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Exercise Prescription Methods and Attitudes in Cardiac Rehabilitation: A NATIONAL SURVEY

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Exercise Prescription Methods and Attitudes in Cardiac Rehabilitation

A NATIONAL SURVEY

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Purpose: High-quality exercise training improves outcomes in cardiac rehabilitation (CR), but little is known about how most programs prescribe exercise. Thus, the aim was to describe how current CR programs prescribe exercise.

Methods: We conducted a 33-item anonymous survey of CR program directors registered with the American Association of Cardiovascular and Pulmonary Rehabilitation. We assessed the time, mode, and intensity of exercise prescribed, as well as attitudes about maximal exercise testing and exercise prescription. Results were summarized using descriptive statistics. Open-ended responses were coded and quantitated thematically.

Results: Of 1470 program directors, 246 (16.7%) completed the survey. In a typical session of CR, a median of 5, 35, 10, and 5 min was spent on warm-up, aerobic exercise, resistance training, and cooldown, respectively. The primary aerobic modality was the treadmill (55%) or seated dual-action step machine (40%). Maximal exercise testing and high-intensity interval training (HIIT) were infrequently reported (17 and 8% of patients, respectively). The most common method to prescribe exercise intensity was ratings of perceived exertion followed by resting heart rate +20-30 bpm, although 55 unique formulas for establishing a target heart rate or range (THRR) were reported. Moreover, variation in exercise prescription between staff members in the same program was reported in 40% of programs. Program directors reported both strongly favorable and unfavorable opinions toward maximal exercise testing, HIIT, and use of THRR.

Conclusions: Cardiac rehabilitation program directors reported generally consistent exercise time and modes, but widely divergent methods and opinions toward prescribing exercise intensity. Our results suggest a need to better study and standardize exercise intensity in CR.

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Exercise training, with a goal to increase cardiorespiratory fitness (CRF), is the primary intervention in cardiac rehabilitation (CR) and the key driving factor producing most of the health benefits derived from the service.[1-3] Even small gains in CRF are tightly associated with improved prognosis,[4-8] which creates an imperative to maximize CRF gains for all patients during CR.

Although many factors impact changes in CRF, exercise intensity appears to be the most important variable.[9] However, little is known about how contemporary CR programs prescribe exercise, how patients progress over time, and how often graded exercise testing (ET) and high-intensity interval training (HIIT) are used. Because our research group was unaware of any recent national data on this topic, we undertook this survey to describe how current CR programs prescribe exercise in CR.

METHODS

We administered an anonymous national survey with help from the American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR) between May and July 2020. All survey materials were reviewed and approved by the AACVPR and the Baystate Health Institutional Review Board. Completion of the survey was considered documentation of consent. Because the survey was administered by the AACVPR, at no point was the identity of any respondents or nonrespondents known to the authors.

Our primary goals were to (1) describe the session duration, mode, and intensity of exercise prescribed in CR and (2) evaluate the prevalence, opinions, and policies regarding ET. For the purpose of this survey, maximal ET was defined as a test that measured CRF using either bicycle or treadmill when a patient reaches volitional exhaustion, with or without cardiopulmonary data.

Survey questions were developed through an iterative process. Details of survey development and the final survey instrument are found in Supplemental Digital Content (SDC) 1 (available at: http://links.lww.com/JCRP/A366) and SDC 2 (available at: http://links.lww.com/JCRP/A367).

The AACVPR distributed the survey directly to all CR program directors using SurveyMonkey email invitations. This email included a $10 promotional code that could be redeemed in the online AACVPR learning center. If there was no response, a survey reminder followed 2 wk later, and again 4 wk later. Because many email systems automatically filter emails from sites such as Survey Monkey, our final survey invitation was sent using the

AACVPR email account. While this improved survey distribution, this system could not track which programs responded.

The survey was considered complete if the respondent answered the demographic questions at the end, although all available data (including partial responses) were used when possible. To assess survey representativeness, the AACVPR provided us a de-identified limited copy of the program characteristics database. This allowed us to compare program characteristics (size, offerings, and location) of respondents and nonrespondents using *t* tests and χ^2 tests as appropriate with JMP 12.1 (SAS Institute). Survey responses were then summarized using proportions, averages, and medians, as appropriate. Additional analytic methods are found in SDC 1 (available at: http://links.lww.com/JCRP/A366).

