JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY
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PUBLISHED BY ELSEVIER

VOL. 70, NO. 18, 2017
ISSN 0735-1097/$36.00
https://doi.org/10.1016/j.jacc.2017.09.030

COUNCIL PERSPECTIVES

Status of Early-Career Academic Cardiology

A Global Perspective

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ABSTRACT

Early-career academic cardiologists, who many believe are an important component of the future of cardiovascular care, face myriad challenges. The Early Career Section Academic Working Group of the American College of Cardiology, with senior leadership support, assessed the progress of this cohort from 2013 to 2016 with a global perspective. Data consisted of accessing National Heart, Lung, and Blood Institute public information, data from the American Heart Association and international organizations, and a membership-wide survey. Although the National Heart, Lung, and Blood Institute increased funding of career development grants, only a small number of early-career American College of Cardiology members have benefited as funding of the entire cohort has decreased. Personal motivation, institutional support, and collaborators continued to be positive influential factors. Surprisingly, mentoring ceased to correlate positively with obtaining external grants. The totality of findings suggests that the status of early-career academic cardiologists remains challenging; therefore, the authors recommend a set of attainable solutions. (J Am Coll Cardiol 2017;70:2290–303) © 2017 by the American College of Cardiology Foundation.

The views expressed in this paper by the Early Career Section Leadership Council of the American College of Cardiology (ACC) do not necessarily reflect the views of *JACC* or the ACC.

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Cardiovascular disease (CVD) is the number 1 cause of morbidity and mortality globally, and its incidence is rising at an alarming rate (1). In the United States alone, it is projected that by 2030, 45% of the population will have at least 1 CVD condition (2). Notably, after a long period of sustained decline in the age-adjusted CVD death rate (1950–2014) (3), age-adjusted death rates for heart disease and stroke in the United States demonstrated statistically significant increases from 2014 to 2015 (4). To address this rising burden of CVD, society relies on academic cardiologists in all settings to drive research (basic, translational, clinical, and population) and to train the next generation of cardiologists. Thus, it is critical to maintain and renew the pipeline of early-career academic cardiologists (ECACs) (**Table 1**).

ECACs, defined as those within 10 years of completion of a cardiology fellowship, face enormous challenges. These challenges include limited funding, insufficient protected time, increased regulatory compliance burden, increased competition from pure-PhD scientists, and personal financial disincentives (5). This has resulted in many cardiologists' choosing to leave or never enter the academic workforce (5,6). As a response in 2014, the Early Career Section Academic Working Group of the American College of Cardiology (ACC), along with senior leadership, published a report based on the status of the funding environment, input from staff members of the National Heart, Lung, and Blood Institute (NHLBI) of the National Institutes of Health (NIH), and a survey of ACC ECACs. The report summarizes challenges faced by these early career academicians and proposes potential solutions that could be implemented by the ACC, academic institutions, and policy makers to address these challenges (5). So how far have we come in the past 3 years? To address this question, the Early Career Section Academic Working Group of the ACC continued collaboration with staff of the NHLBI, resurveyed ECACs, and this time included 1 of the fastest growing segments of the ACC: international cardiologists (7). Furthermore, the American Heart Association (AHA) and international representation also have joined this effort to provide a global view of the state of early-career academic cardiology.

The purpose of this 2017 update is to inform the cardiovascular community, academic leadership, and policy makers on the progress of ECACs since the previous publication (5) and to present potential solutions. We hope this report will serve as a catalyst for discussion and policy changes that will promote the survival and success of ECACs and the profession as a whole.

ABBREVIATIONS AND ACRONYMS

ACC = American College of Cardiology

AHA = American Heart Association

CVD = cardiovascular disease

ECAC = early-career academic cardiologist

NHLBI = National Heart, Lung, and Blood Institute

NIH = National Institutes of Health

PI = Principal Investigator

RVU = relative value unit

METHODS

NHLBI personnel guided extraction of publicly accessible data. The AHA provided its grant funding data. International representation (the German Center for Cardiovascular Research and ACC members working with their respective countries' cardiology societies in Canada, India, Israel, Mexico) also provided data. Chief editors (*Circulation* and *JACC: Basic Translational Science*) provided guidance. The ACC conducted a membership-wide survey that was developed by the Academic Working Group of the Early Career Section of the ACC. Inclusion criteria consisted of self-identification as an academic cardiologist and ≤10 years from completion of cardiology fellowship.

Statistical analysis of the responses was performed using SPSS version 23 (SPSS, Chicago, Illinois). *Z* tests and Student *t* tests were used to identify significant differences for categorical and continuous variables, respectively. Pearson and Spearman correlation tests were used to evaluate the strength of relationships between continuous and rank variables, respectively.

RESULTS

RESPONSES, MOTIVATIONS, AND TRACKS. Invitations to participate were e-mailed to 9,646 early-career members of the entire ACC in January and February 2016. Of the 1,131 responses (12%), 558 (49%) were included in the study, 283 (25%) branched out as pure clinicians, and 290 (26%) did not meet inclusion criteria. Most of the respondents practiced in the United States (80%). International members reside and practice outside the United States. The distributions of professional roles (i.e., academic tracks

and T32HL125247. Dr. Mann is supported by US NIH grants R01HL111094, T32HL007081, and U10HL110309. Dr. Raj is supported by the Canadian Institutes of Health Research (grant MOP142426) and the Cardiac Arrhythmia Network of Canada (grant SRG-17-P27). Dr. Mann is a consultant for Novartis (PARADISE trial). Dr. Hira has received honoraria from Abiomed and Abbott Vascular. Dr. Raj provides industry consulting for GE Healthcare and Lundbeck and research enrollment for Medtronic. Dr. Freeman has received non-promotional speaking fees from Boehringer Ingelheim. Dr. Gopinathannair has received speaking honoraria from Pfizer, Bristol-Myers Squibb, Zoll Medical, Abbott Medical, and HealthTrust PG. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

Manuscript received April 17, 2017; revised manuscript received August 28, 2017, accepted September 14, 2017.

TABLE 1 Description of Academic Cardiology Promotion Tracks

Academic Track	Roles, Efforts, Time Spent
Scientist-researcher	• Dedicate nearly 100% effort to research. • Serve as principal investigator in basic, translational, and/or clinical research. • Minimal or no clinical responsibilities. • Funding comes primarily from peer-reviewed extramural or institutional grants. • The emphasis is on investigation and discovery. • The academic promotion is based on demonstration of scholarship (i.e., publications of original research, large multidisciplinary studies, and sustained record of extramural funding).
Clinician-scientist or physician-scientist	• Provide direct patient care and conduct research as principal investigator (basic, translational, and/or clinical). • Develop and test research hypotheses, have a research focus, contribute through publications and extramural funding. • Strong teaching component, including didactic lectures and serving as the teaching attending for medical students, residents, or fellows on clinical services. • This track offers flexibility between commitment to research, education, and clinical care. • The promotion is based on contributions to research, educational activities, and clinical expertise.
Clinician-educator	• Dedicate a significant amount of time to educational activities. • Educational activities include didactic teaching of students, residents, fellows, and peers (lectures, seminars, tutorials, continuing medical education courses), mentoring and serving as advisor to trainees, clinical teaching and bedside preceptorship, in clinic and/or in procedural areas, commonly through an associated medical school and/or graduate medical education program. • Serve as teachers and mentors for allied health professionals, such as physician assistants, nurse practitioners, and pharmacy students. • The promotion is based on contributions to educational activities and trainees' success.
Clinician-educator-administrator	• Have responsibilities in course administration, rotation administration, and clinical operations in addition to the role of clinician-educator. • Educational leadership responsibilities, such as residency or fellowship director, medical school course or seminar director. • Scholarly approach to educational leadership, developing educational materials (syllabi, curricula, training modules or courses), technologies (simulation), and educational assessment tools. • Demonstrate leadership roles in institutional, regional and national education courses, committees, and publish original research related to educational methods.
Pure clinician	• The primary role is providing direct patient care. • Dedicate almost 100% of their efforts to direct patient care, and teaching is performed primarily in the course of clinical duties. • Typically, this group does not have protected time for research or educational activities, and those who wish to pursue those activities, may have to do so outside of their allotted clinical time and defined duties. • Academic promotion commonly requires some demonstration of scholarship, leadership or teaching in addition to clinical excellence.

