ORIGINAL RESEARCH

Trends and Predictors of Participation in Cardiac Rehabilitation Following Acute Myocardial Infarction: Data From the Behavioral Risk Factor Surveillance System

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***Background*—**Participation in cardiac rehabilitation (CR) after acute myocardial infarction has been proven to significantly reduce morbidity and mortality. Historically, participation rates have been low, and although recent efforts have increased referral rates, current data on CR participation are limited.

***Methods and Results*—**Utilizing data from the Behavioral Risk Factor Surveillance System conducted by Centers for Disease Control and Prevention, we performed a population-based, cross-sectional analysis of CR post-acute myocardial infarction. Unadjusted participation from 2005 to 2015 was evaluated by univariable logistic regression. Multivariable logistic regression was performed with patient characteristic variables to determine adjusted trends and associations with participation in CR in more recent years from 2011 to 2015. Among the 32 792 survey respondents between 2005 and 2015, participation ranged from 35% in 2005 to 39% in 2009 (P=0.005) and from 38% in 2011 to 32% in 2015 (P=0.066). Between 2011 and 2015, participants were less likely to be female (odds ratio [OR] 0.763, 95% confidence interval [CI] 0.646-0.903), black (OR 0.700, 95% CI 0.526-0.931), uninsured (OR 0.528, 95% CI 0.372-0.751), less educated (OR 0.471, 95% CI 0.367-0.605), current smokers (OR 0.758, 95% CI 0.576-0.999), and were more likely to be retired or self-employed (OR 1.393, 95% CI 1.124-1.726).

***Conclusions*—**Only one third of patients participate in CR following acute myocardial infarction despite the known health benefits. Participants are less likely to be female, black, and uneducated. Future studies should focus on methods to maximize the proportion of CR referrals converted into CR participation. **(*J Am Heart Assoc*. 2018;7:e007664. DOI: 10.1161/JAHA.117.007664.)**

Key Words: cardiac rehabilitation • morbidity • mortality • myocardial infarction

Cardiac rehabilitation (CR) incorporates graduated cardiovascular exercise, risk factor modification, education, and social support services.[1] Participation in CR after acute myocardial infarction (AMI) is a safe and effective intervention that is associated with decreased morbidity and mortality.[2-5] Specifically, participation in CR has been correlated with lower unplanned readmissions, higher quality-of-life metrics, healthy lifestyle behavioral choices, and improved exercise capacity.[2-7] Despite these proven benefits, CR is not routinely prescribed following AMI. Moreover, even when prescribed, rates of patient participation in CR have been historically low due to limited access, lack of insurance coverage, and out-of-pocket cost for co-pays.[8-10] Although data from the 1990s and early 2000s have demonstrated the effect of demographic and socioeconomic factors on CR referral and participation,[10-15] current data are lacking. The goal of this study was to assess the current trends in CR participation after AMI in the United States and to identify predictors of participation.

Methods

The data, analytic methods, and study materials will not be made available to other researchers for the purpose of reproducing the results because these data are already available in the public domain on the Centers for Disease Control and Prevention website.[16]

Study Population

We performed a population-based, cross-sectional study, using data from the BRFSS (Behavioral Risk Factor

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Clinical Perspective

What Is New?

- Only one third of patients participate in cardiac rehabilitation following acute myocardial infarction despite its known health benefits.
- Participation levels in cardiac rehabilitation have remained relatively flat over the past decade despite increases in referral rates.
- Women, blacks, and uneducated patients are less likely to participate in cardiac rehabilitation.

What Are the Clinical Implications?

- Encouraging cardiac rehabilitation participation is important for all patients following acute myocardial infarction, particularly in vulnerable populations.
- Because higher referral rates to cardiac rehabilitation do not necessarily translate into increased participation, other measures such as optimizing insurance coverage and improving access may help to increase participation.

