EXERCISE PERFORMANCE, PHYSICAL ACTIVITY, AND HEALTH-RELATED QUALITY OF LIFE IN SUBJECTS WITH STABLE ANGINA

Andrew W. Gardner, PhD[a,c,d], **Polly S. Montgomery, MS**[a,c,d], **Raphael M. Ritti-Dias, PhD**[e], and **Udho Thadani, MD, FACC**[b,f]

Andrew W. Gardner: andrew-gardner@ouhsc.edu; Polly S. Montgomery: polly-montgomery@ouhsc.edu; Raphael M. Ritti-Dias: raphaelritti@gmail.com; Udho Thadani: udho-thadani@ouhsc.edu

[a]CMRI Metabolic Research Program, Oklahoma University Health Sciences Center (OUHSC), Oklahoma City, OK

[b]Department of Medicine, Cardiovascular Section, OUHSC, Oklahoma City, OK

[c]Department of Medicine, Division of Gerontology, University of Maryland, Baltimore, MD

[d]Veterans Affairs Medical Center, Baltimore, MD

[e]School of Physical Education, Pernambuco University, Pernambuco, Brazil

[f]Veteran Affairs Medical Center, OUHSC, Oklahoma City, OK

Abstract

We compared exercise performance, daily physical activity, and health-related quality of life in 115 subjects with stable angina and 441 controls without coronary artery disease or stable angina. Subjects with stable angina had shorter 6-min walk distance (p = 0.003), and lower total leisure-time physical activity (p = 0.003) than the controls. Group differences in these measures remained (p < 0.05) after adjusting for age, race, current smoking, diabetes, hypertension and obesity. Subjects with stable angina also had lower health-related quality of life for physical function (p < 0.001), general health (p = 0.002) and vitality (p < 0.001), but group differences did not remain (p > 0.05) after adjustment for co-morbid conditions. Subjects with stable angina have impaired exercise performance and reduced daily physical activity. Thus, they are prime candidates for exercise interventions designed to improve daily physical activity and lower extremity strength levels.

Keywords

Exercise; Quality of Life; Stable Angina

INTRODUCTION

Cardiovascular diseases are the major cause of death in adults and the elderly in developed countries. Angina is the most common symptom of coronary artery disease (CAD), as it affects more than 9.6 million Americans.[1] The incidence of major adverse events in subjects with stable angina is more than 20% in 24 months,[2] and the annual costs of chronic stable

Address correspondence to: Andrew W. Gardner, Ph.D., Hobbs-Recknagel Professor, General Clinical Research Center, University of Oklahoma Health Sciences Center, 1122 N.E. 13th Street, ORI Suite 150, Oklahoma City, OK 73117. Telephone (405) 271-4272 ext. 42743, FAX: 405-271-4273.

angina are more than $19,000 per patient,[3] indicating that strategies should be developed to decrease the direct and indirect costs of this symptom.

Conservative medical management is recommended for patients whose angina symptoms occur under stable conditions (i.e. predictable frequency and duration). Although the impaired aerobic capacity of patients with CAD has been previously described,[4–9] specific information in CAD subjects with stable angina symptoms is lacking. In fact, stable angina symptoms may lead to an increasingly sedentary lifestyle, thereby decreasing peripheral muscle function and promoting declines in other domains of exercise performance, daily physical activity and quality of life. However, these outcomes have received surprisingly little attention in this population. Understanding the impact that stable angina has on these outcomes may enable exercise prescriptions to be more effective during rehabilitation.

The purpose of this study was to compare exercise performance, daily physical activity, and health-related quality of life in subjects with stable angina and those without angina or known CAD. We hypothesized that subjects with stable angina would have impaired values in each outcome measure.

METHODS

SUBJECTS

Subjects between the ages of 50 and 90 years were evaluated in the Geriatrics, Research, Education, and Clinical Center at the Maryland Veterans Affairs Health Care System (MVAHCS) at Baltimore. Four hundred forty-one subjects without history or symptoms of CAD were recruited from geriatric clinics and from newspaper advertisements. One hundred fifteen subjects with history of exertional chest pain (stable angina) for at least 1 year were recruited from cardiovascular clinics at the site of the Baltimore MVAHCS. Subjects were excluded from this study for the following conditions: (a) poorly controlled blood pressure, (b) congestive heart failure, (c) peripheral artery disease, (d) chronic obstructive pulmonary disease, and, (e) active cancer, renal disease or liver disease. All subjects lived independently at home. The Institutional Review Boards at the University of Maryland and the MVAHCS at Baltimore approved the procedures used in this study.