TABLE 2 Distribution of Roles

Professional Role	2013 Survey (n = 291)	2016 Survey (n = 841)
100% research	0.7	0.7
>75% research	5.8	4.6
40%–75% research	10.0	9.3
<40% research	28.5	25.9
Clinician-educator	18.6	18.5
Clinician-educator-administrator	11.3	7.3
Pure clinician*	25.1	33.7

Values are %. *Indicates early exit from survey and therefore not included in follow-on analyses.

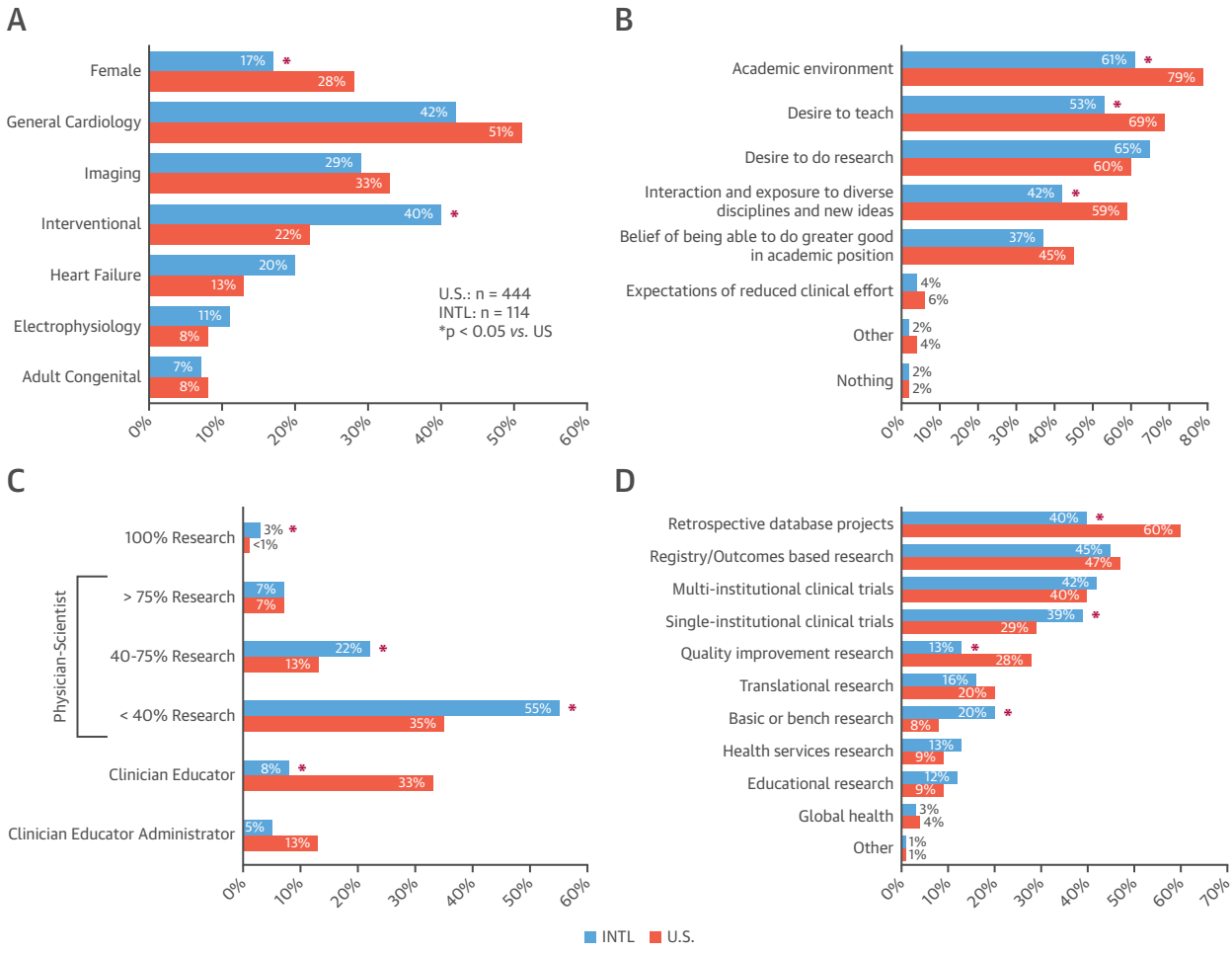
listed in Table 1) remained similar between 2013 and 2016 (Table 2). Thus, comparative analyses would not be confounded by different distribution of academic tracks (Figure 1).

Key motivations for early-career members to pursue academic cardiology consist of academic environment, desire to do research, desire to teach, and interaction with or exposure to diverse disciplines and new ideas (Figure 1B). A significant portion of all respondents (22%) dedicated ≥40% of their professional effort to research. International members differed from U.S. members with a greater percentage engaged in research (Figure 1C), a smaller percentage in teaching (Figure 1C), a greater proportion participating in basic science research and single-institution clinical trials, and a smaller proportion participating in retrospective database projects and quality improvement research (Figure 1D).

RESEARCH FUNDING. After years of declining funding, the NHLBI increased funding of career development K grants from 2013 to 2015 (Figure 2). Mentored Clinical Scientist Development Award K-08 (e.g., basic-translational science research) success rate increased from 26% in 2013 to 51% in 2015. Mentored Patient-Oriented Research Career Development Award K-23 (e.g., clinical research) success rate increased from 30% in 2013 to 38% in 2015. In addition to funding more K grants, the NHLBI increased the amount of K-grant support from $500,000 to $625,000 (not including indirect costs) and developed a new limited competition grant for K-grant awardees to continue their development (RFA-HL-16-020) (8). The NHLBI also increased funding rates of R01 grants from 14.1% in 2013 to 20.9% in 2016 (Online Figure 1). AHA fellow-to-faculty grant success rate declined (from 35% in 2013 to 22% in 2016), and scientist development grant success rate slightly increased (from 16% in 2013 to 19% in 2016); however, overall AHA grant success rates remained steady for the past 10 years (Figure 2). Recently, the ACC has established 2 new 1-year $70,000 grants (Keating and Presidential Awards) for early-career investigators.

With increased NHLBI funding in mind, we then evaluated a group that could have benefited from these increases. This group consists of U.S. members who reported >40% research effort. The NIH has defined >40% research as a significant research commitment (8), and the >40% threshold would likely include members who are committed to pursuing research but have not yet received K grants. Using >75% research effort would have biased the sample toward those who likely already achieved K-grant or K-grant-equivalent funding (because >75% research effort is an NIH K-grant requirement); thus, >75% research effort was not chosen. Within this group,

FIGURE 1 Early-Career Academic Cardiologists' Characteristics



(A) Sex and practice type distribution. **(B)** Motivation for pursuing academic cardiology. **(C)** Academic track and percentage research effort distribution. **(D)** Type of research. INTL = international.

