐ None

6. How often do you evaluate a pregnant or lactating patient with a need for cardiovascular assessment or treatment?

- o Daily
- o Weekly
- o Monthly
- o Every 3-6 months
- o Annually
- o Never

6a. IF DAILY/WEEKLY/MONTHLY/EVERY 3-6 MONTHS, what are the 3 most common reasons you are asked to evaluate these women? CHOOSE 3 and rank order

- ☐ Hypertension
- ☐ Preeclampsia
- ☐ Valvular heart disease
- ☐ Heart failure
- ☐ Pulmonary hypertension
- ☐ Arrhythmia history or management
- ☐ Complex congenital heart disease

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- ☐ Simple congenital heart disease (ASD/PFO, etc.)
- ☐ ACS/CAD
- ☐ Connective tissue disorder (Marfans, Ehlers-Danlos, etc.)

7. How confident do you feel in the following:

	Not at all confident 1	2	3	4	Extremely confident 5	NA
Managing cardiovascular disease in a pregnant patient						
Prescribing a cardiology-related medication to a pregnant patient						
Prescribing a cardiology-related medication to a lactating patient						

8. How comfortable do you feel managing the following areas:

	Not at all comfortable 1	2	3	4	Extremely comfortable 5	NA
Physical examination and physiologic changes of the cardiovascular system during pregnancy						
Hypertension management during pregnancy						
Valvular disease in pregnancy						
Management of arrhythmias during pregnancy						
Simple congenital heart disease						
Complex congenital heart disease						
Acute coronary syndromes during pregnancy						
Chronic coronary artery diseas during pregnancy						
Management of aortopathies during pregnancy and delivery						
Management of prosthetic valves and anticoagulation in pregnancy						
Recommending contraception to women with CVD						
Medication safety in lactation and pregnancy						
Multimodality imaging in pregnancy						
Peripartum cardiomyopathy						
Cardiovascular considerations for mode of delivery						
Pre-pregnancy risk assessment and preconceptual counseling						

9. During your training, did you have formal didactic sessions on topics within cardio-obstetrics?

- o Yes
- o No
- o Not sure

10. Which of the following best describes your clinical exposure to pregnant women with cardiovascular disease during your training?

- o Adequate training

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- ○ Limited/inadequate training
- ○ No exposure
- ○ Other, please specify: _____

11. How much dedicated training (clinical and didactic learning) on cardio-obstetrics did you have during training?

- ○ Less than 1 month
- ○ 1-3 months
- ○ 4-6 months
- ○ 7-12 months
- ○ More than 12 months
- ○ No formal training

12. How important is it for cardio-obstetrics to be part of the ACC catalog of learning options?

Not at all important 1	2	3	4	Extremely important 5	Not sure
○	○	○	○	○	○

13. The ACC is considering offering additional educational content on cardio-obstetrics. Which format do you prefer? please select all that apply.

- ☐ Webinar series
- ☐ Dedicated stand alone in-person specialty conferences
- ☐ Separate educational track at ACC Scientific Sessions
- ☐ Online CME modules
- ☐ ACC SAP
- ☐ ACC Chapter meetings
- ☐ Other, please specify: _____
- ☐ None

14. How likely are you to participate in ACC educational offerings on cardio-obstetrics?

Not at all likely 1	2	3	4	Extremely likely 5	Not sure
○	○	○	○	○	○

And now for a few final questions for demographic purposes only.