MEASUREMENTS

Medical History—The following medical history information was obtained during a physical examination: demographic characteristics, height, weight, waist and hip circumferences, cardiovascular risk factors, co-morbid conditions and a list of current medications. In addition, ankle/brachial index was obtained to screen for the presence of peripheral artery disease.[10] All subjects with stable angina were cleared by the study physician to perform the 6-min walk test.

6-min Walk Test—Two cones were placed 100 feet apart in a marked corridor. Subjects performed a 6-min walk test over this course supervised by trained exercise technicians as previously described.[11] The total distance walked during the test was recorded. The test-retest intraclass reliability coefficient is R = 0.94 for the total 6-min walking distance.[11]

Walking Impairment Questionnaire (WIQ)—Self-reported ambulatory ability was assessed using a validated questionnaire that assesses ability to walk at various speeds and distances and to climb stairs.[12]

Short Physical Performance Battery—The Short Physical Performance Battery score was calculated from the performance of a 4-m walk test, a chair-stand test, and a standing

balance test as previously described.[13–14] Briefly, during the 4-m walk test, walking velocity was assessed by measuring the time required for subjects to walk a distance of 4 m marked out in a corridor at their usual pace. During the chair stand test, lower extremity strength and balance were assessed by performing a repeated chair-rise test in which subjects completed 5 sequential sit-to-stand transfers from an armless 18-in high, straight-backed chair with their arms folded across their chest. During the standing balance test, balance was assessed by measuring the time that subjects could hold a stance in side-by-side, semi-tandem, and full-tandem positions for a maximum of 10 seconds in each stance. The side-by-side stance was performed in which the feet were side-by-side separated by approximately 1 inch. The semi-tandem stance was done next in which the heel of one foot was placed to the side of the first toe of the other foot, with the subject choosing which foot to place forward. The full-tandem stance was performed in which the heel of one foot was directly in front of the toes of the other foot. For each of the 3 tests (4-m walk, repeated chair-rise and standing balance), subjects were scored on a 0 to 4 ordinal scale, with a score of 0 representing inability to perform the test, and scores between 1 and 4 representing quartiles of performance based on normative data on more than 5,000 community-dwelling people published from the Established Populations for the Epidemiologic Studies of the Elderly.[15] The Short Physical Performance Battery score ranges from 0 to 12 (0 = worst function, 12 = best function), and is predictive of mobility loss, nursing home placement, and mortality among community-dwelling elderly individuals.[13–14] The test-retest intraclass reliability coefficient is R = 0.93 for the summary performance score.[15]

Physical Activity—The Minnesota Leisure Time Physical Activity questionnaire (LTPA) was administered by determining the physical activity level of the subjects over the previous year. The LTPA yields an average daily expenditure of physical activity (kcal/day). The mean duration and mean intensity level of LTPA were obtained as previously described.[16] LTPA at the following 3 different intensity levels was also recorded: low intensity (4.0 METS; 1 MET = 1 resting metabolic equivalent), moderate intensity (4.5–6.0 METS), and high intensity (> 6.0 METS).[17–18] Additionally, a physical activity scale (PAS) was used to assess the self-reported physical activity level over the preceding month as previously described.[19–20]

Self-Perceived Health—The Health Utilities Index ranging between 0 (i.e. the worst imaginable health) and 100 (i.e. the best imaginable health) was used to assess self-reported health as previously described.[21] Subjects were asked to select a numeric value on the scale that best corresponded to their current overall health state.

Quality of Life—Health-related quality of life was assessed with the Medical Outcomes Study Short-Form 36 (MOS SF-36) General Health Survey.[22] The MOS SF-36 is a reliable and valid generic instrument which includes multi-item scales measuring the following 8 health domains: physical function, role limitations due to physical problems, general health, bodily pain, social function, role limitations due to emotional problems, mental health and vitality. For each subscale, item scores were recorded, summed, and standardized into a scale from 0 to 100, with better health states resulting in higher scores.