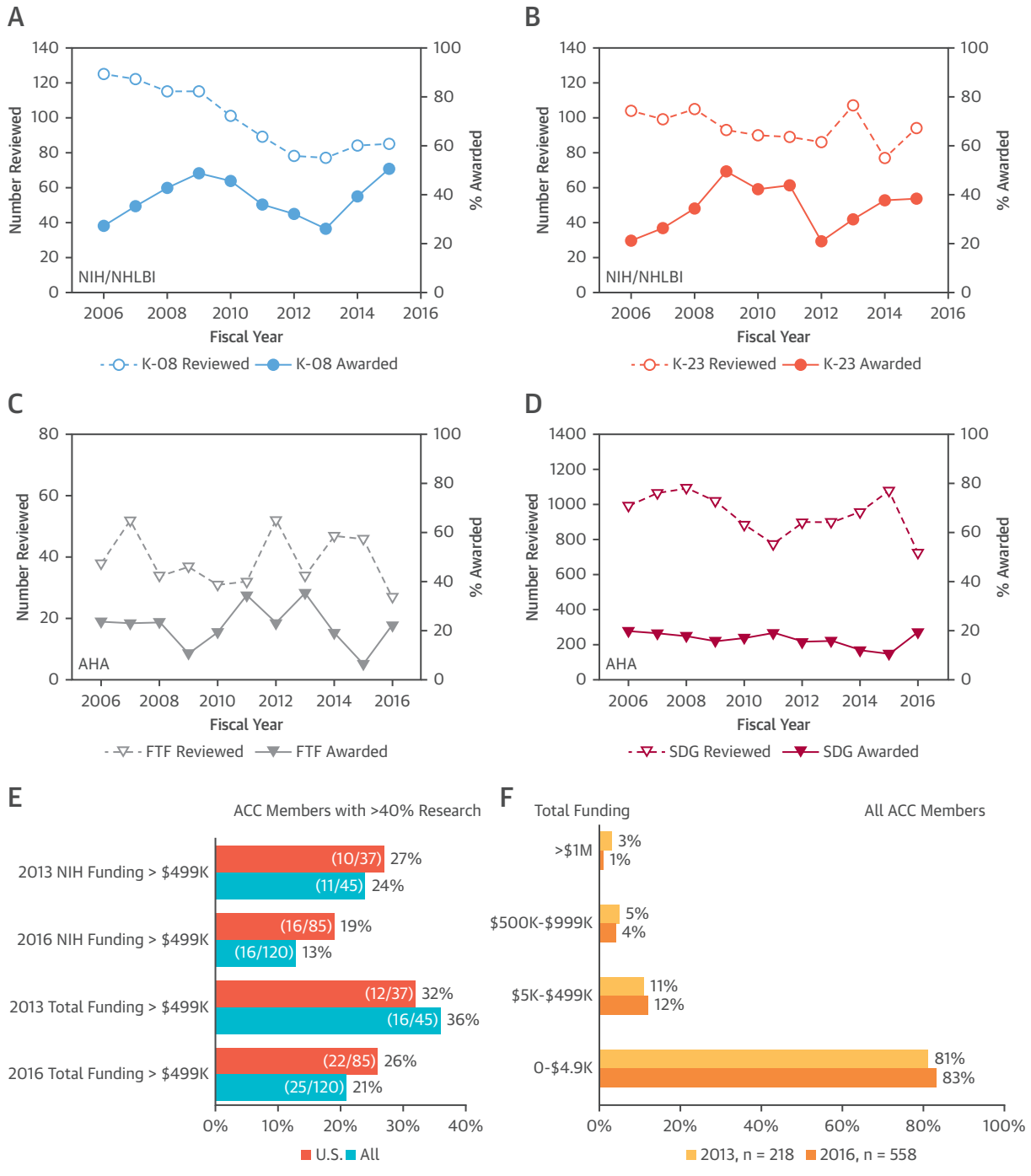
achieving NIH funding >$499,000 decreased from 27% (10 of 37) in 2013 to 19% (16 of 85) in 2016, and achieving NIH funding >$1.2 million decreased from 5.4% (2 of 37) in 2013 to 2.4% (2 of 85) in 2016 (**Figure 2E**). Thus, there were no increases in combined NIH K-grant and R01-grant funding among early-career ACC members despite the increased funding by the NHLBI.

To gain a global perspective, we then tallied total funding for all ACC members (**Figure 2F**). Despite the attempt to increase representation by including co-principal investigators and co-investigators who were not counted in the 2013 study, the percentage of members who do not receive external grant support edged upward from 81% in 2013 to 83% in 2016. There was a 1% improvement for the $5,000 to $499,000 category. However, both top categories trended downward ($500,000 to $999,000: from 5% in 2013 to 4% in 2016; >$1 million: from 3% in 2013 to 1% in 2016). Thus, external grant funding for the entire ACC early-career population is likely to have decreased from 2013 to 2016 (Online Tables 1 and 2).

Matching the publicly available NHLBI database of active K-grant awardees to the ACC database identified ACC ECACs who successfully competed for NHLBI K grants. Although the numbers are small, the latest trends for ACC early-career members achieving K grants are encouraging (**Figure 3**). Among active K-grant awardees who achieved cardiovascular board certification, 25 of 90 (28%) are not members of the ACC.

We performed analyses by U.S. states. The amount of fiscal year 2017 NIH research funding correlated

FIGURE 2 **Funding Environment**



(A) National Institutes of Health (NIH)/National Heart, Lung, and Blood Institute (NHLBI) funding of K-08 Mentored Clinical Scientist Development Award (basic-translational research). **(B)** NIH/NHLBI funding of K-23 Mentored Patient-Oriented Research Career Development Award (clinical research). **(C)** American Heart Association (AHA) Fellow-to-Faculty Transition Award (FTF) (3 recipients declined the award in 2015, depressing the percentage for that year). **(D)** AHA Scientist Development Grant (SDG). **(E)** More than $499,000 external funding for early-career members with >40% research effort. **(F)** Funding distribution for all early-career members for 2013 (only counted funding received as principal investigators [PIs]) and 2016 (counted funding received as PI, co-PI, and co-investigator). ACC = American College of Cardiology.

with the number of hospital beds and the number of teaching hospitals (Figures 4A and 4B). The number of ECACs also correlated with hospital beds and teaching hospitals (Figures 4C and D). However, ECAC funding did not correlate with amount of NIH research funding received by state or number of teaching hospitals (Figures 4E and 4F).

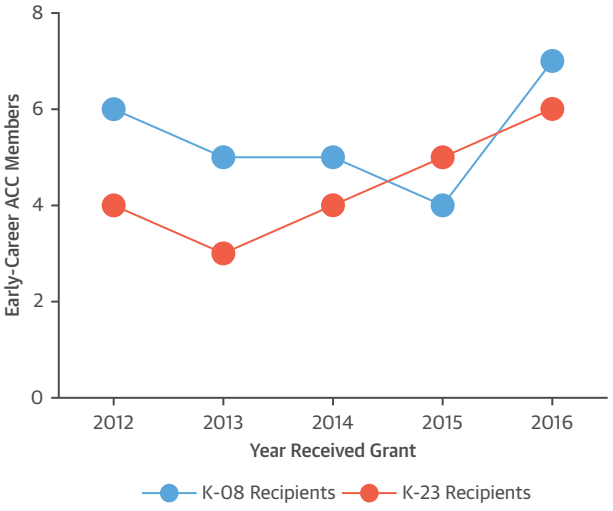
GLOBAL CHALLENGES. The vast majority (sum of top 2 affirmative response = 85% in Figure 5) of both U.S. and international members believe that physicians should be a part of health care research, but ≥70% found lack of time as a challenge. Greater proportions of U.S. members identified challenges of burdensome regulatory compliance, unstable external funding, and competing with pure PhDs. The use of clinical relative value units (RVUs) without credit for research was also a greater challenge for U.S. members. Although all members face challenges of home institutions' not providing sufficient resources or funding, these challenges occur at greater proportions among international members (Figure 5).