Surveillance System) conducted by Centers for Disease Control and Prevention.[16] We acknowledge that the Centers for Disease Control's BRFSS is the original source of the data. Institutional review board approval was not obtained because this is a public use data set, and the data available are not individually identifiable. Data from BRFSS surveys obtained between 2005 and 2015 were collected, and survey-weighted CR participations post-AMI were calculated. The survey question was phrased as 1 of the following: After you left the hospital following your heart attack did you go to any kind of outpatient rehabilitation? (2005) After you left the hospital following your heart attack did you go to any kind of outpatient rehabilitation? This is sometimes called "rehab." (2007) Following your heart attack, did you go to any kind of outpatient rehabilitation? This is sometimes called "rehab." (2009-2015) The survey question was not limited to the year in which the survey was conducted; therefore, it represents lifetime participation in CR post-AMI (ie, survey year 2005 represented CR participation in all years up to and including 2005). Patients responding "Don't Know/Not Sure" or who declined to answer the survey question regarding CR were excluded.

Statistical Analysis

To assess for unadjusted trends in participation, univariable logistic regression was performed with CR as the outcome and survey years (2005-2015) as the categorical predictor. The BRFSS survey methodology changed between 2009 and 2011 by allowing addition of data collection by cellular telephones; therefore, analyses were performed using the 2005-2009 and the 2011-2015 data sets separately. Baseline demographics and characteristics of patients who did and did not participate in CR were compared by survey-weighted Rao-Scott chi-squared tests. Comorbidities were determined by BRFSS survey questions in which participants responded if they had ever been told by a health professional that they had a certain condition (eg, "high cholesterol," "high blood pressure"). Current smokers were defined as having smoked at least 100 cigarettes in the participant's life and currently smoking cigarettes "every day" or "some days." Former smokers were defined as having smoked at least 100 cigarettes in the participant's life and currently not smoking cigarettes.

To assess for adjusted trends and associations with participation in CR in more recent years (2011-2015), multivariable logistic regression was performed with CR as the outcome and patient characteristic variables and survey year as predictor variables. Variables were selected based on findings from prior studies and physiologic rationale for potential association with CR nonparticipation. These independent variables included sex, race, insurance status, employment status, education level, marital status, smoking status, region, and survey year. For the survey years included, regions included the following states: Northeast (Connecticut), Southeast (Arkansas, District of Columbia, Florida, Georgia, Mississippi, South Carolina, Tennessee, Puerto Rico), Midwest (Illinois, Iowa, Minnesota, Missouri, Wisconsin), and West (Arizona, Idaho, Montana, North Dakota, Oregon, Washington). Age was not included in the multivariable regression because a participant's age at the time of the survey did not necessarily correlate with his or her age at the time of the AMI and the CR participation decision. In order to investigate the possible influence of age despite this limitation, a separate univariable analysis was performed with the following groups: ages 18 to 64 and ages 65 years and older. Comorbidities were also excluded from the multivariable analysis due to missing data (ie, unanswered survey questions). Several categories sum to less than the total sample size responding to the CR survey question (11 773); this reflects that some participants were not asked, did not respond, or responded "Don't Know" to these questions, which represents less than 1% for every category except for race (3%), employment (21%), hypertension (25%), hyperlipidemia (5%), and chronic obstructive pulmonary disease (22%). Analyses were performed with Statistical Analysis System software, version 9.4 (SAS Institute, Cary, NC). Statistical significance was set at a *P*-value of <0.05.

Results

From 2005 to 2015, 32 792 patients responded to the BRFSS survey question regarding CR. Of note, fewer than 1% of patients responded "Don't Know/Not Sure" each year except