Two authors (Q.P. and M.S.) reviewed all open-ended responses using content analysis methods to describe patterns with survey responses. We noted each unique formula or method to calculate peak heart rate (HR) or a target heart rate or range (THRR). We noted consistent themes discussed by respondents, noted frequency of mention, and selected representative quotes.

RESULTS

Of 1470 valid email addresses, we received a total of 280 (19%) partial and 246 (16.7%) full responses. Respondents came from all parts of the United States and represented programs that enroll a total of ~81 180 patients/yr. For additional demographics and survey nonresponse analysis, refer to SDC 1 (available at: http://links.lww.com/JCRP/A366).

Most CR sessions consist of a 5-min warm-up, 35 min of aerobic training, 10 min of strength training, and 5 min of cooldown, with some variation between programs (Table 1). Twelve programs reported spending no time (0 min) on resistance training. The predominant modes of exercise were the treadmill or dual-action seated stepper, with a stationary bicycle or arm ergometer as common supplementary exercise modes (see SDC 1, available at: http://links.lww.com/JCRP/A366).

On entry to CR, programs directors estimated that 17 ± 28% of patients had data from a maximal ET (either through recent prior diagnostic testing or performed as part of an exercise assessment in CR). Maximal ET results were used to create or modify the exercise prescription in 16 ± 30% of patients, or in 96% of patients in whom results were available. In total, 63% of programs (165 of 262 responses) reported rarely ordering or utilizing ET data for exercise prescription. Only a few programs (11%, 31/271 respondents) reported directly ordering maximal ET, most of which (19, 61%) were performed using program resources. The majority of programs that performed maximal ET (13 of 19 respondents, 68%) reported that this practice was moderate to highly financially favorable for the program. Additional analyses are provided in SDC 1 (available at: http://links.lww.com/JCRP/A366).

Program directors reported using multiple formulas to calculate maximal predicted HR when maximal ET results were not available. The most common formula (86% of respondents) was 220 − age (yr), but multiple other formulas were reported including 226 − age, 207 − age, 200 − age, 212 − (age × 0.77), 207 − (age × 0.7), and 208 − (age × 0.7).

Most programs (91%) reported using a THRR for at least some patients to guide exercise intensity. When setting a THRR, most programs used resting heart rate (RHR) +20-30 bpm (35%), followed by using a prediction formula (28%), submaximal ET (19%,) or maximal ET (7%) to establish a THRR. In open-ended questions, 152 program directors reported using at least one formula to guide exercise intensity, of which there were 59 unique methods to prescribe exercise intensity (Figure 1). The most common methods were RHR +20-30 bpm, 65-85% peak HR, or 60-80% HR reserve (HRR).

Most programs (98%) reported using ratings of perceived exertion (RPE) to guide exercise intensity. The most common RPE scale was the Borg 6-20 scale (75%), followed by the Borg 0-10 modified scale (23%), the OMNI scale (3%), and the 5-point scale (1%). The most common target RPE (Borg 6-20 scale) range was 11-13 (47%), followed by RPE of 12-15 (39%), with a few programs using 11-14 (5%) or 11-15 (5%). A goal of 3-4 (92%) was the most common intensity on the modified Borg 0-10 CR scale. Use of RPE was generally of moderate to high quality, but some quality gaps were noted (see SDC 1, available at: http://links.lww.com/JCRP/A366).

When asked to rank their top three exercise prescription methods in frequency of use (starting at #1, most frequent), RPE and RHR +20-30 bpm were the most common method used for most CR programs, which was supplemented by several other methods, such as the talk test (Figure 2).

In total, about half (121 or 252 respondents, 48%) of programs reported using HIIT for at least some of their patients. However, among these programs, HIIT was utilized in a mean of 20 ± 23% of their patients, representing only ~8% of total patients in the survey sample. The HIIT commenced during sessions 1-6, 7-11, or after the 12th session in 6%, 36%, or 58% of programs, respectively. The use of ET was not associated with the use of HIIT (see SDC 1, available at: http://links.lww.com/JCRP/A366).

During exercise training, when patients were exceeding their target HR but were asymptomatic, very few programs (2%) reported consistently reducing workload, several (26%) reported sometimes decreasing exercise intensity, and others (17%) reported making no adjustments. In many (38%) programs, however, exercising above the THRR prompted a full reassessment, including occasionally repeating maximal ET, and/or having discussions with the referring physician and/or medical director.

At the conclusion of CR, CRF was assessed most often by using estimated metabolic equivalent of task based on exercise training workloads (45%), followed by the 6-min walk test (41%), maximal ET (5%), submaximal ET (6%), or something else (4%). Upon discharge, a mean of 71 ± 37% of programs reported providing patients an updated THRR for use at home.