International members face limited external research funding streams with limited funding amounts, lack of access to international cardiovascular registries, and lack of research collaborations (Table 3). For example, despite an increase in clinical trials conducted at international sites (9), international members have limited participation in large international registries such as the National Cardiovascular Data Registry (10), which may limit opportunities for transnational research collaborations. Additionally, many international exchange programs are mostly focused on clinical experiences rather than research collaborations (7).

Only a minority of both international and U.S. members reported satisfaction with support for educator development (Figure 5). The status of clinician-educator will be addressed in a separate report.

FACTORS LEADING TO ACHIEVING EXTERNAL GRANT SUPPORT. We performed correlation analyses to identify which factors were associated with achieving increasing levels of funding (Table 4). Input variables consisted of factor rankings (Figure 5) and funding range bins ($0, $1,000 to $99,000, $100,000 to $249,000, $250,000 to $499,000, and >$500,000). Spearman correlation was used because of rank data and skewed funding distribution. Positive correlation consists of resultant $r > 0.1$ ($|r|$ ranges from 0 to 1) that reached statistical significance. The U.S.-members analysis identified factors that correlated with achieving increasing NIH grant amounts. The all-members analysis (including international members) identified factors that correlated with achieving grants from any source. Personal motivation, home institution (resources, value placed on academic pursuits), and connection to collaborators correlated with increasing levels of grant funding for all years and all groups. Home institution providing sufficient bridge funding continued to be a positive correlating factor for increasing NIH funding for U.S. members.

FIGURE 3 K-Grant Awards for American College of Cardiology Early-Career Members

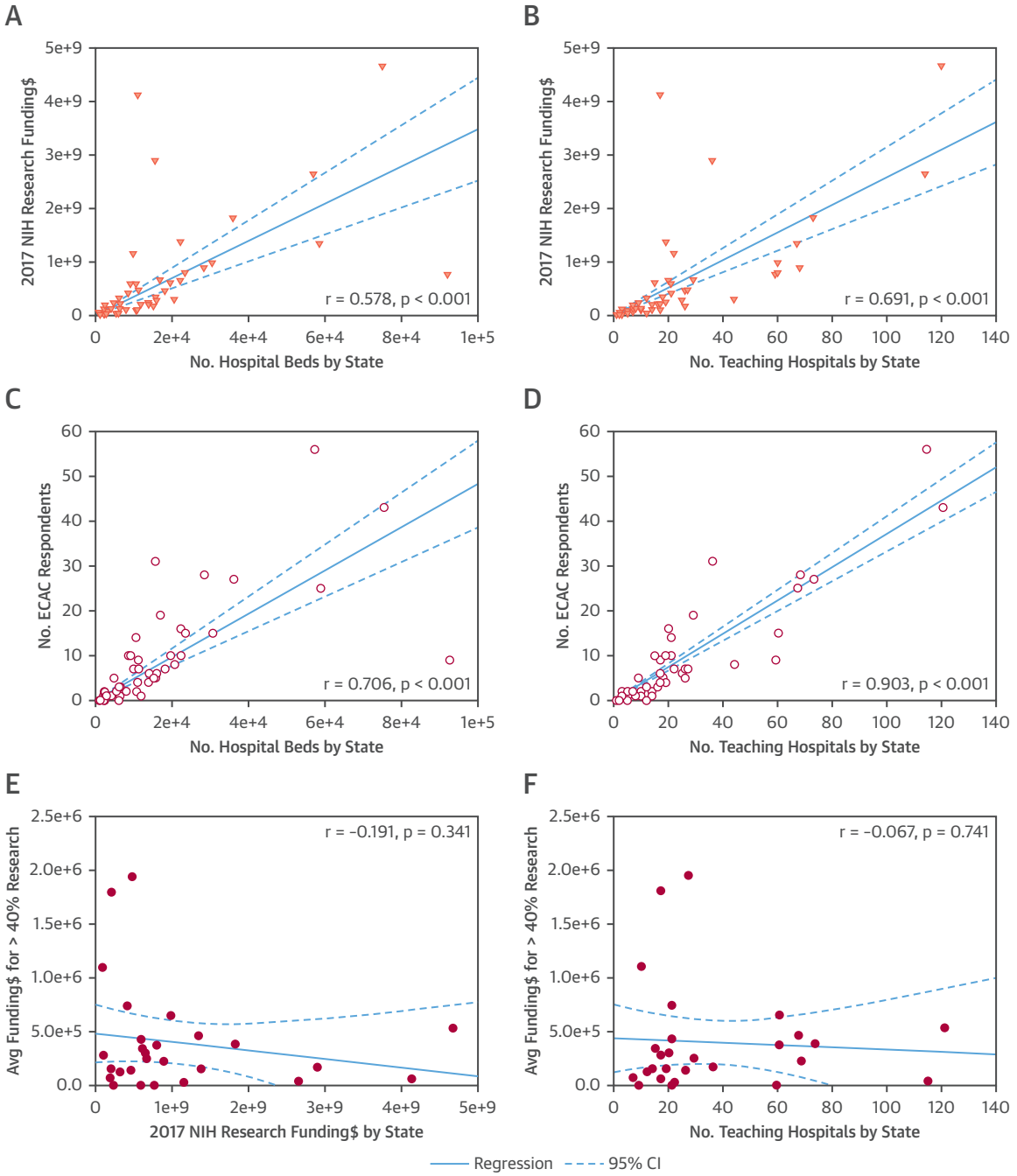


All fiscal year 2017 active National Heart, Lung, and Blood Institute K grants were extracted from National Institutes of Health RePORTer. Principal investigators for these active K grants were matched against the American College of Cardiology (ACC) membership database with ≤10 years from completing fellowship at the time of grant activation. The match showed the number of ACC early-career academic cardiologists successfully competing for K grants by year. Of note, some of the K-grant recipients had aged out of the early-career range at the time of the 2016 survey.

Surprisingly, mentoring ceased to be a positive correlating factor for grant funding in 2016 (Table 4). We then performed a focused analysis on mentoring (Figure 6). Because U.S. members with >40% research effort are positioned to apply for NIH K grants, this group was analyzed. Pearson correlation of mentoring satisfaction versus NIH grant funding showed positive correlation ($r = 0.333$; $p = 0.025$) in 2013 but a lack of any correlation ($r = -0.05$; $p = 0.327$) in 2016. Applying this analysis to all members showed a similar pattern. Pearson correlation of mentoring satisfaction versus total grant funding for all members showed positive correlation ($r = 0.225$; $p = 0.001$) in 2013 but a lack of correlation ($r = -0.036$; $p = 0.349$) in 2016.

