Journal of
Cardiac and Pulmonary Rehabilitation

Research Article Open Access

The Effect of Body Mass Index on Functional Outcome of Patients on Cardiac Rehabilitation

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Abstract

Background: While data suggests that obesity increases the risk for cardiovascular disease, some have demonstrated that after a cardiovascular event those with obesity tend to recover more quickly than do those whose weight is normal; a phenomenon termed the "obesity paradox". This study was designed to determine whether this obesity paradox is also reflected in the recovery of patients with debility secondary to a cardiovascular event undergoing care in a rehabilitation hospital.

Objective: Investigate the association between body mass index (BMI) and the functional progress among patients with a recent cardiovascular decline, admitted to an acute rehabilitation hospital.

Design and methods: Retrospective cohort study which included all patients admitted to a rehabilitation hospital, with a recent diagnosis of acute cardiac decline from January 2000–April 2006. Main Outcome Measures: Functional Independence Measure (FIM) score gain per day by BMI category.

Results: Of the 678 patients admitted during the observation period, BMI was compared with FIM score changes per day (FIM efficiency). After adjusting for age, and sex, the FIM efficiency differed by BMI, though the difference was not statistically significant (p=0.069). While not statistically significant, the normal weight group showed the best results, followed, in order by the obese group, the overweight group, and the underweight group.

Conclusion: This study of patients on a cardiac rehabilitation unit failed to demonstrate that obesity significantly impairs functional progress during the rehabilitation process.

Keywords: Cardiology; Body mass index; Outcome; Rehabilitation

Abbreviations: FIM: Functional Independence Measure; BMI: Body Mass Index; CVD: Cardiovascular Disease; IRF: Inpatient Rehabilitation Facility; CR: Cardiac Rehabilitation; LOS: Length Of Stay; ANCOVA: Analysis Of Covariance; Tukey HSD: Tukey Honestly Significant Difference; AHA: American Heart Association; HRQoL: Health-Related Quality of Life.

Introduction

Globally, the rate of obesity has nearly tripled since 1975 [1]. Recent data shows that 36% of the United States (US) population is obese [2] and that obesity contributes to nearly a quarter of a million deaths annually in the US [3] and greater than 1 million annually in Europe [4].

Excess body fat has been shown to raise the risk for morbidity related to chronic conditions including diabetes, cancer, osteoarthritis, and obstructive sleep apnea [2]. Obesity has also been associated with increased risk of all–cause and cardiovascular disease (CVD) mortality [5-8]. Surprisingly, despite this clear association between obesity and the onset of CVD, some data have demonstrated that, after a cardiac event, obesity may offer clinical advantages during the period of post-cardiac intervention. These have included a reduced morbidity, length of stay, and mortality. This advantage has been referred to as the "Obesity Paradox," and has been reaffirmed in a myriad of publications [9-11].

As others have observed this paradox to include several conditions treated in inpatient rehabilitation hospitals, [12] this study evaluated the association between BMI and the functional outcomes of those admitted with morbidity due to an acute cardiac event.

Methods

Data were analyzed from consecutive patients admitted to a cardiac unit of an acute freestanding inpatient rehabilitation facility (IRF). Patients admitted to this facility are all deemed unable to safely return to their homes at the time of discharge from the cardiac units of the acute care hospital. They were judged to be able to actively participate in three hours of rehabilitation per day including physical therapy, occupational therapy, and speech pathology. All were therefore admitted with a diagnosis of a significant decline in functional capacity (debility) as a result of congestive heart failure and/or myocardial infarction. Data were reviewed for six consecutive years of admissions. During this time 678 patients were admitted to the cardiac rehabilitation unit.

The patients were divided into four separate categories according to their calculated BMI (body weight in kilograms divided by the square of height in meters). The underweight group was defined as having a BMI of less than 18.5 kg/m^2, with the normal weight group as 18.50-25 kg/m^2, the overweight group as 25.1-30 kg/m^2, and the obese group defined as greater than 30 kg/m^2.

Gains in functional performance were documented by the interdisciplinary team using the Functional Independence Measure

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Received April 23, 2018; **Accepted** May 23, 2018; **Published** May 28, 2018

Citation: Burke DT, Samir Al-Adawi MA, Bell RB, Burke DP (2018) The Effect of Body Mass Index on Functional Outcome of Patients on Cardiac Rehabilitation. J Card Pulm Rehabil 2: 120.