15. Which of the following best describes your primary work setting?

- ○ Cardiovascular Group
- ○ Government Hospital or Agency-Military
- ○ Government Hospital or Agency-Veterans Affairs
- ○ Government Hospital or Agency-Other
- ○ Insurance Company (HMO, PPO, IPA)
- ○ Industry (pharma, device)
- ○ Multi-Specialty Group
- ○ Medical School/University
- ○ Non-governmental Hospital
- ○ Solo practice
- ○ Other, please specify _____

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16. What is the ownership structure of your practice? (answer required)
    - o Physician owned
    - o Hospital owned
    - o Government owned
    - o Insurance company owned
    - o Medical school/University owned
    - o Other, please specify _____
    - o Not sure

17. What is your gender?
    - o Male
    - o Female
    - o Non-binary
    - o Other, please specify: _____
    - o Decline to provide

18. Which category describes your race/ethnicity? Please select all that apply.

    - ☐ Asian
    - ☐ Black/African American
    - ☐ Hispanic
    - ☐ Native American/Alaskan Native
    - ☐ Native Hawaiian/Other Pacific Islander
    - ☐ White
    - ☐ Other, please specify: _____
    - ☐ Decline to provide

19. Please share any comments you may have about the topics covered in this survey.

_____

_____

20. Would you like to be entered into our random drawing to win one of four $150 Amazon Gift Cards?
    - o Yes
    - o No

[IF Q.20="YES", PLEASE ASK Q.20A]
20A Please enter your contact information below so that you can be notified if you are one of our winners.
Name _____
Email _____

Thank you so much for your time and insights!

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2. Survey questions for Fellows in Training.

Welcome to the Cardio-Obstetrics Survey!

On behalf of the American College of Cardiology, thank you again for your participation in this important research. This study is a comprehensive effort to characterize those individuals involved in the care of women with and at risk for heart disease before, during, and after pregnancy. Goals are to characterize the current level of cardio-obstetrics training experienced and challenges encountered during fellowsip, and to define current institutional resources and processes. All answers will only be reported in aggregate with no individual or institutional information. This survey should take approximately 2-5 minutes to complete.

When you complete all of the questions be sure to select the "Submit" button.
If you need to exit the survey before you are finished, please select the "Save" button. Your responses will be saved and you can resume taking the survey from the point at which you stopped.

Thank you very much for your time and insights.

1. To begin, in which year of training are you currently in?
   - o 1st year clinical cardiology fellow
   - o 2nd year clinical cardiology fellow
   - o 3rd year clinical cardiology fellow
   - o 1st year research fellow
   - o 2nd year research fellow
   - o Other, please describe: _____

2. What is the primary setting for your training program?
   - o University hospital
   - o Community hospital
   - o Private practice
   - o Other, please specify: _____

3. What is your planned area of specialization?
   - o General Cardiology
   - o Imaging
   - o Heart Failure
   - o Electrophysiology
   - o Invasive/Interventional
   - o Adult Congenital
   - o Critical Care
   - o Undecided
   - o Other (please specify)

4. How many cardiology fellows (clinical and research) are there in your program in total (throughout all years)?
   - o 1-10
   - o 11-20
   - o 21-30
   - o 31-40
   - o 41-50
   - o More than 50
   - o Not sure

5. How often do you take a reproductive history from a new female patient?
   - o Always
   - o Sometimes

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- o Never
- o Depends, please describe: _____
- o Not applicable
- o Decline to answer

5a. IF ALWAYS/SOMETIMES, Which of the following conditions do you investigate? Please select all that apply.

- ☐ Gestational hypertension
- ☐ Preeclampsia/Eclampsia
- ☐ Gestational diabetes
- ☐ Preterm birth
- ☐ Small for gestational age
- ☐ Polycystic ovary syndrome
- ☐ History of assisted reproductive technology/in vitro fertilization
- ☐ Age of first menses
- ☐ Contraceptive methods used
- ☐ Age of menopause
- ☐ History or current use of hormone replacement therapy
- ☐ Other, please describe:
- ☐ None

6. How often do you evaluate a pregnant or lactating patient with a need for cardiovascular assessment or treatment?

- o Daily
- o Weekly
- o Monthly
- o Every 3-6 months
- o Annually
- o Never

7. How confident do you feel in the following:

	Not at all confident 1	2	3	4	Extremely confident 5	NA
Managing cardiovascular disease in a pregnant patient						
Prescribing a cardiology-related medication to a pregnant patient						
Prescribing a cardiology-related medication to a lactating patient						