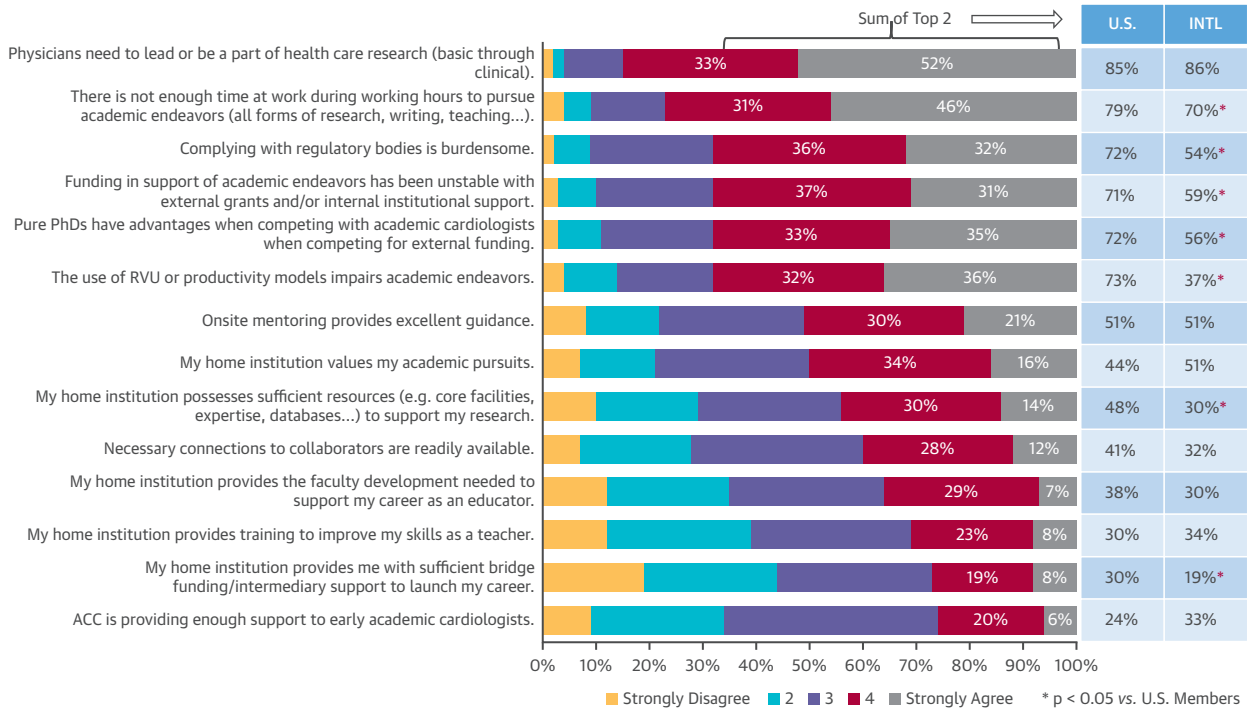
The United States differed from international members on priority of potential research help. U.S. members ranked seed grant and international

FIGURE 4 **Analyses by U.S. States**



Fiscal year 2017 National Institutes of Health (NIH) research funding correlated with number of hospital beds **(A)** and number of teaching hospitals **(B)**. Number of early-career academic cardiologists (ECACs) correlated with number of hospital beds **(C)** and number of teaching hospitals **(D)**. Average funding for ECACs with ≥40% research effort did not correlate with amount of NIH research funding received by state **(E)** and number of teaching hospitals by state **(F)**. Data were extracted from NIH RePORTer (16), Centers for Medicare and Medicaid Services reporting of teaching hospitals (17), and American Hospital Directory (18). CI = confidence interval.

FIGURE 5 Challenges and Resources



Respondents provided ratings for their beliefs and experiences pertaining to academic pursuits. Comparisons were done on U.S. versus international members on summation of the top 2 agreement responses. INTL = international; RVU = relative value unit.

members ranked receiving help in writing as the top useful help (Figure 7).

DISINCENTIVES. Early-career cardiologists suffered significant financial penalties when choosing an academic career (Figure 7). In 2013, 28% of the respondents gave up >$100,000/year to be in academics. This percentage has increased to 36% (11% international, 43% U.S.) in 2016. A greater percentage of international members (39%) do not incur any financial penalties for choosing academic cardiology than U.S. members (25%). The vast majority of U.S. members (85%) are under RVU systems to receive credit for their clinical work, with 61% of these members reporting no credit for nonclinical endeavors. In contrast, only 27% of international members reported participation in a clinical revenue type of system. Similar percentages (13% to 14%) of international and U.S. members reported high likelihood of leaving academics in the next 12 months. This is a slight increase from 11% in 2013. U.S. members reported personal compensation being too low, and international members reported insufficient support for career development as the top reasons for leaving academic careers (Online Table 3).

TABLE 3 Funding Sources and Barriers Among Selected International Sites

Country	Primary Mode of Funding for Cardiovascular Research	Country-Specific Examples of Funding Streams
Canada	Noncommercial*	Canadian Institutes of Health Research, Heart and Stroke Foundation of Canada
Germany	Noncommercial	German Centre for Cardiovascular Research, German Research Foundation, German Cardiac Society
India	Commercial† and noncommercial	Indian Council of Medical Research, Public Health Foundation of India, All India Institute of Medical Sciences
Israel	Noncommercial	Israel Science Foundation, Israel Heart Society
Mexico	Noncommercial	National Council of Science and Technology, Carlos Slim Institute of Health, Mexican Education Ministry
Turkey	Noncommercial	Scientific and Technological Research Council of Turkey
United Kingdom	Commercial and noncommercial	British Heart Foundation, Association of Medical Research Charities, National Institute for Health Research
Barriers to successful academic career:		
Insufficient research infrastructure at home institution		
Lack of access to cardiovascular registries and transnational research collaborations		
Insufficient bridge/pilot funding at home institution		
Limited research funding streams with limited research funding amounts		

*Foundations, charities, government departments, research institutes. †Medical industry, for-profit companies.

TABLE 4 Factors That Correlated With Increasing Amount of External Grant Funding

	U.S. NIH Total 2013	U.S. NIH Total 2016	All Total 2013	All Total 2016
[Motivation] Physicians need to lead or be a part of health care research.	+↑	+↑	+↑	+↑
[Home institution] My home institution provides me with sufficient bridge funding/ intermediary support to launch my career.	+↑	+↑	–	+↑
[Home institution] My home institution possesses sufficient resources (e.g., core facilities, expertise, databases) to support my research.	+↑	+↑	+↑	+↑
[Collaborators] Necessary connections to collaborators are readily available.	+↑	+↑	+↑	+↑
[Mentoring] Onsite mentoring provides excellent guidance.	+↑	–	+↑	–
[Home institution] My home institution values my academic pursuits.	+↑	+↑	+↑	+↑
[Experience] Funding in support of academic endeavors has been unstable with external grants and/or internal institutional support.	–	+↑	–	+↑
[Experience] Complying with regulatory bodies is burdensome.	–	+↑	–	+↑

Spearman correlation was done between responses to challenges and resource factors (1 = strongly disagree, 5 = strongly agree) vs. obtained total grant amount by ranges (0, $1,000 to $99,000, $100,000 to $249,000, $250,000 to $499,000, ≥$500,000). Mentoring changed from being a positive correlation factor for U.S. members to obtain National Institutes of Health (NIH) grants to being noncontributory (2013: $r = 0.236$; $p = 0.001$; 2016: $r = 0.081$; $p = 0.103$). Mentoring changed from being a positive correlation factor for all members for all grants to being noncontributory (2013: $r = 0.241$; $p = 0.001$; 2016: $r = 0.070$; $p = 0.115$).

+↑ = positive correlation with $p < 0.05$; – = no correlation.

