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THE EFFECT OF METABOLIC SYNDROME COMPONENTS ON EXERCISE PERFORMANCE IN PATIENTS WITH INTERMITTENT CLAUDICATION

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Abstract

Purpose—To determine the effect of metabolic syndrome components on intermittent claudication, physical function, health-related quality of life, and peripheral circulation in patients with peripheral arterial disease (PAD), and to identify the metabolic syndrome components that were most predictive of each outcome measure.

Methods—Patients limited by intermittent claudication with either three (n = 48), four (n = 45), or five (n = 40) components of metabolic syndrome were studied. Patients were assessed on PAD-specific measures consisting of ankle/brachial index (ABI), initial claudication distance (ICD), absolute claudication distance (ACD), physical function measures, health-related quality of life, and calf blood flow and transcutaneous oxygen tension responses following three minutes of vascular occlusion.

Results—ICD progressively declined ($p = 0.019$) in those with three (203 ± 167 m; mean ± SD), four (124 ± 77 m), and five (78 ± 57 m) metabolic syndrome components, and ACD progressively declined ($p = 0.036$) in these groups as well (414 ± 224 m vs. 323 ± 153 m vs. 249 ± 152 m, respectively). Furthermore, compared to patients with only three components of metabolic syndrome, those with all five components had impaired values ($p < 0.05$) for peak oxygen uptake, ischemic window, 6-minute walk distance, self-perceived walking ability and health, daily physical activity, health-related quality of life on six of eight domains, calf hyperemia, and calf ischemia following vascular occlusion. Abdominal obesity was the predictor ($p < 0.05$) of exercise performance during the treadmill and 6-minute walk tests, as well as physical activity, whereas elevated fasting glucose was the predictor ($p < 0.05$) of peripheral vascular measures, self-perceived walking ability and health, and health-related quality of life.

Conclusion—PAD patients with more metabolic syndrome components have worsened intermittent claudication, physical function, health-related quality of life, and peripheral circulation. Furthermore, abdominal obesity and elevated fasting glucose are the metabolic syndrome components that are most predictive of these outcome measures. Aggressively treating these

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metabolic syndrome components may be particularly important in managing symptomatology and long-term prognosis of PAD patients.

INTRODUCTION

Intermittent claudication is a symptom of peripheral arterial disease (PAD), and is associated with elevated rates of mortality[1–4] and morbidity.[5] Intermittent claudication afflicts 5% of the US population older than 55 years of age,[6] and occurs during ambulation when the peripheral circulation is inadequate to meet the metabolic requirement of the active leg musculature. Consequently, patients with intermittent claudication have ambulatory dysfunction,[7,8] thereby limiting daily physical activities[9]and negatively affecting health-related quality of life.[10]

In addition to having poor ambulatory function, patients limited by intermittent claudication have numerous co-morbid conditions.[11] Many of these cardiovascular risk factors are associated with insulin resistance,[12] and are clustered in a pattern characteristic of metabolic syndrome.[13] Metabolic syndrome increases the risk of cardiovascular mortality[14] and worsening PAD.[15] Consequently, patients with intermittent claudication and metabolic syndrome have further limitations in exercise performance,[16,17] health-related quality of life,[16] and peripheral circulation[16] than patients without metabolic syndrome, as well as a greater rate of mortality and cardiovascular events during two years of follow-up.[17] To date, it is not established whether having more components of metabolic syndrome further worsens exercise performance in patients with intermittent claudication, and which components of metabolic syndrome are most associated with exercise performance and peripheral circulation.

Therefore, the purposes of this study were to: (1) determine the effect of metabolic syndrome components on intermittent claudication, physical function, health-related quality of life, and peripheral circulation in patients with peripheral arterial disease (PAD), and (2) identify the metabolic syndrome components that were most predictive of each outcome measure.