8. How comfortable do you feel managing the following areas:

	Not at all comfortable 1	2	3	4	Extremely comfortable 5	NA
Physical examination and physiologic changes of the cardiovascular system during pregnancy						
Hypertension management during pregnancy						
Valvular disease in pregnancy						
Management of arrhythmias during pregnancy						
Simple congenital heart disease						

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Complex congenital heart disease						
Acute coronary syndromes during pregnancy						
Chronic coronary artery disease during pregnancy						
Management of aortopathies during pregnancy and delivery						
Management of prosthetic valves and anticoagulation in pregnancy						
Recommending contraception to women with CVD						
Medication safety in lactation and pregnancy						
Multimodality imaging in pregnancy						
Peripartum cardiomyopathy						
Cardiovascular considerations for mode of delivery						
Pre-pregnancy risk assessment and preconceptual counseling						

9. What is the ***primary*** source of information to which you refer for cardio-obstetrics questions?
   - o UpToDate
   - o ACC/AHA Guidelines
   - o JACC
   - o Online search
   - o Attendings at your institution
   - o Other, please specify: _____

10. Does your program have a specialized cardio-obstetrics training module?
   - o Yes
   - o No
   - o Not sure

10a. IF YES: Do you rotate through cardio-obstetrics clinic as a fellow?
   - o Yes, it is mandatory
   - o Yes, only as an elective
   - o No

11. In this past year (July 2019 through current date), did you have a lecture/conference/CME (any form of didactic) on cardio-obstetrics in your program?
   - o Yes
   - o No
   - o Not sure

11a. IF YES, how many ***total*** hours were dedicated to cardio-obstetrics for the year?
   - o 1-5 hours
   - o 6-10 hours
   - o More than 10 hours

12. How important is it for cardio-obstetrics to be included in COCATS requirements?

Not at all important 1	2	3	4	Extremely important 5	Not sure
o	o	o	o	o	o

13. The ACC is considering offering additional educational content on cardio-obstetrics. Which format do you most prefer? please select all that apply.

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- ☐ Webinar series
- ☐ Dedicated stand alone in-person specialty conferences
- ☐ Separate educational track at ACC Scientific Sessions
- ☐ Online CME modules
- ☐ ACC SAP
- ☐ ACC Chapter meetings
- ☐ Other, please specify: _____
- ☐ None

14. How likely are you to participate in ACC educational offerings on cardio-obstetrics?

Not at all likely 1	2	3	4	Extremely likely 5	Not sure
○	○	○	○	○	○

15. What is your gender?
    - ○ Male
    - ○ Female
    - ○ Non-binary
    - ○ Other, please specify: _____
    - ○ Decline to provide

16. Which category describes your race/ethnicity? Please select all that apply.
    - ☐ Asian
    - ☐ Black/African American
    - ☐ Hispanic
    - ☐ Native American/Alaskan Native
    - ☐ Native Hawaiian/Other Pacific Islander
    - ☐ White
    - ☐ Other, please specify: _____
    - ☐ Decline to provide

17. Please share any comments you may have about the topics covered in this survey.

_____

_____

18. Would you like to be entered into our random drawing to win one of four $150 Amazon Gift Cards?
    - ○ Yes
    - ○ No

[IF Q.18=”YES”, PLEASE ASK Q.18A]
18A Please enter your contact information below so that you can be notified if you are one of our winners.
Name _____
Email _____

Thank you so much for your time and insights!

