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State-by-State Variations in Cardiac Rehabilitation Participation Are Associated With Educational Attainment, Income, and Program Availability

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Abstract

PURPOSE—Wide geographic variations in cardiac rehabilitation (CR) participation in the United States have been demonstrated but are not well understood. Socioeconomic factors such as educational attainment are robust predictors of many health-related behaviors, including smoking, obesity, physical activity, substance abuse, and cardiovascular disease. We investigated potential associations between state-level differences in educational attainment, other socioeconomic factors, CR program availability, and variations in CR participation.

METHODS—A retrospective database analysis was conducted using data from the US Census Bureau, the Centers for Disease Control and Prevention, and the 1997 Medicare database. The outcome of interest was CR participation rates by state, and predictors included state-level high school (HS) graduation rates (in 2001 and 1970), median household income, smoking rates, density of CR program (programs per square mile and per state population), sex and race ratios, and median age.

RESULTS—The relationship between HS graduation rates and CR participation by state was significant for both 2001 and 1970 ($r = 0.64$ and 0.44 , respectively, $P < .01$). Adding the density of CR programs (per population) and income contributed significantly with a cumulative r value of 0.74 and 0.71 for the models using 2001 and 1970, respectively ($P_s < .01$). The amount of variance accounted for by each of the 3 variables differed between the 2000 and 1970 graduation rates, but both models were unaltered by including additional variables.

CONCLUSIONS—State-level HS graduation rates, CR programs expressed as programs per population, and median income were strongly associated with geographic variations in CR participation rates.

Keywords

education; income; program availability; state cardiac rehabilitation participation

Outpatient cardiac rehabilitation (CR) is highly effective at reducing morbidity and mortality rates following a myocardial infarction (MI) or coronary revascularization, while also reducing disability and promoting a healthy, active lifestyle.^{1–3} Participation in CR results in a 26% decrease in cardiac mortality over 3 years and a 31% reduction in cardiac rehospitalizations over a 12-month period,^{2,4} rapidly providing health benefits and reductions in health care costs.

While nearly all cardiac event survivors would benefit from CR, only 10% to 35% of eligible candidates in the United States and Canada choose to participate,^{5–9} with participation being equally low in other industrialized countries.^{10,11} Women, older adults, and socioeconomically disadvantaged populations are at a particularly increased risk for nonparticipation in CR.^{5,7} For example, in 1 study, while 20% of older adults (> 65 years) attended CR as recommended, only 3% to 5% of those with dual Medicare/Medicaid status (ie, low socioeconomic status) did so.^{5,12}

There is broad agreement that CR participation rates need to be increased, and as a result, various studies have focused on predictors of nonparticipation.^{13–16} Some of the most reliable predictors determined thus far include strength of the physician referral, employment status, income, sex, age, minority status, depression, comorbid medical conditions, distance to the nearest CR facility, and type of cardiac procedure performed.^{5,17–19}

Interventions that have targeted CR participation rates have focused mostly on referral rates, probably because studies have shown that currently the greatest modifiable predictor of whether a patient will initiate CR is the strength of the physician recommendation.^{13,14, 17} Perhaps as a result, some recent reports of referral rates have been relatively favorable. For example, data from the Acute Coronary Treatment and Intervention Outcomes Network, representing 656 US hospitals and medical centers, showed that following an acute MI, 74% to 84% of patients were referred to CR.²⁰ However, even when physician referral rates are high, actual CR participation does not necessarily follow. For example, in 1 large study, only 34% of those referred to CR actually enrolled,²¹ and this is not an isolated finding.²² As a result, CR participation rates are still far from ideal and more work needs to be done to understand why participation rates remain so low.

One interesting source of variation in CR participation rates is the geographic location of the patient. Wide state-by-state variations in CR participation have been demonstrated by an analysis of 1997 Medicare data.⁵ These state-by-state variations (up to 9-fold) remain to be fully understood. The highest rates of CR participation are clustered in the north central states, and the lowest CR rates are mostly in southern states. Better understanding of this variation may suggest strategies for increasing CR utilization in underserved areas.

Educational attainment is a robust predictor of many health-related behaviors.²³ Rates of smoking,²⁴ obesity and physical activity,²³ substance abuse,²⁵ cardiovascular health,²⁶ and premature death²⁷ are correlated with level of education. Thus, education level could potentially function as a predictor for CR participation rates.

We analyzed the relationship between state-level educational attainment, other socioeconomic and demographic health indicators, density of CR programs (programs per square mile and per state population), and the state-level CR rates. We hypothesized that educational attainment would account for significant, independent variance in state-level variation in CR participation.

