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Exercise Capacity of Cardiac Rehabilitation Participants with Metabolic Syndrome and Inter-Program Variation

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Abstract

Background: Metabolic syndrome prevalence in cardiac rehabilitation (CR) is high and participants have poor baseline and overall improvement in exercise capacity; however, it is unclear if this is due to participant or CR program-level factors. The purpose of this research was to describe, in CR participants, the association between metabolic syndrome and change in exercise capacity, and to examine exercise capacity variation by CR program.

Methods: Data was abstracted from medical charts in four CR programs. A three-category exposure variable was defined as BMI<27 (reference group) and no metabolic syndrome (n=73), BMI ≥ 27 without metabolic syndrome (n=21), and metabolic syndrome (n=156). Hierarchical linear models examined the association between metabolic syndrome and the rate of change in exercise capacity and variation in exercise capacity by CR program.

Results: Sixty-two percent of participants had metabolic syndrome. In multivariable analyses, participants with BMI ≥ 27 without metabolic syndrome and those with metabolic syndrome had slower rates of change in exercise capacity compared to the reference group (β= -0.20, 95% confidence interval (CI): -0.29,-0.10; and β= -0.28, CI: -0.34,-0.23, respectively). There was no difference between the BMI ≥ 27 without metabolic syndrome and the metabolic syndrome groups. Twenty-seven percent of the difference in exercise capacity was due to CR program.

Conclusions: Participants with metabolic syndrome had slower rates of improvement in exercise capacity compared to those without metabolic syndrome. Variation between CR programs highlights the need for standard management of all CR participants but especially for those with metabolic syndrome.

Keywords: Metabolic syndrome X; Exercise; Rehabilitation; Heart diseases; MET level

Introduction

Metabolic syndrome is increasing in worldwide prevalence due to its association with the obesity epidemic. There are multiple established definitions for metabolic syndrome that require three or more of the following factors: abdominal obesity, high blood pressure, insulin resistance, and dyslipidemia of high density lipoprotein cholesterol or triglycerides [1,2]. People with metabolic syndrome are at increased risk for all-cause and cardiovascular mortality, diabetes, more severe cardiovascular disease, and secondary cardiac event after myocardial infarction when compared to persons without metabolic syndrome [3-6].

People with recent cardiac event or procedure can attend cardiac rehabilitation (CR), a multi-component, secondary prevention program, designed to reduce risk and facilitate recovery [7-11]. The benefits of participating in CR include improvements in exercise capacity, blood pressure, cholesterol, and psychosocial factors [12-15]. Characteristic of participants in these programs is that 48 to 58% have metabolic syndrome and 80 to 88% are overweight or obese [16,17].

Regularly scheduled exercise is the component of CR that most directly affects exercise capacity. Prior to CR participation, it is recommended that patients have an exercise test in part to determine starting exercise intensity. Research has demonstrated that during exercise testing, metabolic syndrome is associated with poorer exercise capacity and heart rate recovery [18]. Exercise training does improve exercise capacity in people who are overweight or obese, and in those who have metabolic syndrome [16,20,21]; however, the rate of progression in exercise capacity in CR participants has not been described. Further, these studies may not represent participants in existing CR programs as they were conducted in well-controlled environments where optimal conditions were maintained. It is not clear if similar outcomes are achieved in CR participants with metabolic syndrome attending existing CR programs as these programs may be very different from controlled environments.

Research is needed to investigate the relationship between metabolic syndrome and exercise capacity in existing CR programs. If it is determined that participants with metabolic syndrome do not have improvements in exercise capacity, program modifications may be necessary to ensure that each participant meets their potential to improve exercise capacity and reduce metabolic syndrome-associated risk. Therefore, the purpose of this research was to describe the association between metabolic syndrome and the change in exercise capacity in CR participants, and to examine exercise capacity variation by CR program.

Methods

This was a retrospective cohort study of participants enrolled in four CR programs. Chart abstractions were performed using CR program medical records to obtain session-specific exercise capacity

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data on participants enrolled between November 2006 and January 2008 (n=250). Participants were included who completed seven or more sessions of CR, had a primary diagnosis of valve disease; myocardial infarction; percutaneous coronary intervention; and/or coronary artery bypass graft, and primarily used the treadmill (i.e., in 2 of 3 sessions per week). This research was approved by the Institutional Review Board at participating sites.