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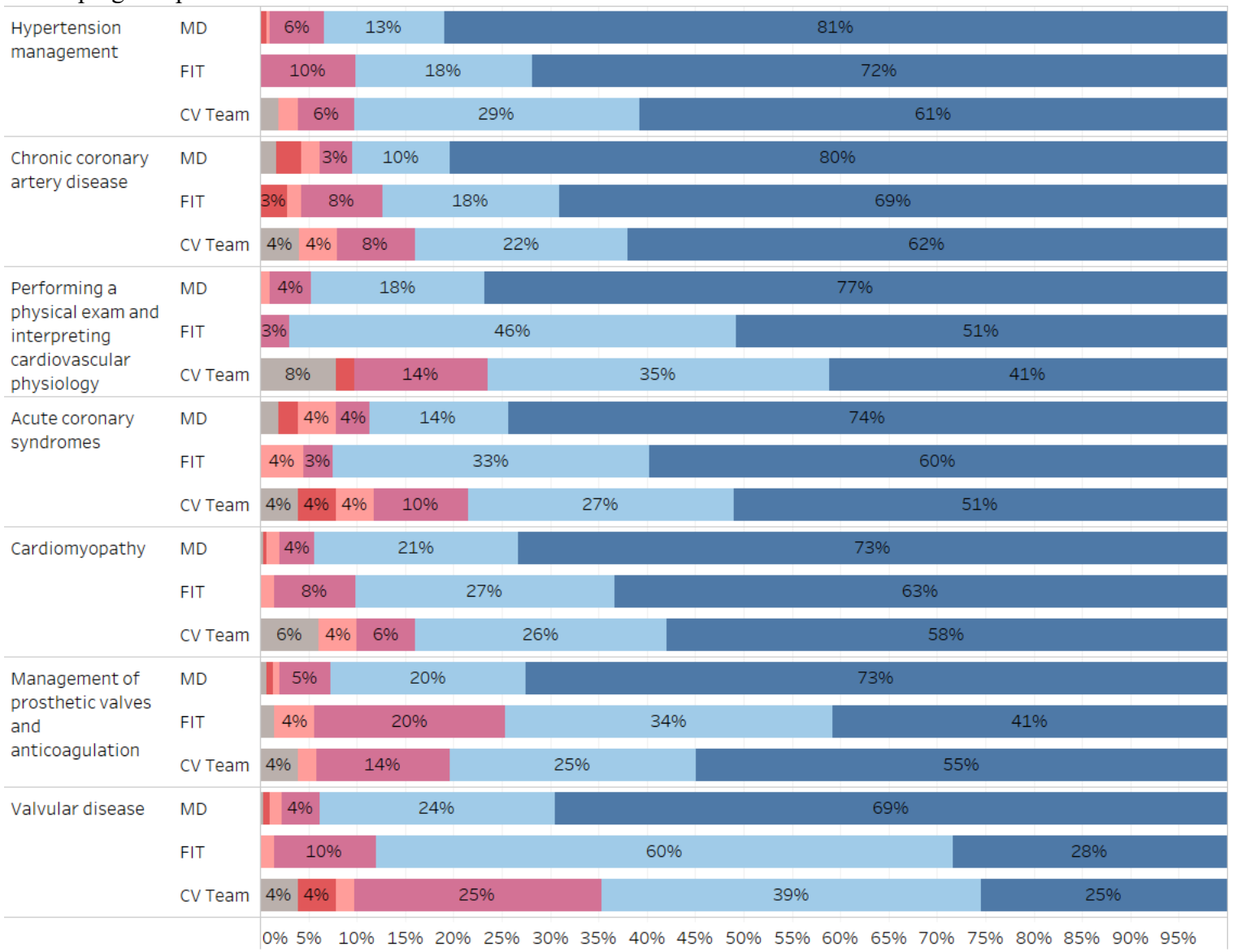
Supplemental Figure 1. Comfort level of cardiologists, FITs, and CV team members in the management of cardiovascular disorders in non-pregnant patients.