STATISTICAL ANALYSES

Unpaired t-tests were used to compare differences between the subjects with and without stable angina for parametric measures, and Mann-Whitney U-tests were used to compare the groups on categorical measures (sex, race, hypertension, etc). Analysis of covariance (ANCOVA) was performed to assess group differences in exercise performance, physical activity, and health-related quality of life after adjusting for differences in baseline clinical characteristics which included age, race, current smoking, diabetes, hypertension and

obesity. All analyses were performed using the SPSS-PC statistical package. Statistical significance was set at a 2-tailed level of $p < 0.05$. Measurements are presented as means ± standard deviations.

RESULTS

The clinical characteristics of the subjects with and without stable angina are shown in Table I. The subjects with stable angina were younger ($p = 0.021$) and had a lower percentage of Caucasians ($p < 0.001$) than the controls. Additionally, the subjects with stable angina had a higher body mass index ($p = 0.008$), a higher waist/hip ratio ($p = 0.039$), and a higher prevalence of obesity ($p = 0.046$), smoking ($p = 0.009$) and hypertension ($p = 0.037$) than the controls. There was a trend for those with stable angina to have greater waist girth ($p = 0.061$) and higher prevalence of diabetes ($p = 0.070$), but these were not statistically significant.

Exercise performance of subjects with stable angina and controls is shown in Table II. Subjects with stable angina had shorter 6-min walk distance ($p = 0.003$), lower WIQ distance ($p < 0.001$), speed ($p < 0.001$), and stair climbing ($p < 0.001$), and a lower Short Physical Performance Battery score in chair stand test ($p < 0.001$) than the controls. Group differences in each measure remained after adjusting for age, race, current smoking, diabetes, hypertension and obesity ($p < 0.05$).

Subjects with stable angina also had a lower score ($p < 0.001$) on the physical activity scale (Table III), as well as lower measures of total LTPA ($p = 0.003$), low intensity LTPA ($p = 0.050$), moderate intensity LTPA ($p = 0.040$), high intensity LTPA ($p = 0.023$), and mean daily duration of LTPA ($p = 0.014$) than the controls. The physical activity scale ($p < 0.001$), total LTPA ($p = 0.016$), and mean daily duration of LTPA ($p = 0.046$) remained lower in subjects with stable angina after adjusting for differences in age, race, current smoking, diabetes, hypertension and obesity.

Subjects with stable angina had lower self-perceived health ($p < 0.001$) that remained significant after adjusting for covariates (Table IV). Although subjects with stable angina also had lower health-related quality of life for the domains of physical function ($p < 0.001$), role limitations due to physical problems ($p < 0.001$), general health ($p = 0.002$), and vitality ($p < 0.001$), these group differences did not persist after adjusting for age, race, current smoking, diabetes, hypertension, and obesity ($p > 0.05$).

DISCUSSION

The major finding of this investigation was that subjects with history of stable angina pectoris had impaired exercise performance, lower levels of physical activity related to leisure, and lower values in multiple domains of health-related quality of life than subjects without stable angina.

This study is the first to objectively quantify ambulatory function during self-paced exercise, and to measure daily physical activity in subjects with stable angina. A key observation in the current investigation was that subjects with stable angina walked a shorter distance than the controls during the 6-min walk test, supporting previous findings that subjects with CAD have impaired aerobic fitness.[23–24] Although the 6-min walk test does not directly assess aerobic capacity, the total distance walked is related to peak oxygen uptake in subjects with congestive heart failure,[25] peripheral arterial disease[11] and respiratory disease.[26] Furthermore, the 6-min walk test is clinically useful because it approximates ambulation performed during daily activities, and the walking distance is a predictor of morbidity and mortality.[27] The walking distance of the subjects with stable angina in this investigation was

better than in subjects with peripheral arterial disease limited by intermittent claudication[11] and in subjects with New York Heart Association (NYHA) Class III heart failure.[25] However, their walking distance was similar to subjects with breathlessness associated with bradycardia,[28] and was worse than in subjects with NYHA Class II heart failure. Consequently, subjects with stable angina have limitations in sustained ambulatory function associated with endurance related tasks. This finding agrees with self-perceived ambulatory function, as subjects with stable angina report greater impairment in their ability to ambulate at various distances and speeds, and to climb stairs.