Main exposure

Multiple definitions exist to describe metabolic syndrome [1,22,23]. In the current research, waist circumference and insulin resistance were not reported requiring development of a modified definition of metabolic syndrome. Research has shown that health risks increase with BMI greater than 27 [24]; therefore, the modified definition included three or more of the following factors: BMI ≥ 27, HDL in males <40 mg/dL and females <50 mg/dL, triglycerides ≥150 mg/dL, documented history of high blood pressure and/or hypertension medication use and documentation of diabetes. HDL measures were missing in 38% of records which did not allow metabolic syndrome to be identified in 26% of the sample. To prevent dropping these records, the sensitivity and specificity of a two factor metabolic syndrome definition (elevated blood pressure and BMI ≥ 27) was compared to a three factor definition (elevated blood pressure, BMI ≥ 27, and increased HDL). Sensitivity was 90% and specificity was 81% and the decision was made to maintain these records. The main exposure variable was accordingly defined as a three category metabolic syndrome variable: BMI<27 and no metabolic syndrome (reference group); BMI ≥ 27 without metabolic syndrome, and metabolic syndrome.

Exercise capacity

MET levels were used to quantify exercise capacity. A MET level is a standard measure of energy expenditure defined as milliliters of oxygen used per kilogram of body weight per minute of activity. Treadmill mile per hour and percent grade were abstracted from the patients' medical charts to calculate the MET level for each CR session.

Statistical analysis

Data was examined for missing values, potential outliers, and normality. MET levels were normally distributed and therefore maintained in their current form. The distribution of potential confounders and predictors were examined across categories of the metabolic syndrome variable and compared using the chi-square test for categorical and Student's t-test for continuous data. Mean change in MET level by metabolic syndrome category was explored using ANOVA. Variables were maintained for multivariable analyses if significant at $P \leq 0.20$.

Hierarchical linear modeling examined the rate of change at hospital-level. Interaction terms were examined. Potential predictors or confounders were identified as starting MET level (continuous), admitting diagnosis (valve disease; myocardial infarction; percutaneous coronary intervention; and/or coronary artery bypass graft), history of cardiovascular event (no/yes), congestive heart failure (no/yes), claudication (no/yes), ejection fraction (below normal <55, normal ≥ 55, or unknown), gender, age at entry (continuous), number of sessions attended (7 to 18, 19 to 24, or 25 to 36), and number of days passed between sessions (continuous). All analyses were conducted in STATA 9.2 software [25].

Results

Overall, 62% of participants had metabolic syndrome, 65% of participants were male and the mean age was 64 (standard deviation (SD) =11.3) (Table 1). There were no differences between groups except with regards to the factors comprising the metabolic syndrome (diabetes, blood pressure, HDL, and triglycerides) and age. The metabolic syndrome group was youngest (mean=62.5 years, SD=11.3) and the reference group was oldest (mean=67.9 years, SD=10.6). There were no differences in mean starting MET level, mean change in MET level, or mean ending MET level across exposure groups (Table 2); however, there were significant differences between starting and ending MET level overall and for each level of the exposure variable (P<0.001).

Rate of change analyses

In unadjusted analyses, participants with BMI ≥ 27 without metabolic syndrome did not differ from the reference group of those with BMI<27 without metabolic syndrome (Table 3). Participants with metabolic syndrome had a slower rate of change in MET level as compared to the reference group of those with BMI<27 without metabolic syndrome (β= -0.15, -0.22, -0.09). In multivariable analyses, participants with BMI ≥ 27 without metabolic syndrome and those with metabolic syndrome had slower rates of change compared to the reference group of those with BMI<27 without metabolic syndrome (β= -0.20, 95 percent confidence interval (CI): -0.29, -0.10; and β= -0.28, CI: -0.34, -0.23, respectively) when controlling for age, gender, number of sessions attended, heart failure, history of claudication, admitting diagnosis, ejection fraction, and history of cardiovascular event. There was no difference between the BMI ≥ 27 without metabolic syndrome and the metabolic syndrome group. The variance for hospital was 0.38 (standard error=0.27; CI: 0.09, 1.5). The intraclass correlation coefficient equaled 27.4.