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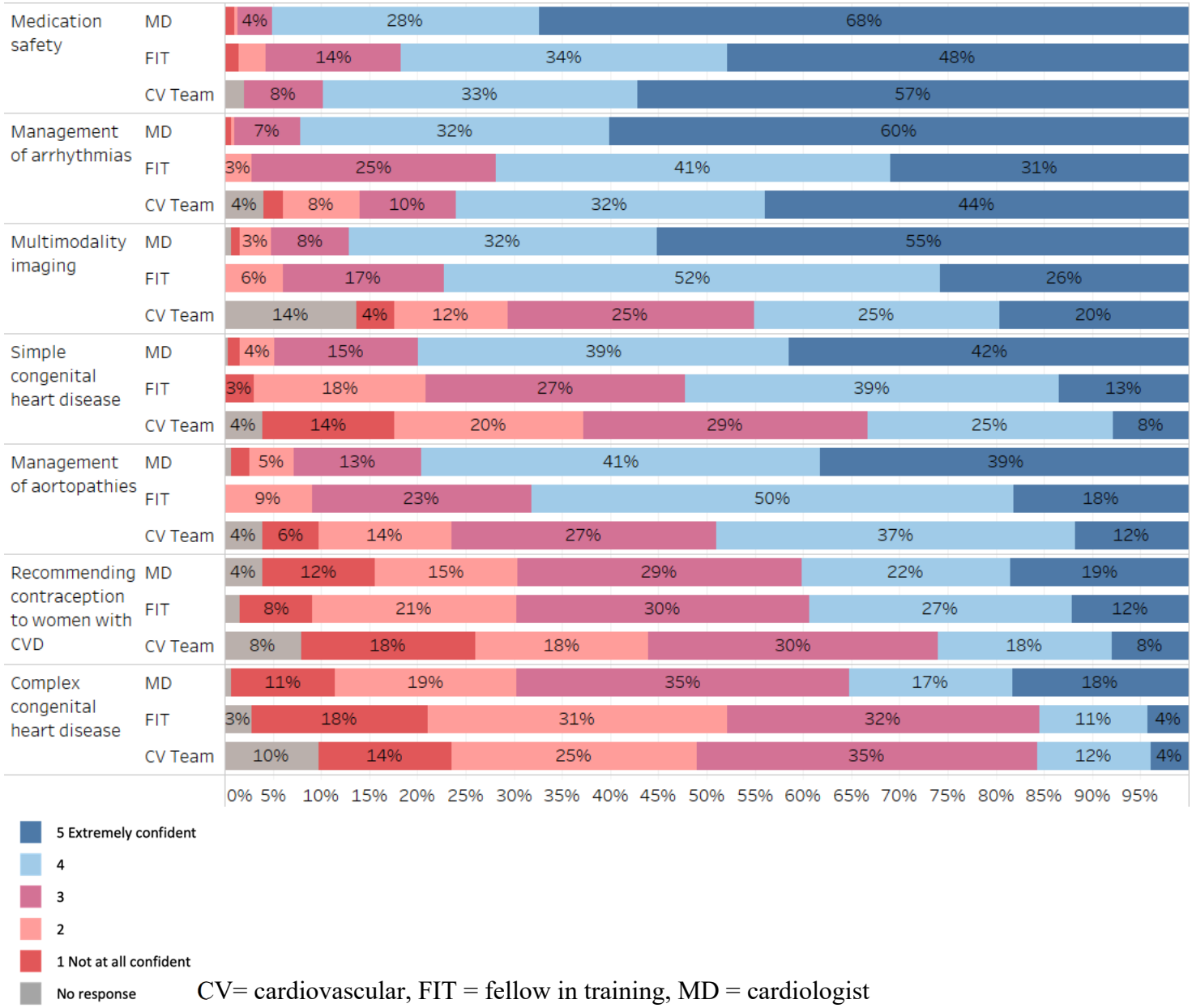