METHODS

This study was a retrospective database analysis on a state level. Data for the analyses were obtained from the following sources: CR participation rates by state were obtained from Suaya et al,⁵ where CR rates were calculated by analyzing Medicare claims from 1997, measuring outpatient CR use (defined as at least 1 billed CR session) after hospitalizations for acute MI or coronary artery bypass graft surgery in beneficiaries who survived for at least 30 days after hospital discharge. High school (HS) graduation rates by state that were approximately contemporaneous (2001) with the Medicare database were obtained from Greene.²⁸ These rates are calculated by comparing the number of HS diplomas awarded to the number expected, given the size of the school-age population. The 2000 US Census Bureau provided state values for population averages for household income (adjusted by cost of living), sex (ratio of males to total population), race (ratio of white population to total population), and age (average age reported for that state). Resources from the Centers for Disease Control and Prevention provided values for smoking rates (proportion of current smokers in the population) by state for 1997. In addition, earlier HS graduation rates by state from 1970 (closer in time to when those in need of CR in 1997 would likely have been completing their HS education) were also examined. These state-level rates were calculated as the number of diplomas awarded compared with the current number of 17-year-olds (data obtained from the 1970 census²⁹ and the National Center for Education Statistics³⁰).

Statistics

Pearson product moment correlation coefficients were calculated to measure the relationship between CR participation rates and HS graduation rates, CR density (by programs per square mile and programs per population), smoking rate, median age, sex, race, and median income. The adjusted relationships of each variable to CR participation rate were explored by performing a multivariate ordinary least square linear regression. A significance value of $P < .01$ was used for all analyses.

RESULTS

Cardiac rehabilitation participation rates ranged from a low of 5.7% (Idaho) to a high of 42% (Iowa), with an average of 19.6% (see Table 1). The highest values were clustered in the north central states, and half of the 10 lowest rates were in the southern states (Figure 1). Contemporaneous HS graduation rates by state showed a very similar pattern ranging from a

low of 54% (Georgia) to a high of 93% (Iowa), with an average of 72.6% (Table 1). Once again, the highest values were clustered in the north central states and the lowest values were clustered in the southern states. The state-level geographic distributions of these 2 variables are strikingly similar (Figure 1).

The correlation between CR participation and contemporaneous (2001) and earlier (1970) HS graduation rates by state were highly significant ($r = 0.64$, $P < .01$; $r = 0.44$, $P < .01$). These relationships remained significant after controlling for the influence of mean household income, smoking rates, density of CR programs (per square mile), age, race, and sex in multivariate linear regressions. Within these regression models, variations in the density of CR programs (per population) and household income were also significant, independent predictors accounting cumulatively for 54% and 50% of the variance in CR participation by using contemporaneous and earlier HS graduation rates, respectively (Table 2). Educational attainment was the strongest predictor when contemporaneous graduation rates were used, followed by CR density and income, respectively, while CR density was the strongest predictor followed by income and educational attainment, respectively, when earlier graduation rates from 1970 were examined.

DISCUSSION

In view of persistently low participation rates in CR, and high state-by-state variability, improved ability to identify at-risk populations would drive research and potentially lead to new or more focused approaches to increasing participation. Many factors may contribute to these state-by-state differences. For example, practitioners in certain states may be more oriented to preventive services such as CR, states vary in the availability of CR programs (with the present results suggesting that greater availability per population predicts greater participation), and most germane to the purpose of the present study, certain populations may vary in their propensity to participate in positive health-related behaviors such as CR. Previous research has demonstrated that age and race are important predictors of participation in CR, and now the current study provides compelling evidence that even after controlling for the influence of those known predictors, populations with low educational attainment are less inclined to participate in CR.

Educational attainment has a robust relationship with a strikingly wide range of health-related behaviors, extending from smoking rates and obesity to seat belt use.^{23,31} As such we tested HS graduation rates, along with a host of other potential predictors, including CR program density, smoking prevalence (to serve as a proxy for other health-related behaviors), and a range of sociodemographic data, to see which variables best correlate with the observed variation in CR participation data. Educational attainment was a robust predictor even after controlling for this wide range of potential predictors, and whether rates were approximately contemporaneous with the period of CR participation being predicted or from an earlier time more closely aligned with the period when those in need of CR would have been completing their HS education. Importantly, household income was an independent predictor in these same models, not only indicating its importance in accounting for variance in CR participation but also demonstrating that the variance in CR participation that educational attainment is accounting for is independent of financial resources. This

same dissociation of income and educational attainment has been reported across other health-related behaviors as well.²³ Current theorizing regarding the influence of educational attainment on health is focusing on its contributions to one's ability to adapt to changing or complex environmental contingencies, including use of new medical regimens and technologies.^{23,32} There is little question that participation in CR involves adapting to substantive lifestyle changes.

It should be noted that this study is correlational in nature and only compares educational attainment and CR participation rates on a state level. While this limits the conclusions that can be drawn about the relationship between educational attainment and CR participation (ie, no conclusions can be drawn about causality or relationships between these variables on an individual level), given the overwhelming evidence of the predictive value of educational attainment for participation in a wide range of health-related behaviors on the individual level (even those that require no resources, such as seat belt use^{33,34}), it is certainly plausible that educational attainment is also an important predictor for CR utilization.