Conclusions

This research found that CR participants with metabolic syndrome had significantly slower increases in exercise capacity when compared to those with BMI less than 27 and no metabolic syndrome in adjusted analyses; however, no differences were observed between participants with metabolic syndrome and those without metabolic syndrome but with a high BMI (≥ 27). There were no differences observed between the three levels of the exposure variable and mean starting exercise capacity, mean change in exercise capacity, or mean ending exercise capacity. Interestingly, 27% of the variance in the rate of change in exercise capacity was attributed to the CR program attended by the participants.

Previous research has demonstrated significant improvements in exercise capacity in CR participants who are overweight or obese or who have metabolic syndrome [16,20,12]. However, participants in these programs were managed under optimal conditions that included a baseline exercise stress test to determine starting exercise capacity before beginning the exercise program, and increase in exercise intensity that maintained the participant near their anaerobic threshold. It is not known what proportion of CR programs operate under optimal conditions. In Ohio, approximately 53% of CR programs perform or obtain an entry exercise test while 38% only review the patient's age and history to determine initial exercise setting [26]. A goal for increasing exercise capacity for CR is determined by 68% of Ohio programs [26]. Additionally, 78% of Ohio programs that staffed an exercise physiologist/specialist, compared to 56% of programs that did not staff an exercise physiologist, administered or obtained a recent exercise test at program entry (p=0.04) [26]. Of the 250 participants in the current research, only one medical chart indicated the patient began CR with an exercise stress test and only one program staffed a full-time

	Overall	BMI<27 and no metabolic syndrome (n=73)	BMI ≥ 27 and no metabolic syndrome (n=21)	Metabolic syndrome (n=156)	*P* Value
	No. (%) or Mean(SD)	No. (%) or Mean(SD)	No. (%) or Mean(SD)	No. (%) or Mean(SD)	
Hospital					
A		3 (4.1)	0	5 (3.2)	
B		16 (21.9)	7 (33.3)	32 (20.5)	
C		38 (52.1)	10 (47.6)	90 (57.7)	0.84
D		16 (21.9)	4 (19.1)	29 (48.6)	
Diabetes (yes)	73 (29.2)	3 (4.1)	1 (4.8)	69 (44.2)	<0.001
High blood pressure (yes)	231 (92.4)	67 (87.7)	15 (71.4)	152 (97.4)	<0.001
High density lipoprotein (low)	159 (64.6)	12 (17.4)	5 (23.8)	142 (91.0)	<0.001
Triglycerides(≥150)	52 (21.1)	5 (7.3)	0	47 (30.1)	<0.001
Congestive heart failure (Yes)	23 (9.2)	6 (8.2)	3 (14.3)	14 (9.0)	0.65
History of claudication (Yes)	33 (13.2)	11 (15.1)	5 (23.8)	17 (10.9)	0.20
Admitting diagnosis					
Valve	12 (4.8)	4 (5.4)	3 (14.3)	5 (3.2)	
Angina	33 (13.2)	8 (11.0)	4 (19.1)	21 (13.5)	
PCI	29 (11.6)	6 (8.2)	2 (9.5)	21 (13.5)	
MI	67 (26.8)	20 (27.4)	5 (23.8)	42 (26.9)	0.48
CABG	109 (43.6)	35 (48.0)	7 (33.3)	67 (42.9)	
Ejection fraction					
Normal range	109 (43.6)	36 (49.3)	8 (38.1)	65 (41.7)	
Below normal	58 (23.2)	14 (19.2)	7 (33.3)	37 (23.7)	
Don't know	83 (33.2)	23 (31.5)	6 (28.6)	54 (34.6)	0.65
Number of sessions attended					
7 to 18	46 (18.4)	17 (23.3)	3 (14.2)	26 (16.7)	
19 to 24	43 (17.2)	9 (12.3)	4 (19.1)	30 (19.2)	0.59
25 to 36	161 (64.4)	47 (64.4)	14 (66.7)	100 (64.1)	
History of cardiovascular event (Yes)	149 (59.6)	41 (56.2)	13 (61.9)	95 (60.1)	0.81
Gender (Male)	162 (64.8)	50 (68.5)	16 (76.2)	96 (61.5)	0.33
Mean age	64.1 (11.3)	67.9 (10.6)	62.2 (10.6)	62.5 (11.3)	0.002

BMI=body mass index; PCI=percutaneous coronary intervention; MI=myocardial infarction; CABG=coronary artery bypass graft; No.=number; SD=standard deviation

Table 1: Clinical Characteristics of the Study Population by Metabolic Syndrome Condition, n=250.