DISCUSSION

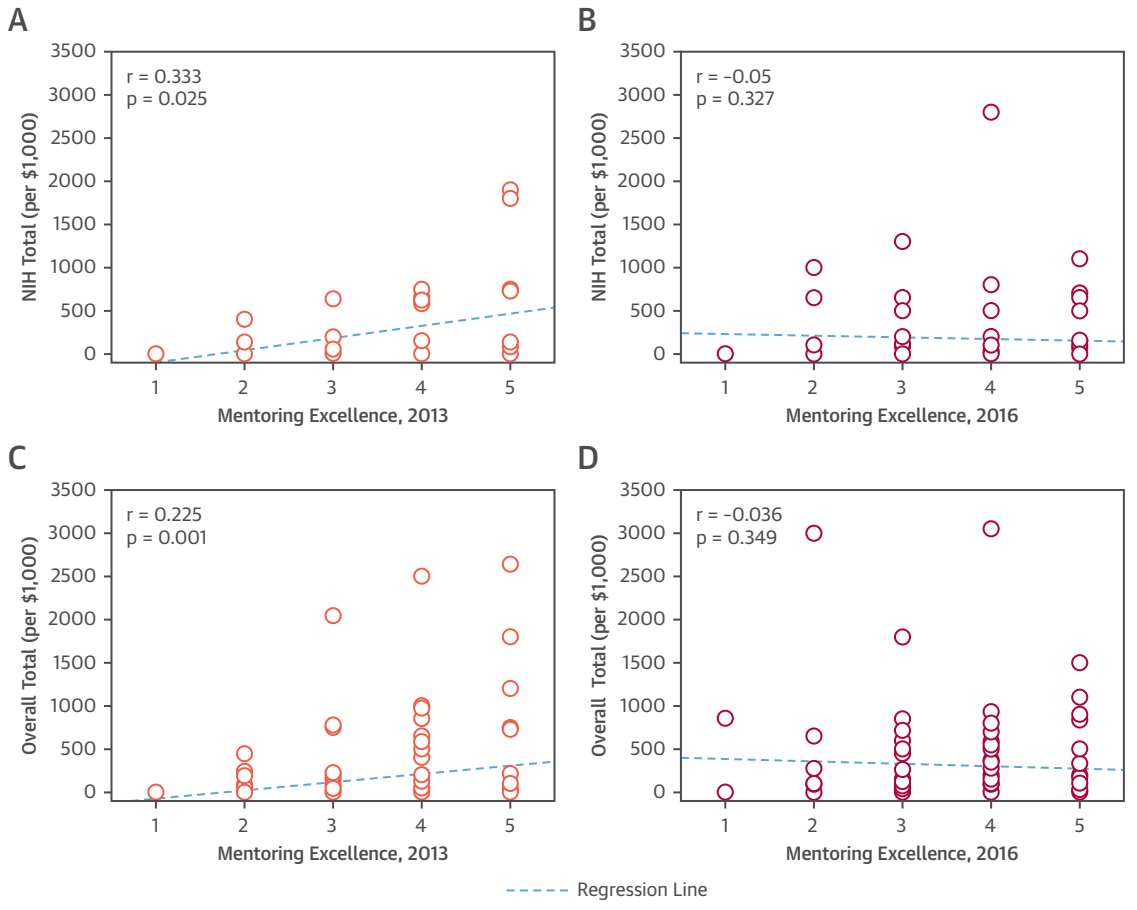
Globally, the status of ECACs has declined slightly since 2013; however, there were a number of positive developments as well. Negative items included the following: a global reduction in gaining funding for research has likely occurred (**Figure 2,** Online Tables 1 and 2), only a minority of respondents reported satisfaction in teaching development (**Figure 5**), the ability of mentoring to positively affect grant outcome has diminished (**Figure 6**), financial disincentives for pursuing academics are increasing (**Figure 7**), and 14% of early-career members now reported a high likelihood of leaving academics. In the United States, these results are consistent with a declining physician-scientist workforce as documented by the NIH (6). Positive developments included the following: the NHLBI has increased funding significantly through multiple mechanisms, the ACC has provided new grants, and although currently small in number, ACC early-career academic members continued to obtain NHLBI K grants (**Figure 3**). In summary, continued attention should be directed to the development of ECACs.

Mentoring needs attention. A local mentor who can provide support, feedback, and when necessary hard-hitting critique, is pivotal importance in launching a physician-scientist's career. All early-career cardiologists need someone of whom "dumb questions" can be asked, someone who edits papers and grants with a fierce red pen, and someone who works through talks slide by slide. The NIH has recognized the importance of the mentor; consequently, the NIH formally evaluates the quality of applicants' mentors in determining who will receive K grants (11–13). Mentoring positively correlated with increasing grant funding in 2013 but not in 2016, while all other positive factors remain unchanged (**Table 4, Figure 6**). Together with ECACs' inability to capitalize on NHLBI significantly increasing K-grant funding that specifically targets physician-scientists, mentoring appears to have lost its effectiveness. This can be caused by loss of effective mentors or mentoring ceasing to play a role. Regardless, restoring effective mentoring is crucial.

Different mentoring needs exist. NIH K-grant requirements include active R01-level funding, record of successful mentees, ability to support mentees' research, actively publishing, and being the expert in the field (11–13). Early-career members will also need guidance in career development, negotiating a faculty position, and negotiating institutional support. Conversely, those who desire to mentor also need helpful development. Mentoring does not happen spontaneously. Rather, a matchmaking process needs to occur, and a beneficial relationship needs to develop. Currently, both mentoring needs and mentor development needs remain relatively unknown. Perhaps the first step to restore effective mentoring is to gain a better understanding of the needs. Subsequently, mentor support programs can be developed.

The mixed success of early-career members achieving career development-level funding support needs attention. Results showed diverging trends of decreasing percentage of U.S. early-career members receiving the NIH K-grant level of funding (**Figure 2E**), despite significant NIH and NHLBI funding increases (**Figures 2A and 2B**). However, we identified many board-certified cardiologists with NIH K grants who are not ACC members. Determining why these cardiologists have chosen not to join the ACC is a topic that needs to be addressed. Conversely, a very small core of members are having some success (**Figure 3**). We need to find ways to extend the success of this small core to others who want to pursue academic cardiology. Broadening the opportunities for protected research time can expand success to others. Trainees and early-career physician-scientists must achieve first authorship of an original research paper and expertise in their selected areas to be competitive in grant application (11). An MD-PhD has a chance to accomplish this difficult task in 2 years (6,11). An MD with less experience will likely need ≥3 years (6,11).