CV= cardiovascular, FIT = fellow in training, MD = cardiologist

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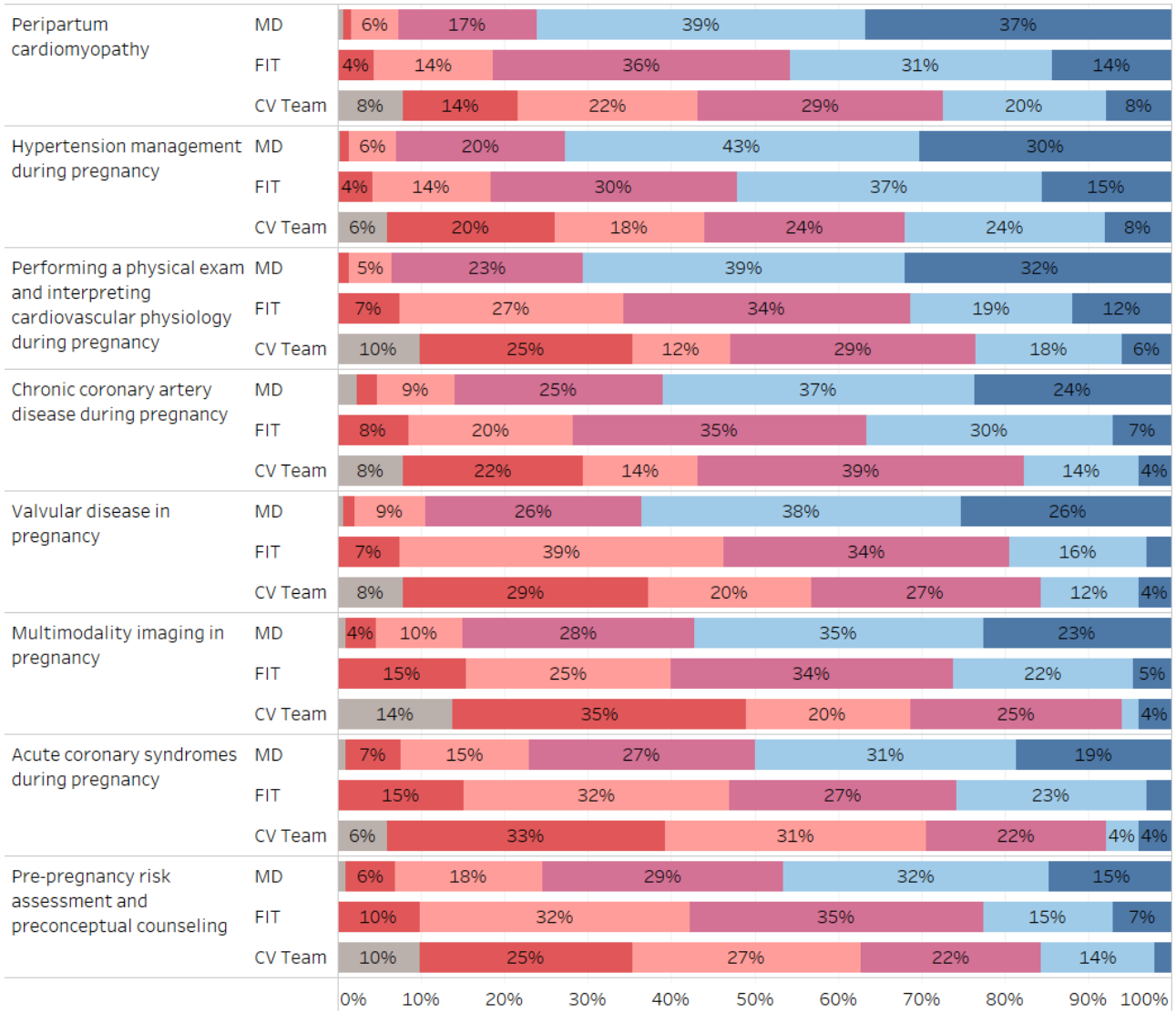
Supplemental Figure 2. Comfort level of cardiologists, FITs, and CV team members in the management of cardiovascular disorders in pregnant patients.