	BMI <27 and no Metabolic Syndrome (n=73)	BMI ≥27 and no Metabolic Syndrome (n=21)	Metabolic Syndrome (n=156)	Overall	*P* Value
	ml $O_2 \cdot kg^{-1} \cdot min^{-1}$ (SD)	ml $O_2 \cdot kg^{-1} \cdot min^{-1}$ (SD)	ml $O_2 \cdot kg^{-1} \cdot min^{-1}$ (SD)	ml $O_2 \cdot kg^{-1} \cdot min^{-1}$ (SD)	
Mean starting MET level	2.4 (0.77)	2.4 (0.69)	2.3 (0.56)	2.3 (0.64)	0.40
Mean MET level change	2.3 (1.1)	2.5 (1.2)	2.2 (1.2)	2.3 (1.2)	0.57
Mean ending MET level	4.7 (1.2)	4.8 (1.3)	4.5 (1.3)	4.6 (1.3)	0.31
P value for mean starting to mean ending MET level	<0.001	<0.001	<0.001	<0.001	

BMI=body mass index; ml=milliliters; O_2=oxygen; kg=kilogram; min=minute; SD=standard deviation ; MET=metabolic equivalence

Table 2: Average Change in Exercise Capacity by Metabolic Syndrome Condition, 250.

exercise physiologist. The lack of entry stress testing is evidenced by the lack of difference in mean entry exercise capacity across levels of the exposure groups. As indicated previously, people with metabolic syndrome perform more poorly during exercise testing and have worse cardiovascular disease when compared to those without metabolic syndrome [3-6,18]. Presumably, if all patients in the current research had an entry exercise test, a difference in mean starting exercise capacity would have been observed between the exposure groups. This research highlights the importance of exercise testing prior to CR as a critical step for determining appropriate starting exercise capacity and increases in exercise capacity over the duration of the CR program. However, research is needed on exercise stress testing before CR entry and its implications for the initial exercise prescription and corresponding increases in capacity.

In the current research, 27% of the variance in exercise capacity outcomes was attributed to the CR program of attendance suggesting a lack of standardized management of patients. Variation may be attributed to program practices and staff-level factors that impact the outcomes observed in CR programs. Recommended practices have been described by the American Heart Association and American Association of Cardiovascular and Pulmonary Rehabilitation for the assessment, intervention, and expected outcomes of participants but these are only guidelines and nationally, it is not known what proportion of programs follow what proportion of the guidelines [27]. Additionally, there are no national guidelines specific to the care of CR participants with metabolic syndrome. Previous research found that 26% of CR programs in Ohio assess participants for metabolic syndrome and that only 8% have guidelines specific for these participants [28]. Coupled with the findings in the current research, this suggests that from a system-wide approach, opportunities exist for standard management of all CR participants but especially for management in those patients with metabolic syndrome. This includes assessing participants for

	Unadjusted model		Hierarchical Linear Model	
	β	95% CI	β	95% CI
Metabolic syndrome condition				
BMI<27	ref		ref	
BMI≥27 no metabolic syndrome	-0.06	-0.17, 0.05	-0.20	-0.29, -0.10
metabolic syndrome	-0.15	-0.22, -0.09	-0.28	-0.34, -0.23
Sessions attended				
7 to 18			ref	
19 to 24			0.19	0.09, 0.30
25 to 36			0.55	0.46, 0.64
Congestive heart failure			-0.28	-0.37,-0.20
History of claudication			-0.30	-0.39, -0.21
Admitting diagnosis				
Valve			ref	
Angina			0.35	0.21, 0.49
PCI			0.74	0.60, 0.87
MI			0.62	0.49, 0.75
CABG			0.44	0.31, 0.56
Ejection fraction				
Normal range			ref	
Below normal			-0.01	-0.08, 0.06
Unknown			-0.14	-0.22, -0.06
History of cardiovascular event			-0.26	-0.33, -0.19
Gender[1]			0.67	0.61, 0.72
Age[2]			-0.03	-0.03, -0.03