Additionally, subjects with stable angina scored lower on the Short Physical Performance Battery than the controls. The score of the subjects with stable angina is similar to subjects with peripheral arterial disease [29–30] and lower functioning elderly,[14] and indicates that they have an elevated risk for mobility loss, nursing home placement, and all-cause mortality.[13–14] Among the tests included in this battery, the largest difference between subjects with stable angina and controls was in the chair stand test, an indicator of muscle strength and endurance. Previous study also observed reduced muscle strength[31] and endurance [31–33] in subjects with CAD compared to age-matched controls. Their poor muscle endurance correlates with poor aerobic capacity[31], and seems to be caused by abnormalities in skeletal muscle function including a higher recruitment of motor units to generate the same amount of strength than controls.[32] Interestingly, exercise interventions designed to improve muscle strength/endurance in patients with CAD seems to revert these abnormalities[34].

Encouragement to perform physical activities has been recommended as an important component of cardiac rehabilitation for patients with CAD.[35] The results of the present study showed that subjects with stable angina had a lower total LTPA, primarily due to spending less time engaged in physical activities. These data suggest that although subjects with stable angina engage in similar intensities of LTPA as controls, they are limited in their ability to endure activities at any given intensity. As a result, the more sedentary lifestyle of subjects with stable angina places them at greater risk for subsequent morbidity and mortality[36–37] than the controls which highlights the importance of physical activity counseling and the need of assessment of physical activity levels in clinical settings.[38]

In addition to having lower LTPA, subjects with stable angina also had impaired health-related quality of life on multiple domains compared to the controls. The subjects with stable angina had lower scores on physical health domains related to physical function, role limitations due to physical problems, and general health, as well as a lower score on the mental health domain related to vitality. These results are in agreement with a recent study that observed lower health related quality of life, including physical and emotional domains in subjects with CAD compared to subjects without CAD.[39] However, these differences did not persist after controlling for age, race, current smoking, diabetes, hypertension, and obesity, suggesting that the lower values in health-related quality of life in subjects with stable angina are more closely related to having a greater burden in co-morbid conditions than to having stable angina. Previous studies also observed an association between co-morbid conditions and quality of life in patients with CAD.[40–41] Interestingly, the subjects with stable angina and the controls had similar scores for bodily pain, suggesting that those with stable angina either are not active enough to experience symptoms often or the symptoms are somewhat small in magnitude.

This study is limited by the cross-sectional design comparing subjects with and without stable angina. Causality cannot be established, as it is possible that subjects with stable angina had impaired exercise performance, lower physical activity levels, and lower health-related quality of life than the controls even prior to the development of symptoms. The

present findings are also limited to subjects with stable angina, and may not be generalized to subjects with varying levels of CAD. However, subjects with stable angina had a good proportion of women and African-Americans, and they had typical cardiovascular disease risk factors. Thus, the findings of the present study are generalizable to the majority of subjects with stable angina who typically have numerous co-morbid conditions. The presence of angina symptoms during the self-paced exercise tests was not assessed. Therefore, we were not able to determine if exercise performance in subjects was limited by angina symptoms. A final limitation is that information about medications was not quantified to explain group differences in exercise and physical activity measures. Rather, this information was obtained during the medical history to help determine the presence of cardiovascular risk factors and the clinical management of stable angina.

In conclusion, subjects with stable angina have impaired exercise performance and reduced daily physical activity. Thus, subjects with stable angina are prime candidates for exercise interventions designed to improve daily physical activity and lower extremity strength levels.

Acknowledgments

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Table I

Clinical characteristics of subjects with stable angina and controls. Values are means (SD) and percentages.