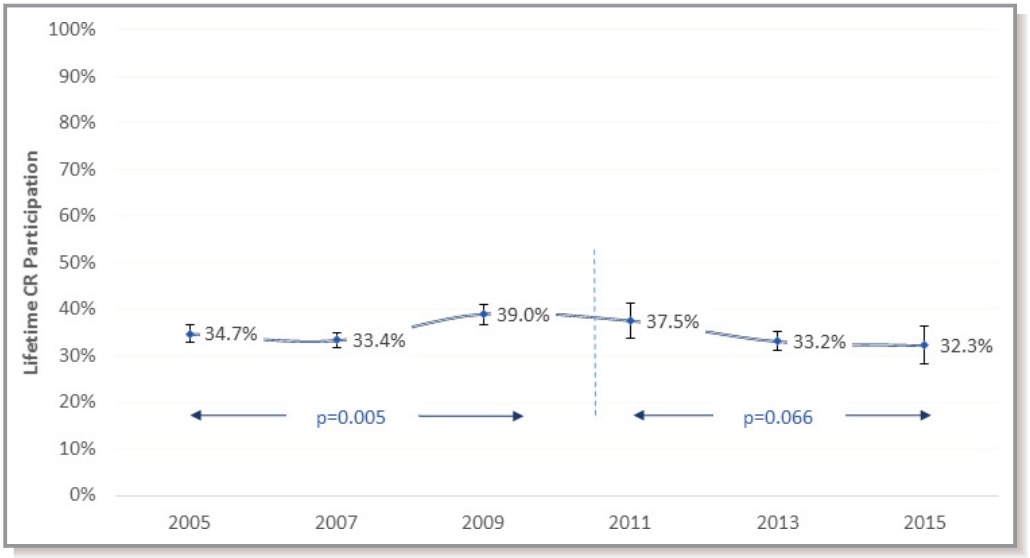

Figure. Trends in lifetime cardiac rehabilitation participation following acute myocardial infarction from 2005 to 2015.

in 2005 (1.02%) and 2013 (1.58%). Additionally, fewer than 1% of patients declined the question regarding cardiac rehabilitation each year except from 2009 (1.08%) and 2013 (2.2%). Trends in participation in CR ranged from 32% to 39% (Figure, Table 1). There was a significant increase in participation from 2005 to 2009 (P=0.005) and a nonsignificant decrease between 2011 and 2015 (P=0.066). Baseline demographics of those who did and did not participate in CR from 2011 to 2015 are shown in Table 2. Patients who did not participate in CR were more likely to be younger, female, black/Hispanic/multiracial, unmarried, uninsured, unemployed or employed for wages (compared with self-employed/student/retired), and to have less education. Nonparticipants were also significantly more likely to be current smokers and were less likely to have diabetes mellitus and hyperlipidemia. In the multivariable model, patients who participated in CR remained significantly less likely to be female, black, uninsured, current smokers, have less education, and were less likely to be employed for wages (or unemployed) compared with self-employed/student/retired participants (Table 3). There was also significant regional variation with respondents from the Southeast and West regions being significantly less likely to participate in CR compared with those from the Midwest and Northeast (Tables 2 and 3). Additionally, patients aged 65 years and over were more likely to participate in CR compared with patients aged 18 to 54 (OR 1.787, 95% confidence interval 1.540-2.074, P<0.0001).

Discussion

Because higher referral rates to CR may translate into higher participation rates,[17,18] efforts to increase utilization of post-AMI CR have focused primarily on improving physician referral rates. Data from the American Heart Association's Get With The Guidelines program demonstrated a nationwide average referral rate of 56% following admission for AMI, percutaneous

Table 1. Trends in Cardiac Rehabilitation Participation—2005-2015

Survey Year	Survey Respondents	Lifetime CR Participants	Lifetime CR Participation	95% Confidence Interval	*P* Value
2005	6650	2308	34.7%	32.8 to 36.7	Ref
2007	9324	3114	33.4%	31.8 to 35.0	0.283
2009	5045	1968	39.0%	36.8 to 41.1	0.005
2011	2481	930	37.5%	33.8 to 41.2	Ref
2013	8297	2755	33.2%	31.2 to 35.2	0.041
2015	995	321	32.3%	28.2 to 36.4	0.066

Analyses performed separately between the 2005-2009 and 2011-2015 data sets due to methodology changes in the BRFSS survey. BRFSS indicates Behavioral Risk Factor Surveillance System; CR, cardiac rehabilitation; Ref, reference.