(FIM) scale, administered on admission and then repeated at discharge. The three subsets of the FIM used in the analysis included activities of daily living (FIM assessment 1–6), mobility (FIM assessment 9–13) and cognition (FIM assessment 14–18). Other parameters analyzed included the FIM change (difference between admission and discharge FIM scores) and the FIM efficiency (FIM change divided by the length of stay). The FIM efficiency was defined as the mean gain in score per day. Length of stay (LOS) was also analyzed.

Statistical analysis

Baseline demographics and FIM scores were compared between the four weight categories with a one-way analysis of variance for continuous variables and with the chi-square test for proportions (Table 1). Analysis of covariance (ANCOVA) was used to describe differences in FIM scores after adjusting for age, gender and weight group. The FIM efficiency adjusted mean was estimated for each of the four weight categories. Tukey's HSD (honestly significant difference) test was used to calculate six pairwise comparisons between the four weight groups. The FIM efficiency was calculated using multivariable regression analysis and adjusted for gender, age, and LOS. All statistical tests were 2-sided and a p-value ≤ 0.05 was considered statistically significant.

Results

During the study, period 678 patients, ranging in age from 63 to 84 years, were admitted to the cardiac rehabilitation unit of the IRF. A mean age of 73 years was found for the underweight group, 76 years for the normal weight group, 76 years for the overweight group, and 71 years for the obese group.

Of the patients admitted, 52% were male, including 32% of the underweight group, 55% of the normal group, 58% of the overweight group, and 45% of the obese group. The mean admission FIM score was 70 in the underweight group, 75 in the normal weight group, 76 in the overweight group, and 74 in the obese group (p=0.44). Discharge FIM scores were also similar between weight categories with a mean of 90 in the underweight group, 100 in the normal group, 99 in the overweight group, and 99 in the obese group (p=0.16).

Table 1 summarizes the demographic and FIM scores, demonstrating that 5.9% were underweight, 41% were normal weight, 27.9% were overweight and 25.1% were obese. The mean BMI for the same categories were 16.5 kg/m^2, 22.1 kg/m^2, 27.1 kg/m^2 and 35.7 kg/m^2 respectively. Gender and age differences were identified between the four weight groups. The mean FIM efficiencies of the underweight, normal weight, overweight and obese were 0.9/day, 1.7/day, 1.2/day, and 1.5/day respectively. The mean gain in FIM scores from admission to discharge for the entire group was 23 points.

In the chi-square test, the FIM efficiency was not found to be statistically significant between the groups (P=0.069). However, in the subtest analysis significant differences between groups were found for the motor FIM efficiency, with the underweight group having the lowest (worst) FIM efficiency followed by the overweight and obese groups (p=0.04). The normal group had the highest motor FIM efficiency of the BMI subgroups (Tables 2-4).

The adjusted FIM efficiency means by weight category are provided in Tables 2- 4. After adjusting for age and gender, the FIM efficiency motor subscores did not differ significantly by BMI subgroups. After adjusting for age and gender, FIM efficiency cognitive subscores did not differ significantly by BMI sub score.