FIGURE 6 **Focused Mentor Excellence to Grant Funding Analyses**

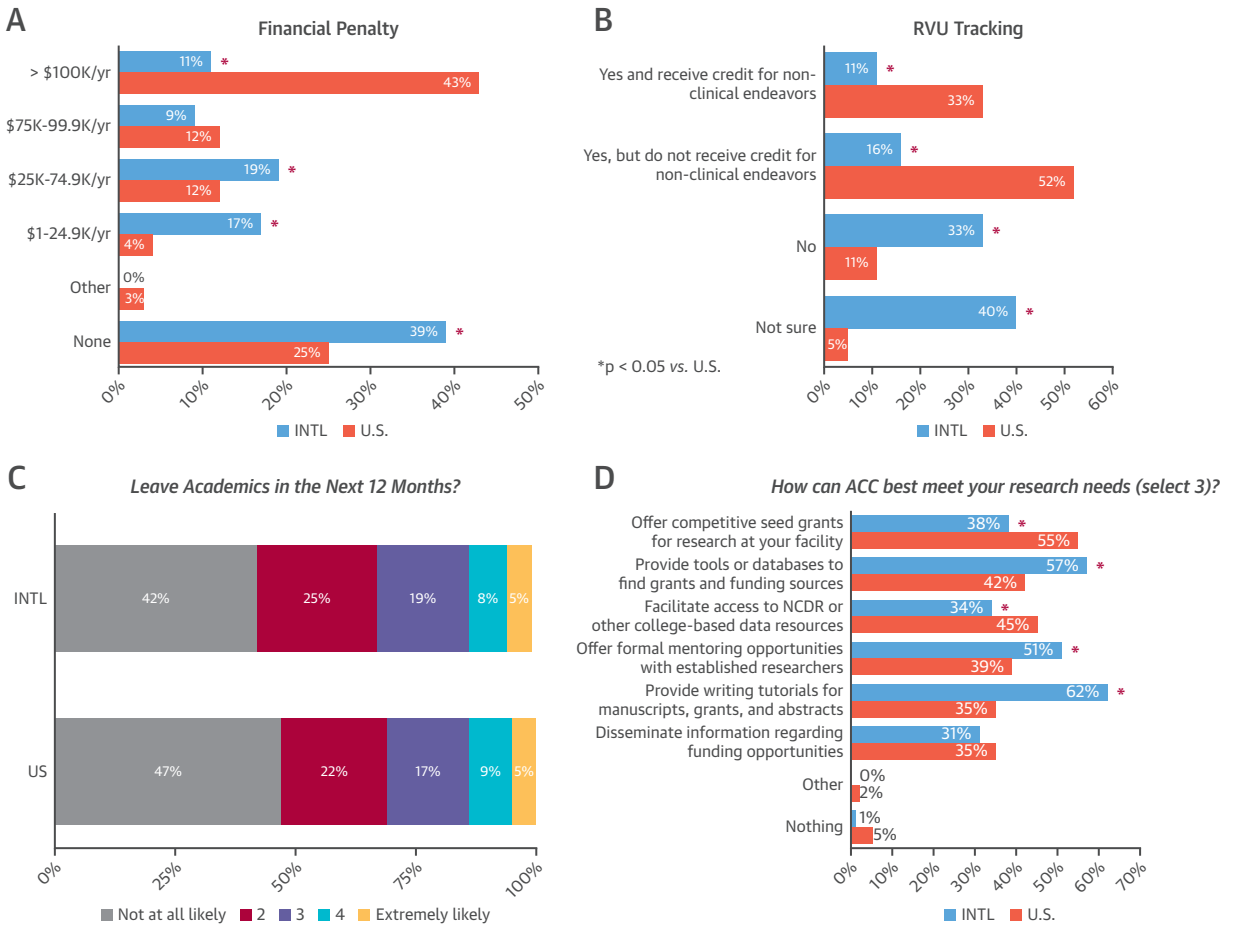


Early-career members' reported on-site mentoring provides excellent guidance (1 = strongly disagree to 5 = strongly agree) plotted against external grant amount received. **(A)** Total 2013 National Institutes of Health (NIH) funding for U.S. members reporting >40% of research effort. **(B)** Total 2016 NIH funding for U.S. members reporting >40% of research effort. **(C)** Total 2013 external funding for all members. **(D)** Total 2016 external funding for all members. Pearson correlation analyses were performed between members' ratings of mentoring to achieved grant support (correlation coefficients [r] and p values are listed within the figures).

Unfortunately, the current Accreditation Council for Graduate Medical Education 3-year CVD program does not allow time for the development of this competitive portfolio (14). Thus, the protected time to complete research training must occur in addition to a 3-year cardiology fellowship. Paid instructor-level or new faculty positions with at least 75% protected research time support the development of competitive portfolios. In fact, K-grant awardees hold these positions at the time of K-grant application (15). Programs with active NIH T32 training grants, NIH Clinical Translational Science Awards, or institutional supported career development awards (such as Vanderbilt's Faculty Research Scholars Program) can provide these additional years of protected time. However, only a few centers currently provide these opportunities. Thus, we need to encourage interested institutions, including private and community-based health care systems, to develop these early-career faculty programs with protected research time outside of NIH funding to broaden opportunities.

This study also revealed that the transition from career development award (K grant) to independent funding (R01 grant, which provides ≥$1.25 million) is a particularly vulnerable period. Early-career members achieving >$1 million grant support fell from 3% in 2013 to 1% in 2016. These very small and declining percentages may reflect ACC members' encountering significant challenges in making the transition to independent funding. On average, it takes K-grant

FIGURE 7 Penalties and Requested Help



(A) Members' reported salary reductions for pursuing academic cardiology with respect to their peers. **(B)** Reported application of RVUs. **(C)** Likelihood of leaving academic cardiology in the next 12 months. **(D)** Top 3 areas where members believe the American College of Cardiology can best meet their research needs. NCDR = National Cardiovascular Data Registry; other abbreviations as in Figure 5.

recipients longer than 4 years and >3 R01 proposal attempts before obtaining R01 grants (15). K grants require active practice licenses; thus, physician-scientists are protected when competing for these grants. However, R01 grants have no such protection. With PhD-only scientists who do not have clinical responsibilities being much more numerous (11), K-grant recipients now face increased competition when applying for R01 grants. With the combination of financial disincentives (43% took >$100,000/year pay reductions) and the pressure to meet clinical RVU goals (52% do not receive RVUs for academic pursuits), these forces can easily push U.S. academic cardiologists to do more clinical work instead of spending efforts on experiments and writing grants. This shift toward clinical work can reduce both the quality and quantity of proposals being submitted. Developing funding streams that support physician-scientists and minimizing the financial disincentives may help. Developing suitable methods to provide credit for academic pursuits may also alleviate the pressure for clinical productivity.

International early-career members have similar characteristics but additional needs. All members chose academic cardiology for similar reasons (Figure 1). All members believe that cardiologists should participate in health care research (Figure 5). International members need help with expanding institutional research infrastructure, including participation in international research collaborations, cardiovascular registries, and diversification of research funding streams.

TABLE 5 Recommendations

Recommendations to ACC and cardiovascular professional organizations

- Continue to conduct studies of members and publish results on a regular basis (e.g., every 3 yrs).
- Develop a registry that will follow a representative cohort of early-career academic cardiologists in their progression over time (starting from the last yr of fellowship and for 10 yrs after completion of fellowship).
- Conduct follow-on studies to fill knowledge gaps.
  - Mentoring needs (career development, becoming NIH-funded principal investigator, contract negotiations)
  - Needs of mentors (this can be critical to foster collegiate intergenerational communications and to ensure a base level of mentoring skills)
  - Early-career members' commitment and associated needs (e.g., committed to academic cardiology, want to explore possibilities, committed to clinical care)
- Promote mentoring.
  - Provide mentoring workshops after identification of mentoring and mentors' needs
  - Provide increased recognition beyond one award per yr (e.g., by category: basic, translational, clinical; by stage: early [first 5 yrs of mentoring experience], middle [mentored from 5–15 yrs], senior [mentored for >15 yrs and has a record of mentees achieving independent faculty positions])
  - Upgrade existing mentoring database
- Modify current early-career junior faculty 1-yr awards to cover at least 2 yrs.
  - Require home institution to guarantee >50% research effort
  - As a possible no-cost expanding method, funding one $70,000/yr grant for 2 yrs instead of two $70,000/yr grants for 1 yr
  - Consider seeking additional industry, philanthropy, and membership donations to fund this program
  - Consider expanding this program in the future after learning from results and establishing fund
- Help establish a heart disease philanthropic foundation that will fund research and assist patients (the Susan G. Komen Foundation is a good example from breast cancer: its mission statement is "Save lives by meeting the most critical needs in our communities and investing in breakthrough research to prevent and cure breast cancer"). Unlike the ACC and AHA, this foundation needs to be free from lobbying to maintain tax exemption and good will of contributing public. The Better Business Bureau Wise Giving Alliance reported total program expenses for 2015: American Cancer Society, $708,516,000; Susan G. Komen Foundation $217,779,902; AHA, $527,297,000. These numbers suggest that a heart disease–based foundation in addition to the AHA is possible and needed.
- Advocate for increased funding for the NHLBI in T-32 training grants, career development grants, and research grant targeting early-career physician-scientists.
- Develop a workshop and exchange program to help international members in writing.
- Develop a requirement statement for advanced cardiovascular research training (e.g., level II and level III) for the next iteration of ACC curriculum recommendation document (COCATS).
  - Writing team needs to include recent K-08, K-23, and R-01 recipients
  - NHBLI input will also be useful

Recommendations to academic centers and clinical institutions

- Continue to compete for federal funding that supports protected research time (i.e., T-32, CTSA).
- Develop funding mechanisms outside of federal grants that can fund protected research time at >75% effort during the fellowship yrs for >2 yrs.
- Develop partnership with land-grant universities (e.g., tenure-track professor positions) to provide funding for salary to support protected research time of faculty academic cardiologists outside of clinical revenue stream (e.g., Baylor Scott & White–Texas A&M University).
- Develop partnerships with philanthropic foundations to provide funding for salary to support protected research time of faculty academic cardiologists outside of clinical revenue stream (e.g., Vanderbilt University Medical Center Faculty Research Scholars Program).
- Developed methods to provide credit for academic pursuits such research and teaching. The credit can be in nonmonetary form, such as valued components for promotion.