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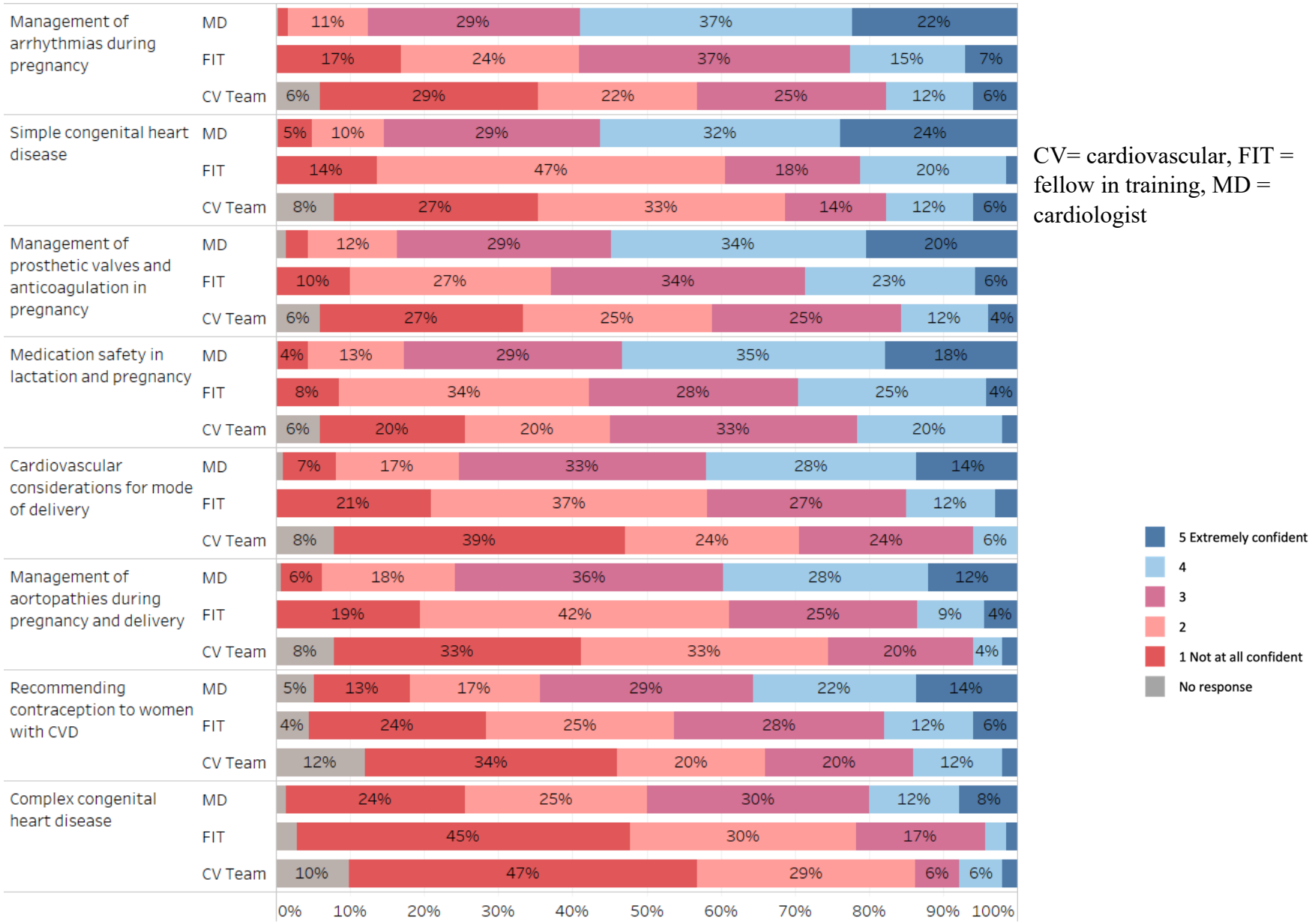

CV= cardiovascular, FIT = fellow in training, MD = cardiologist

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Supplemental Table 1. Demographic comparison between survey respondents and the American College of Cardiology membership at the time of survey distribution.