Table 2. Participant Demographics and Comorbidities—2011-2015

	Cardiac Rehabilitation		
	Yes (n=4237)	No (n=7536)	*P* Value
Age, y			
18 to 44	69 (4%)	312 (10%)	<0.0001
45 to 64	1145 (34%)	2484 (42%)	
65+	3023 (62%)	4740 (48%)	
Sex—female	2587 (32%)	3681 (40%)	<0.0001
Race/ethnicity			
White, non-Hispanic	3511 (81%)	5656 (70%)	<0.0001
Black, non-Hispanic	276 (7%)	764 (12%)	
Hispanic	174 (8%)	417 (12%)	
Other*	196 (4%)	532 (6%)	
Marital status—married	2200 (59%)	3198 (50%)	<0.0001
Education			
College graduate	1164 (20%)	1398 (12%)	<0.0001
High school graduate†	2584 (63%)	4649 (60%)	
Less than high school graduate	480 (17%)	1469 (29%)	
Employment			
Employed for wages	436 (15%)	742 (17%)	<0.0001
Self-employed/retired‡	2289 (65%)	3621 (50%)	
Unemployed§	560 (20%)	1607 (33%)	
Insurance status—insured	4081 (95%)	6910 (88%)	<0.0001
Current smoker	581 (16%)	1646 (25%)	<0.0001
Comorbidities			
Hypertension	3226 (99%)	5629 (99%)	0.356
Hyperlipidemia	3035 (74%)	4950 (68%)	0.001
Diabetes mellitus	1510 (37%)	2470 (32%)	0.004
Obesity	1502 (36%)	2562 (37%)	0.718
Chronic kidney disease	473 (11%)	738 (11%)	0.780
COPD‖	734 (23%)	1537 (25%)	0.128
Depression	1132 (27%)	2117 (29%)	0.313
Region			<0.0001
Northeast	125 (3%)	148 (2%)	
Southeast	1803 (45%)	4184 (56%)	
Midwest	1225 (33%)	1169 (19%)	
West	1084 (20%)	2035 (23%)	

Values are count (weighted percentage).
*Other includes responses of "Other race only, non-Hispanic" and "Multiracial, non-Hispanic."
†Includes "College 1 year to 3 years (Some college or technical school)."
‡Includes "Homemaker" and "Student" as well.
§Includes "Out of Work" and "Unable to Work."
‖Chronic obstructive pulmonary disease; survey question also includes emphysema and chronic bronchitis.

Table 3. Multivariable Logistic Regression Model for CR Participation—2011-2015

	OR (95% CI)	*P* Value
Sex (ref: male)	0.763 (0.646-0.903)	0.002
Insurance status (ref: insured)	0.528 (0.372-0.751)	0.0004
Education (ref: college graduate)		
High school graduate*	0.688 (0.585-0.810)	<0.0001
Less than high school graduate	0.471 (0.367-0.605)	<0.0001
Marital status (ref: married)	0.862 (0.730-1.018)	0.080
Employment (ref: wage employed)		
Self-employed/retired†	1.393 (1.124-1.726)	0.003
Unemployed‡	1.041 (0.799-1.355)	0.767
Smoking (ref: never smoker)		
Former smoker	1.148 (0.974-1.353)	0.100
Current smoker	0.758 (0.576-0.999)	0.049
Race/ethnicity (ref: white)		
Black	0.700 (0.526-0.931)	0.014
Hispanic	0.798 (0.498-1.279)	0.349
Other	0.710 (0.475-1.062)	0.095
Region (ref: Midwest)		
Southeast	0.497 (0.416-0.594)	<0.0001
Northeast	0.912 (0.602-1.383)	0.665
West	0.468 (0.379-0.578)	<0.0001
Survey year (ref: 2011)		
2013	0.993 (0.812-1.215)	0.949
2015	1.016 (0.764-1.353)	0.911

CI indicates confidence interval; CR, cardiac rehabilitation; OR, odds ratio; ref, reference value.
*Includes "College 1 year to 3 years (Some college or technical school)."
†Includes "Homemaker" and "Student" as well.
‡Includes "Out of Work" and "Unable to Work."