METHODS

PATIENTS

Screening—A total of 423 PAD patients with stable symptoms of intermittent claudication and metabolic syndrome participated in this study in the Geriatrics, Research, Education, and Clinical Center at the Maryland Veterans Affairs Health Care System (MVAHCS) at Baltimore as part of a previous investigation.[16] Patients were recruited from the Vascular Clinic at the site of the Baltimore MVAHCS between 1994 and 2002. Patients were included in this study if they had Fontaine stage II PAD[18] defined by the following inclusion criteria: (a) a history of intermittent claudication, (b) ambulation during a graded treadmill test limited by intermittent claudication,[7] (c) an ankle/brachial index (ABI) at rest < 0.90,[6] and (d) presence of metabolic syndrome.[13] Patients were excluded from this study for the following conditions: (a) absence of PAD, (b) inability to obtain an ABI measure due to non-compressible vessels, (c) asymptomatic PAD (Fontaine stage I), (d) rest pain PAD (Fontaine 7 stage III), (e) use of medications indicated for the treatment of intermittent claudication (cilostazol and pentoxifylline) within three months prior to investigation, (f) exercise tolerance limited by factors other than claudication (e.g., severe coronary artery disease, dyspnea, poorly controlled blood pressure), (g) active cancer, renal disease, or liver disease, and (h) absence of metabolic syndrome. A total of 133 patients were deemed eligible for this investigation, whereas 290 patients were ineligible. Of the ineligible patients, 89 either did not have PAD or were not limited by intermittent claudication, while the remaining 201 were limited by intermittent claudication but did not have metabolic syndrome and were described in a previous report as the control group.[16] All patients 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. Written informed consent was obtained from each patient prior to investigation.

Metabolic Syndrome Classification—According to the National Cholesterol Education Program (NCEP) Adult Treatment Panel (ATP) III,[13] metabolic syndrome is defined as having three or more of the following components: (1) abdominal obesity (waist circumference > 102 cm in men and > 88 cm in women), (2) elevated triglycerides (≥ 150 mg/dl), (3) reduced HDL cholesterol (<40 mg/dl in men and < 50 mg/dl in women), (4) elevated blood pressure (≥ 130/85 mmHg), and (5) elevated fasting glucose (≥ 110 mg/dl) as well as those with diabetes. Although several definitions of metabolic syndrome exist, the NCEP ATP III definition was used in this investigation because it was specifically established on a population from the United States. In the total group of 423 patients, 334 screened positive for PAD, and of these 133 patients (40%) screened positive for metabolic syndrome, whereas the remaining 201 patients (60%) screened negative.

MEASUREMENTS

Medical History—Demographic information, height, weight, cardiovascular risk factors, co-morbid conditions, claudication history, and a list of current medications were obtained during a physical examination and medical history interview to begin the evaluation.

Claudication Distances and Peak Oxygen Uptake—Patients performed a progressive, graded treadmill protocol (2 mph, 0% grade with 2% increase every 2 minutes) until maximal claudication pain as previously described.[7] The initial claudication distance (ICD), absolute claudication distance (ACD), and peak oxygen uptake were measured. Using these procedures, the test-retest intraclass reliability coefficient is R = 0.89 for ICD,[7] R = 0.93 for ACD[7] and R = 0.88 for peak oxygen uptake.[19]

Walking Economy and Fractional Utilization—Oxygen uptake was measured during a constant, submaximal work rate at a treadmill speed of 2 mph and a grade of 0% until maximal claudication pain, or for a maximum of 20 minutes.[20] Walking economy was measured as the oxygen uptake obtained during the final minute of the test. To quantify the intensity of the walking economy test as a percentage of peak capacity, fractional utilization was calculated as the walking economy oxygen uptake / peak oxygen uptake.

ABI and Ischemic Window—As previously described, ABI was obtained from the more severely diseased lower extremity by the Doppler ultrasound technique before and at 1, 3, 5, and 7 minutes after each treadmill test.[21] The reduction in ankle systolic blood pressure following treadmill exercise from the resting baseline value was quantified by calculating the area under the curve (AUC), referred to as the ischemic window.[22]

6-Minute Walk Test—Patients performed an over ground, 6-minute walk test supervised by trained exercise technicians as previously described.[23] The pain-free and total distance walked during the test were recorded. The test-retest intraclass reliability coefficient is R = 0.75 for distance to onset of claudication pain, and R = 0.94 for total 6-minute walking distance.[23]

Walking Impairment Questionnaire (WIQ)—Self-reported ambulatory ability was assessed using a validated questionnaire for PAD patients that assesses ability to walk at various speeds and distances, and to climb stairs.[24]

Short Physical Performance Battery—The Short Physical Performance Battery score was calculated from the performance of a 4-meter walk test, a chair stand test, and a standing balance test as previously described.[25,26] For each of the three tests, patients 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.[25] 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.[25,26] The test-retest intraclass reliability coefficient is R = 0.93 for the Short Physical Performance Battery score.[27]

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.[28] Patients were asked to select a numeric value on the scale that best corresponded to their current overall health state.