*variance component hospital=0.38 (CI:0.09, 1.5)
BMI=body mass index; PCI=percutaneous coronary intervention; MI=myocardial infarction; CABG=coronary artery bypass graft
[1]reference=female gender; [2]unit change per year of increase in age

Table 3: Rate of Change in Exercise Capacity for Cardiac Rehabilitation Participants, 250.

metabolic syndrome at entry to CR, developing metabolic syndrome interventions and guidelines that may be followed by CR programs nationwide, and conducting or obtaining an exercise test when starting CR so as to ensure improvement.

These data were limited in that there were missing values for the risk factors that comprise the metabolic syndrome requiring a modified definition; however, these missing values are not uncommon to CR programs. The algorithm used in this research to identify metabolic syndrome in CR participants is appropriate to use when laboratory values are missing. Differences in exercise capacity may not have been observed between the two groups with BMI ≥ 27 due to the sample size. The amount of exercise participants performed outside of CR couldn't be explored and may have had an effect on exercise capacity change. The lack of entry stress testing may have influenced the results compared to those without. If rate of change does differ between patients with metabolic syndrome and those without, these patients may need more intense, longer duration of CR, or phase III (maintenance) CR to achieve optimal outcomes. Strengths of this research included the use of longitudinal data from four different hospitals that permitted a novel examination of rate of change and the variance in exercise capacity outcomes associated with CR program.

This research examined exercise capacity for participants with metabolic syndrome in typical CR programs and found differences in outcomes when compared to patients with BMI<27 and no metabolic syndrome. Typical CR programs differ from programs where research is carried out and from where our evidence based interventions are developed. In this study exercise capacity was influenced by CR program of attendance. Understanding the outcomes achieved in everyday practice is necessary to implement evidenced-based interventions for the management of metabolic syndrome in CR programs to ensure that all participants achieve maximum benefits.

References

1. National Institutes of Health (2002) Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) Final Report. Circulation 106: 3143-3421.
2. Alberti KGMM, Zimmet (1999) Definition, diagnosis, and classification of diabetes and it's complications. World Health Organization.
3. Clavijo LC, Pinto TL, Kuchulakanti PK, Turgeon R, Chu WW, et al. (2006) Metabolic syndrome in patients with acute myocardial infarction is associated with increased infarct size and in-hospital complications. Cardiovasc Revasc Med 7: 7-11.
4. Isomaa B, Almgren P, Tuomi T, Forsén B, Lahti K, et al. (2001) Cardiovascular morbidity and mortality associated with the metabolic syndrome. Diabetes Care 24: 683-689.
5. Nakatani D, Sakata Y, Sato H, Mizuno H, Shimizu M, et al. (2007) Clinical impact of metabolic syndrome and its additive effect with smoking on subsequent cardiac events after acute myocardial infarction. Am J Cardiol 99: 885-889.
6. Wilson PW, Dagostino RB, Parise H, Sullivan L, Meigs JB (2005) Metabolic syndrome as a precursor of cardiovascular disease and type 2 diabetes mellitus. Circulation 112: 3066-3072.
7. AACVPR (2004) Guidelines for Cardiac Rehabilitation and Secondary Prevention Programs. (4thedn), Human Kinetics, Champaign, USA.
8. Lavie CJ, Milani RV (2001) Benefits of cardiac rehabilitation and exercise training programs in elderly coronary patients. Am J Geriatr Cardiol 10: 323-327.
9. Lavie CJ, Milani RV, Cassidy MM, Gilliland YE (1995) Benefits of cardiac rehabilitation and exercise training in older Persons. Am J Geriatr Cardiol 4: 42-48.
10. Lavie CJ, Milani RV, Littman AB (1993) Benefits of cardiac rehabilitation and exercise training in secondary coronary prevention in the elderly. J Am Coll Cardiol 22: 678-683.
11. Wenger NK, Froelicher ES, Smith LK, Ades PA, Berra K, et al. (1995) Cardiac rehabilitation as secondary prevention. Agency for Health Care Policy and Research and National Heart, Lung, and Blood Institute. Clin Pract Guidel Quick Ref Guide Clin : 1-23.