	Underwt N=40				Normal N=279				Overwt N=189				Obese N=170				Combined N=678				Test Statistic
Sex M	32% 13 of 40				55% 154 of 279				58% 109 of 189				45%				52%				P=0.0051
	a	b	c		a	b	c		a	b	c		a	b	c		a	b	c		
Age(years)	65	79	83	(73 ± 16)	71	79	84	(76 ± 13)	72	77	83	(76 ± 11)	63	73	78	(71 ± 11)	68	77	83	(74 ± 12)	P < 0.0012
LOS(days)	10.8	18	28.5	(22.3 ± 17.1)	9.5	17	27	(19.4 ± 13.1)	10	15	24	(19.0 ± 14.2)	11	16.5	27	(21.0 ± 17.0)	10	16	26	(19.9 ± 14.7)	P=0.562
Height(m)	1.6	1.7	1.8	(1.7 ± 0.1)	1.6	1.7	1.8	(1.7 ± 0.1)	1.6	1.7	1.8	(1.7 ± 0.1)	1.6	1.7	1.7	(1.7 ± 0.1)	1.6	1.7	1.8	(1.7 ± 0.1)	P=0.112
Weight(kg)	39.9	44.5	54.4	(47.0 ± 9.3)	56.9	63.5	69.9	(63.2 ± 9.3)	70.3	77.1	83.9	(77.9 ± 10.7)	87.1	95.3	108.9	(99.4 ± 18.3)	61.2	72.6	86.2	(75.4 ± 20.3)	P < 0.0012
Admission FIM	59	73	85	(70 ± 22)	64	76	90	(75 ± 20)	62	78	93	(76 ± 21)	59	77	90	(74 ± 21)	62	76	91	(75 ± 21)	P=0.442
Discharge FIM	76	98	116	(90 ± 30)	84	109	120	(100 ± 24)	86	110	119	(99 ± 26)	85	109	120	(99 ± 27)	84	109	119	(99 ± 26)	P=0.162
FIM difference	4.2	20.5	35	(18.7 ± 17.0)	12	24	34	(23.5 ± 16.7)	13	24	33	(22.3 ± 17.9)	17	24	34	(24.0 ± 17.0)	13	24	34	(23.0 ± 17.1)	P=0.432
Admission FIM cognitive	25.8	31.5	35	(28.5 ± 8.2)	26	31	35	(29.0 ± 6.5)	27	31	34	(29.3 ± 6.1)	27	32	35	(29.7 ± 6.6)	27	31	35	(29.2 ± 6.5)	P=0.322
Discharge FIM cognitive	29	33	35	(29.8 ± 8.2)	29	34	35	(31.2 ± 5.9)	30	34	35	(31.0 ± 6.7)	31	35	35	(31.5 ± 6.3)	30	34	35	(31.1 ± 6.4)	P=0.122
FIM difference cognitive	0	1.5	4	(1.3 ± 4.7)	0	2	4	(2.2 ± 4.7)	0	1	4	(1.7 ± 5.3)	0	1	4	(1.8 ± 4.7)	0	1	4	(1.9 ± 4.9)	P=0.752
Admission FIM motor	30	41	54	(42 ± 16)	36	47	58	(46 ± 16)	35	48	60	(47 ± 17)	31	46	57	(44 ± 16)	34	46	58	(46 ± 16)	P=0.172
Discharge FIM motor	48	67	81	(60 ± 23)	56	76	85	(69 ± 20)	56	77	85	(68 ± 21)	52	74	85	(67 ± 22)	53	75	85	(68 ± 21)	P=0.112
FIM difference motor	4	20	29	(17 ± 14)	11	23	31	(21 ± 14)	12	22	29	(21 ± 14)	14	24	31	(22 ± 14)	12	23	30	(21 ± 14)	P=0.342
FIM efficiency	0.2	0.8	1.8	(0.9 ± 1.2)	0.7	1.4	2.2	(1.7 ± 3.1)	0.8	1.4	2.1	(1.2 ± 2.6)	0.7	1.4	2.2	(1.5 ± 1.6)	0.7	1.4	2.2	(1.5 ± 2.6)	P=0.0692
FIM efficiency motor	0.2	0.7	1.5	(0.9 ± 1.0)	0.6	1.2	2	(1.5 ± 2.1)	0.8	1.2	1.8	(1.2 ± 1.5)	0.6	1.3	2.1	(1.4 ± 1.4)	0.6	1.2	2	(1.4 ± 1.7)	P=0.042
FIM efficiency cognitive	0	0	0.2	(0.1 ± 0.4)	0	0.1	0.2	(0.2 ± 1.2)	0	0.1	0.2	(-0.1 ± 1.3)	0	0	0.2	(0.1 ± 0.4)	0	0.1	0.2	(0.1 ± 1.0)	P=0.572
BMI	15.8	16.9	17.7	(16.5 ± 1.6)	20.6	22.3	23.7	(22.1 ± 1.9)	25.8	26.9	28.4	(27.1 ± 1.5)	31.9	34	37.1	(35.7 ± 5.6)	22	25.3	30	(26.6 ± 6.7)	P < 0.0012
a b c represent the lower quartile a, the median b, and the upper quartile c for continuous variables. x ± s represents X ± 1 SD.																					
Tests used: 1Chi Square test; 2Kruskal-Wallis test																					

Table 1: Demographic and Functional Independence Measure (FIM) Scores by BMI Categories for 678 Cardiac Patients at an Acute Rehabilitation Hospital.