Table 1

Exercise Time in a Typical Session of Cardiac Rehabilitation

Time Spent, min	Mean ± SD	Median (IQR)
Warm-up	5	5 (5, 5)
Aerobic exercise	36 ± 8	35 (30, 40)
Resistance training	10 ± 5	10 (7.5, 15)
Cooldown	6 ± 4	5 (5, 5)
Functional training	4 ± 4	0 (0, 5)
Total time	60 ±12	60 (52.5, 66)

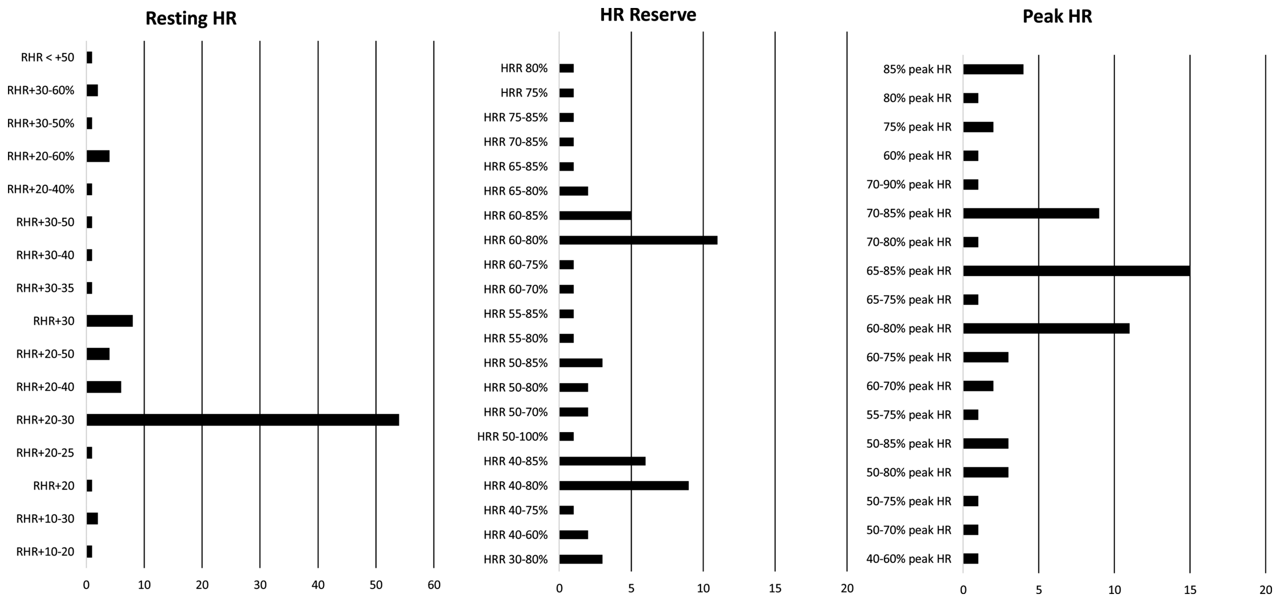

Figure 1. Frequency of exercise prescription methods mentioned. As seen, a wide variety of exercise intensity methods and ranges were reported. In general, the use of resting HR was the most commonly reported technique but use of HRR or peak HR was also reported with significant frequency. Please note scale differences between RHR (max 60) and HRR and peak HR (max 20 each). Abbreviations: HR, heart rate; HRR, heart rate reserve; RHR, resting heart rate.

Program directors reported strong and widely divergent opinions about the value and importance of maximal ET, with 10-20% of respondents either strongly agreeing or strongly disagreeing with multiple different opinion statements (Table 2). Notably, 28% of program directors either agreed or strongly agreed that ET was a "waste of time and money" and 40% of program directors either disagreed or strongly disagreed that their staff members provided consistent exercise prescriptions within their own program. More favorable opinions of ET were weakly positively correlated with frequency of maximal ET use (see SDC 1, available at: http://links.lww.com/JCRP/A366).

In 206 open-ended responses, several themes emerged. First, many programs (n = 50) felt that formulas to calculate THRR should not be used in most patients, given the high prevalence of β-blocker use. Second, several programs (n = 42) described adjusting the THRR over specific pre-determined intervals throughout the program. Third, some (n = 34) programs stressed the supreme importance of clinician experience in individualizing exercise intensity such that HR data should only supplement clinical assessments. Fourth, some programs (n = 30) utilized risk stratification to determine exercise intensity, such that different patient groups, typically grouped by diagnosis or procedure, were prescribed exercise differently by program policy. Fifth, in a few programs (n = 27), physicians directly determined the exercise prescription. Full qualitative analysis and representative quotes can be found in SDC 3 (available at: http://links.lww.com/JCRP/A368).