Variables	Control Group (n = 441)	Stable Angina Group (n = 115)	P
Age (years)	64 (10)	61 (11)	0.021
Weight (kg)	86.2 (18.3)	89.0 (18.6)	0.138
Body Mass Index (kg/m^2)	29.6 (5.6)	31.2 (6.3)	0.008
Waist Girth (cm)	97.5 (13.1)	100.1 (13.8)	0.061
Hip Girth (cm)	109.4 (11.9)	110.1 (12.7)	0.603
Waist/Hip Ratio	0.89 (0.09)	0.91 (0.08)	0.039
Sex (% Men)	61	59	0.683
Race (% Caucasian)	77	57	< 0.001
Current Smoking (%)	11	20	0.009
Diabetes (%)	10	17	0.070
Hypertension (%)	46	64	0.037
Dyslipidemia (%)	38	44	0.222
Abdominal Obesity (%)	49	55	0.317
Obesity (%)	38	48	0.046

Abdominal obesity was defined as having a waist girth > 88 cm in women, and > 102 cm in men. Obesity was defined as having a body mass index 30 kg/m^2.

Table II

Exercise performance and self-reported health of subjects with stable angina and controls. Values are means (SD).

Variables	Control Group (n = 441)	Stable Angina Group (n = 115)	Unadjusted P	Adjusted P [*]
6-Min Walk Distance (m)	485 (100)	449 (96)	0.003	0.037
WIQ Distance Score (%)	76 (34)	57 (38)	< 0.001	< 0.001
WIQ Speed Score (%)	65 (32)	48 (32)	< 0.001	< 0.001
WIQ Stair Climbing Score (%)	67 (35)	48 (36)	< 0.001	< 0.001
SPPB Score (points)	10.5 (1.2)	10.1 (1.2)	0.004	0.017
SPPB Chair (points)	2.7 (1.1)	2.2 (1.1)	< 0.001	0.002
SPPB Stand (points)	3.8 (0.5)	3.8 (0.6)	0.714	0.890
SPPB Walk (points)	4.0 (0.2)	3.9 (0.3)	0.040	0.109

WIQ = walking impairment questionnaire, SPPB = short physical performance battery.

[*] Adjusted for age, race, current smoking, diabetes, hypertension, and obesity.

Table III

Physical activity measures of subjects with stable angina and controls. Values are means (SD).

Variables	Control Group (n = 441)	Stable Angina Group (n = 115)	Unadjusted P	Adjusted P [*]
Total LTPA (kcal/day)	212 (226)	144 (157)	0.003	0.016
Low Intensity LTPA (kcal/day)	64 (112)	42 (76)	0.050	0.082
Moderate Intensity LTPA (kcal/day)	127 (164)	93 (120)	0.040	0.124
High Intensity LTPA (kcal/day)	18 (47)	8 (15)	0.023	0.121
Mean Intensity LTPA (kcal/min)	4.8 (1.0)	4.7 (1.0)	0.637	0.963
Mean Duration LTPA (min/day)	47 (52)	34 (34)	0.014	0.046
Physical Activity Scale (units)	2.3 (1.5)	1.7 (1.2)	< 0.001	< 0.001

LTPA = leisure-time physical activity, kcal = kilocalories.

[*] Adjusted for age, race, current smoking, diabetes, hypertension, and obesity.

Table IV

Health-related quality of life measurements of subjects with stable angina and controls. Values are means (SD).

Variables	Control Group (n = 441)	Stable Angina Group (n = 115)	Unadjusted P	Adjusted P [*]
Self-Perceived Health (%)	80 (17)	63 (24)	< 0.001	< 0.001
Physical Function (%)	72 (27)	44 (21)	< 0.001	0.669
Role Limitations – Physical (%)	65 (40)	30 (33)	< 0.001	0.335
Bodily Pain (%)	65 (27)	68 (22)	0.778	0.562
General Health (%)	67 (23)	55 (16)	0.002	0.792
Social Function (%)	84 (23)	78 (24)	0.543	0.933
Role Limitations–Emotional (%)	77 (38)	60 (44)	0.338	0.690
Mental Health (%)	82 (16)	81 (12)	0.859	0.847
Vitality (%)	66 (22)	49 (22)	< 0.001	0.219

[*] Adjusted for age, race, current smoking, diabetes, hypertension, and obesity.