Four Categories	N	Mean	95 CI lwr	95 CI upr	Standard Err
Normal	279	1.67	1.37	1.98	0.16
Underwt	40	0.92	0.12	1.73	0.41
Overwt	189	1.17	0.79	1.54	0.19
Obese	170	1.56	1.16	1.95	0.2

Table 2: Adjusted Means FIM.eff for Four BMI Categories.

Four Categories	N	Mean	95 CI lwr	95 CI upr	Standard Err
Normal	279	1.49	1.28	1.69	0.1
Underwt	40	0.87	0.33	1.41	0.27
Overwt	189	1.23	0.98	1.48	0.13
Obese	170	1.41	1.15	1.68	0.13

Table 3: Adjusted Means Motor FIM.eff for Four BMI Categories.

Four Categories	N	Mean	95 CI lwr	95 CI upr	Standard Err
Normal	279	0.19	0.07	0.31	0.06
Underwt	40	0.05	−0.27	0.37	0.16
Overwt	189	−0.06	−0.21	0.08	0.08
Obese	170	0.14	−0.02	0.3	0.08

Table 4: Adjusted Means Cognitive FIM.eff for Four BMI Categories.

Discussion

The American Heart Association (AHA) states that cardiac rehabilitation (CR) is used as a therapeutic program intended to aid in persons with CVD [13]. Most of these programs are outpatient in nature. In these programs medical personnel supervise and create a program comprising exercise, education and counseling [13]. In a recent systematic review, Sumner et al. [14] concluded that CR reduced the total death rate and enriched health-related quality of life (HRQoL) of patients recovering from a cardiac event. In a minority of cases however, patients do not have the physical capacity to return home and travel back and forth to an outpatient cardiac rehabilitation program. In these instances, the medical issues surrounding the patients' acute cardiac issue combine to produce a physical debility that requires subsequent specialized inpatient care at an IRF.

This study was designed to determine whether the obesity paradox, found in patients managed acutely after a cardiac event, would also be reflected in patients managed in a post-acute IRF. While not supporting the obesity paradox in this setting, the data are clinically important in that they demonstrate that the rate of recovery on the rehabilitation unit was not adversely affected by elevated BMIs.

In the setting of stroke, several small studies have explored the relationship between BMI and rehabilitation after a stroke. Kalichman et al. [15] found that, after an average of 75 days of rehabilitation, there was a negative correlation between BMI and change in FIM. In the study however, the length of stay was not included in the multiple regression analysis. Nishioka et al. [16] found the opposite results, noting that the FIM gain was positively associated with obesity, while Burke et al. [17] in similar findings, and found that overweight patients had the greatest FIM gain per day.

Outside of the hospital setting, others have noted a dose response relationship between BMI and increasing functional impairment or self-reported mobility [18]. Therefore, most conclude that an increased BMI, especially obesity, adversely affects function. Intuitively, one might therefore believe that obesity would interfere with the functional progress of an individual admitted for rehabilitation with an acute cardiovascular event. As was found in patients assessed during acute hospitalization, we found that an elevated body mass index, including obesity, did not adversely impact the progress of individuals admitted for acute rehabilitation after an acute cardiac event. These data suggest that BMI should not be a consideration for rejecting a candidate for admission to an inpatient cardiac rehabilitation.

Study Limitations

This study is limited by those issues inherent in retrospective analyses. We were not able to review those individuals considered for the inpatient rehabilitation unit, and therefore do not know whether there was a selection bias that might have influence the outcomes. If the admission process was influenced by the body mass index of those applying for treatment, this process might influence the outcomes that we observed. An additional limitation is that we did not review the discharge disposition by BMI to determine whether the patients entered an independent living environment based on their functional status rather than on other factors including BMI. Future studies could include both the admission and discharge criteria as well as other comorbidities.

Conclusion

While this study demonstrates obese and normal weight patients trend toward more rapid improvement, it failed to show similar results to those stated in the obesity paradox. Also, our findings failed to demonstrate that obesity significantly impairs functional progress during the rehabilitation process.

Acknowledgements

Kirk Easley, MApStat and Shuo Chen, PhD for statisitical assistance

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