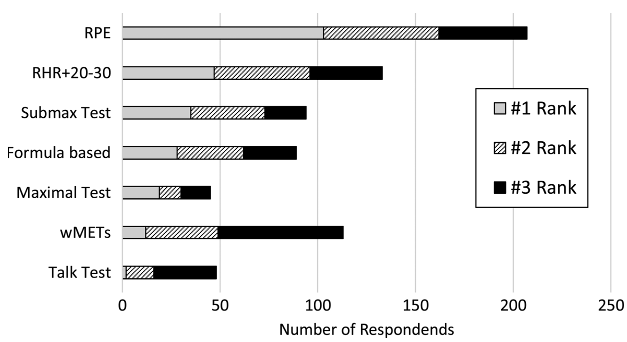

Figure 2. Most common exercise prescription methods in cardiac rehabilitation. Program directors ranked—in descending order—the exercise modality most frequently used in their cardiac rehabilitation program. As noted, RPE was the most common first rank, followed by resting HR +20-30 bpm. Abbreviations: MET, metabolic equivalent of task; RHR, resting heart rate; RPE, ratings of perceived exertion.

DISCUSSION

In this national survey of CR program directors in the United States, we found generally consistent reports about exercise duration and modality in CR, but substantial variability in how exercise intensity is prescribed. Most programs prescribe exercise intensity using RPE without a baseline maximal ET and, when establishing a THRR, most often used RHR +20-30 bpm. However, program directors also reported using dozens of formulas to establish a THRR and noted inconsistencies in exercise prescription techniques between their own staff members. Our results show that most CR programs are not following guidelines for either ET or exercise intensity. They also demonstrate a significant opportunity to improve the quality and consistency of the exercise we deliver in CR so that more patients meet AACVPR performance measures for improvement in CRF.[10]

Our data, in conjunction with prior publications, suggest a potential declining trend in the use of ET over the past two decades. Specifically, in three regional surveys of New York, Ohio, and Midwest CR programs, DeTurk and Scott,[11] Zullo et al,[12] and O'Neil et al[13] found that 90% (2005), 73% (2007), and 33% (2017) of programs used ET to prescribe exercise, respectively. In the only national survey of which we are aware, in 2002, Andreuzzi et al[14] found that 40% of AACVPR programs used maximal ET, but this was only published as an abstract. Thus, regardless of the comparison, our results are the lowest reported use (17%) of maximal ET in any US survey. Internationally, these results are higher than those found in Japan (~10%,

Table 2

Summary of Opinions About Maximal Exercise Testing and Exercise Prescription in Cardiac Rehabilitation[a]

Please Indicate Your Level of Agreement With the Following Statements: 2: Strongly Disagree, −1: Disagree, 0: Neither Agree nor Disagree, 1: Agree, 2: Strongly Agree	Mean ± SD	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
A maximal exercise stress test is important to provide information to individualize the exercise prescription for patients in CR	0.1 ± 1.1	8	23	32	27	11
A maximal exercise stress test is important to safely prescribe exercise for most patients in CR	−0.2 ± 1.1	10	37	28	17	8
If there were no barriers to the use of maximal exercise stress testing, I would prefer to have all patients complete a test prior to or during participation in CR	0.3 ± 1.2	7	19	26	30	17
Maximal exercise stress testing prior to or during participation in CR is a waste of money and time for our patients	0.1 ± 1.1	11	24	35	24	6
High-intensity interval training is safe for most patients in CR	0.2 ± 1.1	2	29	30	30	9
The use of a target HR to guide exercise intensity is worth the extra effort to collect the needed data to compute the target HR range or value (compared with an RPE-based exercise prescription)	0.5 ± 1.0	2	16	22	45	15
For the same kind of patient, our staff members consistently provide the same kind of exercise prescription	0.3 ± 1.0	4	24	13	52	6

Abbreviations: CR, cardiac rehabilitation; HR, heart rate; RPE, ratings of perceived exertion.
[a]Data are presented as mean ± SD or %.