	Physician		Cardiovascular Team Member		Fellow-in-Training	
	Survey Respondents	**ACC Members**	**Survey Respondents**	**ACC Members**	**Survey Respondents**	**ACC Members**
Self-reported Gender						
Unknown	3.8%	9.2%	2.0%	2.8%	13.7%	18.0%
Decline	0.0%	0.1%	0.0%	0.4%	1.0%	0.2%
Female	25.6%	13.8%	84.3%	81.9%	27.5%	21.3%
Male	70.6%	76.9%	13.7%	14.9%	57.8%	60.4%
Other	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Age (5-year intervals)						
30 or younger	0.0%	0.1%	9.8%	9.9%	10.8%	14.9%
31-35	10.2%	7.9%	21.6%	16.7%	72.5%	66.1%
36-40	13.4%	12.9%	17.6%	15.0%	11.8%	11.5%
41-45	11.9%	11.1%	13.7%	12.1%	3.9%	3.3%
46-50	11.0%	10.7%	3.9%	12.0%	0.0%	0.7%
51-55	11.3%	10.2%	13.7%	9.2%	0.0%	0.1%
56-60	14.5%	12.6%	7.8%	9.8%	0.0%	0.1%
61-65	12.8%	12.6%	5.9%	7.5%	0.0%	0.0%
66-70	6.1%	10.0%	2.0%	3.2%	0.0%	0.5%
71+	5.8%	7.4%	0.0%	0.7%	0.0%	0.0%
N/A	2.9%	4.6%	3.9%	3.7%	1.0%	2.8%
Self-Reported Race/Ethnicity						
Unknown	39.5%	54.9%	23.5%	28.3%	57.8%	73.3%

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Asian	14.2%	12.0%	9.8%	5.2%	10.8%	10.1%
Black/African American	2.3%	1.8%	2.0%	2.6%	3.9%	1.5%
Decline To Provide	1.7%	1.0%	0.0%	1.3%	2.0%	0.9%
Hispanic/Latin	5.2%	3.1%	5.9%	2.7%	5.9%	2.8%
Native American/Alaskan Native	0.0%	0.1%	0.0%	0.3%	0.0%	0.0%
Native Hawaiian/Other Pacific Islander	0.3%	0.1%	2.0%	0.4%	0.0%	0.0%
Other	4.4%	3.2%	2.0%	1.5%	4.9%	2.8%
White	32.3%	23.9%	54.9%	57.7%	14.7%	8.5%
Region						
East North Central	14.5%	14.9%	9.8%	20.1%	19.6%	17.2%
East South Central	6.7%	5.6%	5.9%	5.6%	5.9%	4.7%
Middle Atlantic	16.0%	18.3%	19.6%	12.3%	18.6%	21.8%
Mountain	2.6%	5.5%	7.8%	7.0%	3.9%	3.5%
New England	9.3%	6.6%	7.8%	6.9%	7.8%	8.9%
Pacific	10.8%	11.9%	5.9%	10.9%	6.9%	9.4%
South Atlantic	22.7%	20.3%	23.5%	21.4%	18.6%	17.4%
West North Central	6.4%	6.5%	7.8%	8.7%	8.8%	7.4%
West South Central	10.2%	9.9%	11.8%	6.8%	7.8%	8.8%
Other - PR/GU/VI	0.9%	0.5%	0.0%	0.2%	2.0%	0.8%
Board Certification						
Adult Congenital	3.2%	1.0%				
Adult Cardiology	82.6%	84.6%				

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Electrophysiology	7.6%	7.5%
Heart Failure/Transplant	4.9%	3.5%
Interventional Cardiology	22.4%	25.8%
Nuclear Medicine	2.9%	2.8%
Surgery	0.3%	1.8%
Pediatric Cardiology	5.8%	3.8%

CVT= cardiovascular team member, FIT = fellow in training

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