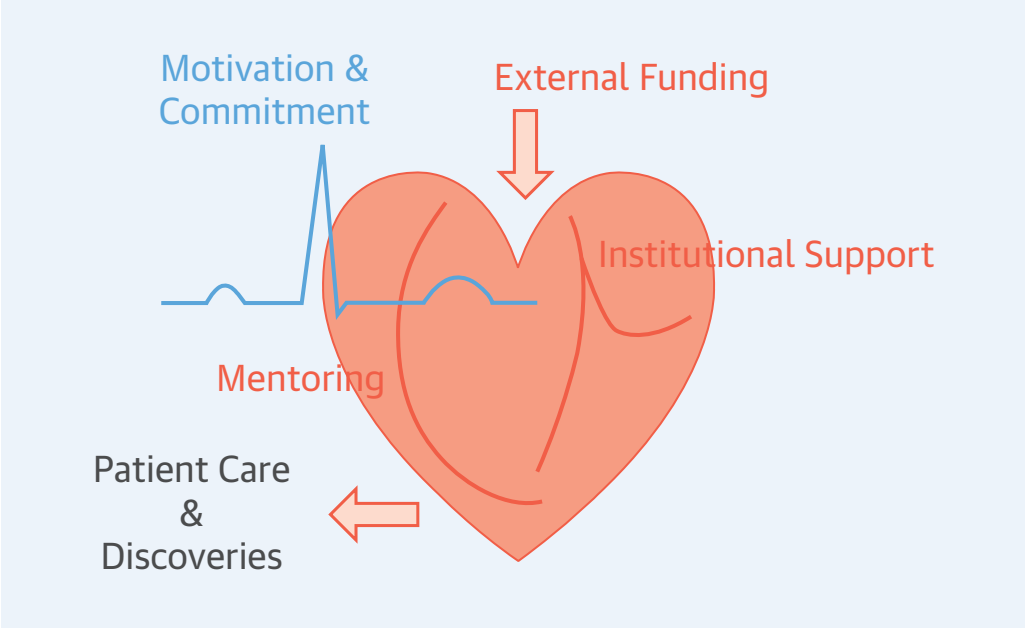
ACC = American College of Cardiology; AHA = American Heart Association; COCATS = Core Cardiovascular Training Statement; CTSA = Clinical Translational Science Award; NIH = National Institutes of Health; NHLBI = National Heart, Lung, and Blood Institute.

TABLE 6 Factors for Choosing an Institution

What to Look for in a Fellowship Program	What to Look for in a Cardiologist Position That Can Support Academic Pursuits
• Institutional resources ◦ NIH CTSA ◦ NIH T-32 grant; grant type: T32; center: HL) ◦ Nonfederal mechanisms to fund protected research time for fellows >2 yrs ◦ Protected research time (>75% research for >2 yrs) to produce first-author paper and transferrable reagents/models to apply for grant (2 yrs is the minimum; non MD-PhDs will likely need ≥3 yrs) ◦ One may need to trade off clinical skill vs. research time if one wants to complete the clinical portion in 24 months • Mentors who can meet NIH K-grant qualifications (recognized expert in the field, active R01 grant or equivalent, actively publishing, track record of mentees successfully transitioning to positions of independent principal investigator) • Core facilities and ongoing research in the area of interest • Track record of fellows transitioning to faculty positions that supported independent investigation	• Institutional resources ◦ Startup fund to run research without external support for >3 yrs (>$750,000; not including salary support for yourself) ◦ Protected research time and compensation if promised protected research time is interrupted (i.e., increased funding and technical support) ◦ CTSA and institutional KL2 ◦ Core facilities that can directly support your research • Mentoring ◦ Mentors who meet NIH K-grant qualifications and will truly invest in you ◦ Mentorship program (e.g., career development, proposal preparation, promotion) • Collaboration ◦ Existence of potential collaborators ◦ Culture of collaboration (need to find junior faculty member[s] who will speak to you honestly)

Abbreviations as in Table 5.

CENTRAL ILLUSTRATION **Early-Career Academic Cardiologist**



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Personal motivation and commitment sustains progress. Institutional support and mentoring help deliver external funding to sustain life. Successful actions provide scientific discoveries and deliver outstanding patient care.

STUDY LIMITATIONS. ACC membership limitation and a 12% response rate may not sufficiently represent the entire ECAC population's progression. Life priorities will change with each ECAC generation. This study does not provide answers on why the funding of U.S. ECACs does not reflect the resources of their respective states. As a solution, we would like to suggest the creation of a registry to follow ECACs starting from their last year in fellowship training to 10 years of practice. Involving program directors and cardiology chiefs can increase participation. This registry potentially will provide more accurate and timely information.

CONCLUSIONS

We believe that successful development of ECACs is critical for continued viability of cardiology as a profession as well as advancing improved cardiovascular care globally. As illustrated by our study, even with some bright developments, the global status of early-career academic cardiology remains uncertain. On the basis of our analyses, we propose a set of potentially attainable solutions (Table 5) and call on the cardiovascular medicine community to help implement them.

ACC AND CARDIOVASCULAR PROFESSIONAL ORGANIZATIONS. Professional societies provide guidance and leadership for both the profession and cardiovascular care. As illustrated by the uncertain status of early-career academic cardiology, we urge the ACC and other societies to continue evaluating the needs of their members, publishing results, and implementing solutions. For now, restoring effective mentorship is a critical need. The ACC has implemented new 1-year awards for early career members, and other societies also have provided early-career support. We thank the ACC and other societies for these actions. However, as detailed earlier, 1-year duration is too short for an early-career academic cardiologist to become competitive. Consequently, we urge expansion of the coverage to 2 years. Asking home institutions to provide matching funds could provide a method for expansion to 2-years. With looming budget instability at the federal level and resulting hesitation of institutions in supporting non-revenue-generating academic infrastructure, the development of new philanthropic support dedicated to funding research and patient assistance in heart disease can help alleviate significant funding needs.

ACADEMIC MEDICAL CENTERS AND CLINICAL INSTITUTIONS. Actions of these entities determine the fate of early-career cardiologists and their ability to pursuit academic interests. We believe that these entities hold the key to broaden the base to support the successful development of ECACs. Besides continuing to provide core capabilities and collegiate academic environment, we urge the development of institutional programs to provide protected research time and find equitable methods to account for the value of academic pursuits.

CURRENT AND FUTURE ACADEMIC CARDIOLOGISTS. We believe that elucidating mechanisms and developing new treatments for CVD is an important cause with a global impact. However, one needs to understand the challenges and then make a strong commitment if pursuit of this career is still desired. With commitment, one needs to choose wisely where to develop on the basis of factors that have led to success (**Central Illustration**). These factors (**Table 4**) consist of institutional resources (funding, core capabilities), institutional commitment to academic pursuits, availability of collaborators, and effective mentoring. **Table 6** provides detailed recommendations, Online Table 4 provides current institutions with active NIH T-32 grants, and the site identifies active NIH Clinical Translational Science Award locations. Our recommendations focus on resources not on clinical setting; therefore, one needs to look beyond university-based academic centers for institutions (e.g., capable private or community-based health care systems) that can provide the resources. It is important for us to function cohesively and persevere through the ebb and flow of funding environments. We must also recognize the importance of political advocacy and the role we must play in garnering attention to research and academic pursuits in order to improve the current status. In conclusion, we wish you success, for there is great joy in not only practicing medicine but changing the way medicine is practiced.

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KEY WORDS cardiology profession, clinician-scientist, early-career academic cardiologist, mentoring, physician-scientist

APPENDIX For supplemental methods and as well as figure and tables, please see the online version of this article.