2006)[15] but lower than in the Netherlands (70%, 2012)[16] or Canada (57%, 2019).[17]

Given that most professional society guidelines recommend maximal ET (Table 3), this appears to represent a significant gap in the quality of care delivered in US CR programs. However, the strong and mixed opinions about maximal ET we observed also suggest that its value in CR is not well established. We are aware of only two observational studies that assessed the impact of maximal ET in CR; one showed that an exercise prescription based upon ET facilitated greater increases in CRF, but the other showed no difference.[18,19] To our knowledge, no prospective randomized controlled study has ever been done, despite ongoing controversies in this area.[20,21] Such a study is certainly needed.

In the absence of a maximal ET and measured peak HR, programs appear to use a mix of formulas to estimate a peak HR, such as 220 − age, even though this formula grossly overestimates peak HR for the majority of patients in CR.[31,32] While this formula can be useful as a general guide in healthy populations, it is inappropriate for use in patients with heart disease who are almost universally on β-blockers. Even tailored formulas, specifically developed for patients with heart disease on high-dose β-blockers, have too much individual variability to be reliably used for exercise prescription.[33]

We noted significant variability both between and within programs in exercise intensity methods. Such variability has been noted previously,[13,16] and may be due to inconsistencies in international guidelines and the lack of a universal HR formula in clinical trials.[9,32] Altogether, these findings suggest that no clear standard is consistently recognized by the CR community to guide exercise intensity. Instead, exercise intensity appears to use a "trial and error" approach,[13] in which RPE is the primary guide and HR data are used adjunctively.[11,13] However, there does not even appear to be a standard when using RPE, as multiple scales and target ranges were reported. Additionally, we found important quality problems in the way RPE is administered, particularly because many programs fail to properly anchor RPE based on physiologic monitoring, responses, and clinician feedback.[34] This is a problem, because low-fidelity RPE often results in a low exercise intensity and suboptimal exercise gains.[35-37]

While guidelines do not agree on every aspect of exercise intensity, they do offer direction on several points. Notably, HRR, or oxygen uptake reserve where available, is the preferred exercise prescription method (Table 3). This is because HRR incorporates both peak and resting HRs, is closely correlated to oxygen uptake reserve, and is valid even in patients taking β-blockers.[38] Thus, while percent peak HR appears to be commonly used, it is only recommended in guidelines as a supplemental method. Additionally, while RHR +20-30 bpm is a useful rule of thumb for patients who are still hospitalized or soon after starting CR, it has been shown to underprescribe exercise to almost 50% of CR patients, and should only be used on rare occasion.[39,40] Regarding the specific range, all guidelines agree that 60-70% HRR is an acceptable intensity, although most guidelines suggest a higher limit such as 80 or 85% HRR. We advise against using intensities between 40 and 59% HRR, as these ranges produce no change in CRF in patients with heart disease.[41] This lack of improvement in CRF may have been a key reason for the null findings of the RAMIT trial,[42,43] and cautions programs against employing light to moderate exercise intensity.[41]

We found that about half of programs offered HIIT, which is lower compared with O'Neil et al[13] and Vromen et al,[16] who found that 69 and 75% of CR programs offered interval training to some patients, respectively. Our reported rate (48%) may be lower because we only assessed "higher-intensity" intervals, rather than also including moderate-intensity intervals. Although HIIT appears promising for CR patients,[44] only a small minority are prescribed HIIT and it is typically initiated late in the course of CR. Opinions toward the safety of HIIT were also mixed, so it appears additional research, education, and implementation efforts are needed before HIIT will become commonplace in US CR programs.

Our qualitative analysis noted several unique findings that, to our knowledge, have not been reported in the literature previously. First, many programs employ a stepped THRR over the course of CR, so that formal intensity