Increasing participation in CR continues to be a challenging issue. One approach has been to optimize referral rates of patients to CR, which has met with some success.^{22,35} Indeed, analysis of trends in CR participation rates by using the Behavioral Risk Factor Surveillance System (which surveyed people in 19 and 21 states in 2001 and 2005, respectively) showed an increase in CR rates in post-MI patients from 29.5% to 34.7%.^{36,37} However, continued improvement in CR participation may require the development of novel or intensive intervention efforts. For example, helping patients navigate the health system through informational telephone calls and assistance in enrollment postdischarge can increase CR enrollment among the general population.³⁸ However, patients with lower educational attainment may be making up a considerable amount of nonparticipating patients. Results from this study as well from others³⁹ suggest that this could be the case. Accordingly, special interventions targeting these groups need to be considered. At the patient level, interventions that have proven effective for more affluent or highly educated patients may not be as effective in the low-education segment. A similar effect has been seen in the smoking cessation field where relatively nonintensive interventions (such as provision of help quit lines and increasing the availability of nicotine replacement therapy) are relatively successful with higher-education populations but insufficient for motivating change in more challenging populations.⁴⁰

One approach that has proven effective in changing other health-related behaviors in lower-education populations is the use of financial incentives. In this approach, objectively verified behavioral outcomes are reinforced on a regular schedule with financial rewards. Interventions based on this approach, which has its roots in promoting drug abstinence, have been adapted to modify a range of behaviors from weight loss to contraception use.⁴¹ In a specific example, this approach has been used to reduce smoking among pregnant women. For example, in 1 systematic review, the use of financial incentives was found to produce 4-fold higher rates of abstinence than other approaches in this population characterized by low educational attainment.⁴² Such an approach could potentially be adapted to the challenge of CR participation rates.⁴³ However, it should be noted that such interventions would only be successful if the opportunity for CR is already in place. In the absence of uniformly high

referral rates and locally available CR locations, interventions on a patient level would be ineffective.

There are a few limitations to this study that should be considered. First, this study is fully retrospective in nature. In addition, the data sources vary in timing, from the CR data from 1997 to the HS graduation rates from 2001 and 1970. Future examinations of the relationship between educational attainment and CR participation should take these factors into account. Future studies may benefit from being prospective in nature or examining this relationship on a finer scale (ie, by individual data rather than by state).

CONCLUSIONS

Socioeconomic variables, such as educational attainment and household income, account for considerable variation in CR participation rates by state, and this relationship likely holds on an individual scale. While graduation rates and income levels are not easily modifiable, this information may help target efforts to enroll at-risk patients in CR through more provider and patient awareness and intense or specialized recruitment and participation adherence procedures.

Acknowledgments

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Figure 1. Cardiac rehabilitation participation rates in 1997 and high school graduation rates in 2001 by state. Data sources: Suaya et al⁵ and Greene.²⁸

Table 1Cardiac Rehabilitation Rates in 1997 and High School Graduation Rates in 2001 by State^a

State	High School Graduation Rate, %	CR Participation Rate, %
Alabama	62	10.5
Alaska	67	30.2
Arizona	59	12.7
Arkansas	72	11.4
California	68	16.9
Colorado	68	25.1
Connecticut	75	21.4
Delaware	73	25.1
District of Columbia	59	11.4
Florida	59	13.2
Georgia	54	9.7
Hawaii	69	16.7
Idaho	78	5.7
Illinois	78	25.3
Indiana	74	23.8
Iowa	93	42.0
Kansas	76	22.7
Kentucky	71	13.2
Louisiana	69	16.9
Maine	78	21.6
Maryland	75	8.3
Massachusetts	75	23.5
Michigan	75	18.4
Minnesota	82	36.7
Mississippi	62	10.9
Missouri	75	21.2
Montana	83	22.4
Nebraska	85	39.2
Nevada	58	13.5
New Hampshire	71	21.8
New Jersey	75	17.3
New Mexico	65	10.6
New York	70	13.3
North Carolina	63	10.8
North Dakota	88	38.6
Ohio	77	17.4
Oklahoma	74	8.6
Oregon	67	15.5
Pennsylvania	82	17.8

State	High School Graduation Rate, %	CR Participation Rate, %
Rhode Island	72	19.8
South Carolina	62	22.4
South Dakota	80	40.0
Tennessee	60	13.5
Texas	67	15.9
Utah	81	19.8
Vermont	84	18.4
Virginia	74	16.6
Washington	70	14.5
West Virginia	82	17.5
Wisconsin	85	31.6
Wyoming	81	26.9

Abbreviation: CR, cardiac rehabilitation.

^aData sources: Suaya et al⁵ and Greene.²⁸

Table 2

Variance in State-Level CR Participation Rates Accounted for by High School Graduation Rates (2001 and 1970), CR Program Density, and Income

<i>R</i>	<i>R</i> ²
Model 1	
0.642 ^a	0.412
0.707 ^b	0.500
0.736 ^c	0.542
Model 2	
0.579 ^d	0.335
0.654 ^e	0.427
0.709 ^f	0.503

Abbreviation: CR, cardiac rehabilitation.

^aPredictors: HS graduation rate 2001.

^bPredictors: HS graduation rate 2001, CR program density by population.

^cPredictors: HS graduation rate 2001, CR program density by population, income.

^dPredictors: CR program density by population.

^ePredictors: CR program density by population, income.

^fPredictors: CR program density by population, income, HS graduation rate 1970.