12. Brochu M, Poehlman ET, Savage P, Fragnoli-Munn K, Ross S, et al. (2000) Modest effects of exercise training alone on coronary risk factors and body composition in coronary patients. J Cardiopulm Rehabil 20: 180-188.

13. Maines TY, Lavie CJ, Milani RV, Cassidy MM, Gilliland YE, et al. (1997) Effects of cardiac rehabilitation and exercise programs on exercise capacity, coronary risk factors, behavior, and quality of life in patients with coronary artery disease. South Med J 90: 43-49.

14. Marchionni N, Fattirolli F, Fumagalli S, Oldridge N, Del Lungo F, et al. (2003) Improved exercise tolerance and quality of life with cardiac rehabilitation of older patients after myocardial infarction: results of a randomized, controlled trial. Circulation 107: 2201-2206.

15. Warner JG Jr, Brubaker PH, Zhu Y, Morgan TM, Ribisl PM, et al. (1995) Long-term (5-year) changes in HDL cholesterol in cardiac rehabilitation patients. Do sex differences exist? Circulation 92: 773-777.

16. Milani RV, Lavie CJ (2003) Prevalence and profile of metabolic syndrome in patients following acute coronary events and effects of therapeutic lifestyle change with cardiac rehabilitation. Am J Cardiol 92: 50-54.

17. Savage PD, Banzer JA, Balady GJ, Ades PA (2005) Prevalence of metabolic syndrome in cardiac rehabilitation/secondary prevention programs. Am Heart J 149: 627-631.

18. Spies C, Otte C, Kanaya A, Pipkin SS, Schiller NB, et al. (2005) Association of metabolic syndrome with exercise capacity and heart rate recovery in patients with coronary heart disease in the heart and soul study. Am J Cardiol 95: 1175-1179.

19. Caminiti G, Volterrani M, Marazzi G, Massaro R, Vitale C, et al. (2009) Metabolic syndrome predicts lower functional recovery in female but not in male patients after an acute cardiac event. Int J Cardiol 135: 296-301.

20. Lavie CJ, Milani RV (1996) Effects of cardiac rehabilitation and exercise training in obese patients with coronary artery disease. Chest 109: 52-56.

21. Shubair MM, Kodis J, McKelvie RS, Arthur HM, Sharma AM (2004) Metabolic profile and exercise capacity outcomes: their relationship to overweight and obesity in a Canadian cardiac rehabilitation setting. J Cardiopulm Rehabil 24: 405-413.

22. The IDF consensus worldwide definition of the metabolic syndrome. International Diabetes Federation.

23. Einhorn D, Reaven GM, Cobin RH, Ford E, Ganda OP, et al. (2003) American College of Endocrinology position statement on the insulin resistance syndrome. Endocr Pract 9: 237-252.

24. Pi-Sunyer FX (1991) Health implications of obesity. Am J Clin Nutr 53: 1595S-1603S.

25. StataCorp LP (2010) Computer program.

26. Zullo MD, Jackson LW, Whalen CC, Dolansky MA (2012) Evaluation of the recommended core components of cardiac rehabilitation practice: an opportunity for quality improvement. J Cardiopulm Rehabil Prev 32: 32-40.

27. Balady GJ, Ades PA, Comoss P, Limacher M, Pina, IL, et al. (2000) Core components of cardiac rehabilitation/secondary prevention programs: A statement for healthcare professionals from the American Heart Association and the American Association of Cardiovascular and Pulmonary Rehabilitation Writing Group. Circulation 102: 1069-1073.

28. Zullo MD, Dolansky MA, Jackson LW (2011) Metabolic syndrome: identification and management in cardiac rehabilitation. J Cardiopulm Rehabil Prev 31: 92-99.

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