Table 3

Guidelines Statements on Exercise Testing and Intensity

Guideline	Reference	Maximal Exercise Testing	Primary Prescription	Secondary	HIIT	Other Notes
AACVPR 4th	Williams (2004)[22]	Recommended	50-80% of "exercise capacity"	RPE 11-16	…	No recommendation for % pHR or HRR
AACVPR 5th	Williams (2013)[23]	Recommended	40-80% HRR or $\dot{V}O_2$ reserve	RPE 11-16	…	If no GXT, RPE of 11-14
AACVPR 6th	American Association of Cardiovascular and Pulmonary Rehabilitation (2021)[24]	Recommended	40-80% HRR or $\dot{V}O_2$ reserve	RPE 11-16	Allowable	If no GXT, RPE of 11-13; RHR +20-30 bpm
AACVPR–Squires	Squires et al (2018)[25]	n/a	60-85% HRR	RPE 11-16	In select patients	Primarily discusses exercise progression
ACSM–9th	American College of Sports Medicine (2014)[26]	Recommended	40-80% HRR or $\dot{V}O_2$ reserve	RPE 11-16	Allowable	
ACSM–10th	American College of Sports Medicine (2018)[27]	Recommended	40-80% HRR or $\dot{V}O_2$ reserve	RPE 12-16	Allowable	If no GXT, RHR +20-30 bpm; formulas for estimating pHR allowable
AACVPR, CACR, EACRP	Mezzani et al (2012)[28]	Strongly Recommended	Between VT_1 and VT_2 >60% HRR or $\dot{V}O_2$ reserve	40-80% $\dot{V}O_{2peak}$ 50-85% pHR RPE 13-16	In select patients	RHR +20-30 bpm *not* recommended
French Society of CR	Pavy et al (2013)[29]	Recommended, $\dot{V}O_2$ preferred	HR at VT_1 60-80% HRR	RPE 12-14 RPE 4-6	In select patients	
British ACPICR	Association of Chartered Physiotherapists in Cardiac Rehabilitation (2015)[30]	Not recommended	40-70% HRR	RPE 11-14 or 2-4	Limited use	Formulas for estimating pHR allowable

Abbreviations: AACVPR, American Association of Cardiovascular and Pulmonary Rehabilitation; ACPICR, Association of Chartered Physiotherapists in Cardiac Rehabilitation; ACSM, American College of Sports Medicine; CACR, Canadian Association of Cardiovascular Prevention and Rehabilitation; CR, cardiac rehabilitation; GXT, graded exercise test; HIIT, high-intensity interval training; HRR, heart rate reserve; pHR, peak heart rate; RHR, resting heart rate; RPE, ratings of perceived exertion; $\dot{V}O_2$, oxygen uptake; $\dot{V}O_{2peak}$, peak oxygen uptake; $VT_{1 \text{ or } 2}$, ventilatory threshold 1 or 2.

progresses with time (eg, from 50-60% HRR, then 60-70% HRR, then 70-80% HRR, adjusted every 2-3 wk). Second, referring physicians often directly chose the THRR, instead of CR clinicians doing the intake evaluation. Third, AACVPR risk category, patient procedures, or patient conditions were often used to formally establish the exercise intensity. To our knowledge, these methods have not been evaluated for their strengths and limitations and should be explored in future studies.

The primary limitation of this study was the low response rate and possible unrepresentative survey sample. However, nearly 250 program directors completed the survey, which has more respondents than the combined studies of DeTurk and Scott,[11] Zullo et al,[12] and O'Neil et al.[13] Additionally, our study represents programs that prescribe exercise to thousands of patients each year, and our nonresponse analysis suggested our programs were reasonably representative of AACVPR registered CR programs (see SDC 1, available at: http://links.lww.com/JCRP/A366). Second, our survey was administered on the tail end of the first surge of COVID-19 in the United States. Although we specifically asked respondents to answer based on their practice patterns from January 2020 (pre-pandemic), this survey timing may have contributed to our low response rate or altered question responses in unpredictable ways. Third, in an effort to streamline the survey, we did not assess frequency or volume of exercise in our survey, but it is well known that most CR programs offer up to 36 sessions and patients attend 2-3 exercise sessions/wk.[45] Additionally, we did not assess the availability and use of cardiopulmonary ET, the availability and use of overground walking/running on a track, exercise prescription methods in permanent atrial fibrillation, details about types and protocols for submaximal testing, approaches to resistance training, details about HIIT intensity and intervals, and further details about ET, such as which kinds of patients were tested, what factors were involved in that decision, typical protocols used, and how abnormal results impacted exercise prescription. These topics should be pursued in further research. Fourth, not every respondent answered our open-ended questions and responses varied in length from a few words to several paragraphs. Thus, extrapolating any of these percentages to all CR programs is unwise. These findings should be regarded as primarily hypothesis generating. Strengths of this study include its national reach, its comprehensive approach to classifying exercise intensity, and its focus on the role and opinions toward ET.

CONCLUSIONS

Among respondents, most programs use RPE and RHR +20-30 bpm without maximal ET to guide exercise intensity, even though nearly all professional society guidelines recommend maximal ET and the use of an HRR-based approach. How these exercise prescription patterns impact CRF changes is unknown but is worrisome for an exercise intensity that is too low and not tailored to individual physiological responses. Future studies should address these questions in prospective trials where maximal ET is a key point of randomization.

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