coronary revascularization, and surgical revascularization between 2000 and 2007.[19] More recently, an analysis from the National Cardiovascular Data Registry showed an increase in the rates of referral for post-AMI CR from 72.9% of eligible patients in 2007 to 80.7% in 2012.[20] The underlying problem, however, is that only one third to one half of patients referred to CR actually participate, and there is no evidence that this proportion has improved over the past several decades.[10,14] In fact, 1 study, albeit geographically limited (Mayo Clinic in Olmsted County, MN), reported no temporal increase in CR participation rates over a period of 23 years (from 1987 to 2010).[4]

Using the BRFSS data, we found that only one third of patients participated in CR following AMI over the past decade and that participation levels remained relatively flat over this time period despite increases in referral rates. Of note, the

slight variation in CR participation demonstrated by the 2005-2009 and 2011-2015 data sets is driven, at least in part, by variations in states sampled throughout the survey years (the BRFSS weighting formula aims to adjust for these factors). For example, the 2013 survey included 6 of the top 10 lowest-performing states (Hawaii, District of Columbia, Arkansas, Mississippi, Georgia, Tennessee) as compared with the 2009 survey, which included only 4 of these low-performing states. While one-third participation is higher than participation in the late 1990s,[8-10] it is still strikingly low considering its proven beneficial effects in this patient population. Patient participation in CR is a focus of the Million Hearts Cardiac Rehabilitation Collaborative, supported by the Centers for Disease Control and Prevention and the Centers of Medicare and Medicaid Services, which has set the goal of CR participation to 70% by 2022.[21] Our results and the Mayo Clinic's data[4] regarding CR participation should be interpreted in the setting of increasing CR referral rates over the past decade[20] in that higher referral rates do not necessarily translate into increased participation. Several studies have shown that a more in-depth discussion (either through telephone calls, home visits, or letters) and encouragement of enrollment by medical personnel result in higher CR participation rates.[22-25]

Our study represents 1 of the largest analyses to date focused on CR participation following AMI. Prior studies have often been limited to data from single or several hospitals or a focus on the Medicare population.[10-15] Similar to these studies, we found a strong association between CR nonparticipation and female sex, nonwhite race, lack of insurance, tobacco use, and lower education levels. We also found that those who were self-employed, homemakers, or retired were more likely to participate in CR, presumably because of schedule flexibility. In addition to health insurance coverage and ability to attend CR, insufficient access to CR programs remains an important limiting factor as demonstrated by studies that have found geographical proximity to appropriate CR facilities to be 1 of the strongest predictors of CR participation following AMI and coronary artery bypass surgery.[11,26] To overcome these barriers, some experts have suggested the development of home-based CR programs[27] or financial incentives for patients who participate.[28]

Our study has several limitations. First, it carries the inherent limitations of a cross-sectional study—namely, the limited ability to clearly establish temporality of associations and the inability to define associations of causality. Second, these data consist of self-reported CR participation, and although a correlation with actual participation is logical, this has not been rigorously established in the literature. Additionally, these data represent trends in lifetime CR participation, not annual participation rates. Given these characteristics, annual increases or decreases in the rate of CR participation may be partially blunted by the proportion of participants reporting CR from years before the survey. This concern is mitigated by the inclusion of data over a full decade; with such longitudinal data, even a subtle steady increase in participation would likely have been identifiable, if present. Further, the trend actually appears to reflect lower participation in recent years. Another limitation is that it is possible that some of the "predictors" of CR participation may have arisen later in the participant's life, although this is only a concern for the factors of insurance status and employment status (as compared with sex, race, and education status). Still, this limitation is not likely to have substantially altered the conclusions given the strength of the study's findings.

In conclusion, only one third of patients participate in CR following AMI despite its known health benefits. Nonparticipants are more likely to be female, black, and to have lesser degrees of education. Stressing the importance of CR participation is crucial for all post-AMI patients, particularly these vulnerable socioeconomic populations. Increasing referral rates is only 1 part of the solution. Optimizing insurance coverage and improving access to CR programs should help to increase participation, as should optimizing referral techniques in order to maximize conversion of CR referrals to CR participation.

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Disclosures

None.

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