Daily Physical Activity—Physical activity level was monitored over two consecutive weekdays by a Caltrac accelerometer (Muscle Dynamics, Torrance, CA) attached to the belt of each subject as previously described.[9,29] Additionally, a physical activity scale (PAS) was used to assess the self-reported physical activity level over the preceding month as previously described.[9,29] The accelerometer measure of physical activity has a test-retest intraclass reliability coefficient of R = 0.84,[29] and provides a valid estimate of daily physical activity assessed by the gold standard technique of doubly labeled water.[31]

Quality of Life—Health-related quality of life was assessed with the Medical Outcomes Study Short-Form 36 (MOS SF-36) General Health Survey.[30] The MOS SF-36 is a reliable and valid generic instrument which includes multi-item scales measuring the following eight 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.

Calf Blood Flow—Calf blood flow was obtained at rest and following three minutes of arterial occlusion (i.e., reactive hyperemia) in the more severely diseased leg using venous occlusion mercury strain-gauge plethysmography as previously described.[31] The test-retest intraclass reliability coefficient is R = 0.86 for calf blood flow.[31]

Transcutaneous oxygen tension—Transcutaneous oxygen tension ($TcPO_2$) was measured at rest and following three minutes of arterial occlusion on the medial portion of the calf musculature of the more affected leg with a Clark-type polarographic electrode and a $TcPO_2$ Monitor (Novametrix Medical System, Model 818). The change in calf $TcPO_2$ following arterial occlusion is a measure of the ischemic response to this test. The test-retest intraclass reliability coefficient is R = 0.87 for calf $TcPO_2$.[19]

STATISTICAL ANALYSES

One-factor analysis of variance (ANOVA) and Kruskal-Wallis H tests were used for parametric and non-parametric measures, respectively, to assess whether differences in clinical characteristics existed among the three groups of PAD patients with either three, four, or five components of metabolic syndrome. All of the ANOVA tests met the assumption of having normally distributed data. Analysis of covariance (ANCOVA) was then used to assess group differences in claudication distances, physical function measures, health-related quality of life, and peripheral vascular measures after adjusting for age, ABI, body mass index, current smoking, duration of intermittent claudication, obesity, race, sex and weight. To control for multiple testing, significant main effects were followed by a Tukey's Test with alpha set as .

05 to examine the three possible comparisons among the group means. Additionally, stepwise multiple regressions were performed to identify the metabolic syndrome components that were predictive of claudication distances, physical function measures, health-related quality of life, and peripheral vascular measures after adjusting for age, ankle/brachial index, body mass index, current smoking, duration of intermittent claudication, obesity, race, sex and weight. All analyses were performed using the SPSS-PC statistical package. Statistical significance was set at $p < 0.05$. Measurements are presented as means ± standard deviations.

RESULTS

Differences Between Metabolic Syndrome Groups

By definition, the prevalence of each component of metabolic syndrome (elevated fasting glucose, elevated blood pressure, elevated triglycerides, reduced HDL, and abdominal obesity) was 100% in the group having all five criteria of metabolic syndrome (Table I). Furthermore, the prevalence of each metabolic syndrome component was different among the groups ($p < 0.001$). There was a progressive increase in weight ($p < 0.001$), BMI ($p < 0.001$), and prevalence of obesity ($p < 0.001$) as the number of metabolic syndrome components increased. The three groups were similar on age, sex, race, ABI, history of having intermittent claudication, and prevalence of current smoking ($p > 0.05$).

There was a progressive decline in ICD ($p = 0.022$) and ACD ($p = 0.039$) as the number of metabolic syndrome components increased (Table II). Group differences also were found for peak oxygen uptake ($p = 0.041$), walking economy ($p = 0.045$), fractional utilization ($p = 0.026$), ischemic window following the graded treadmill test ($p = 0.035$), and ischemic window following the walking economy test ($p = 0.026$). For each of these measures, the trend was that patients with three metabolic syndrome components had the most favorable values, whereas those with five metabolic syndrome components had the least favorable values.

As shown in Table III, differences among groups were found for 6-minute walk pain-free ($p = 0.024$) and total ($p = 0.044$) distances, WIQ stair climbing score ($p = 0.021$), self-perceived health ($p < 0.001$), physical activity scale ($p = 0.015$), and monitored daily physical activity ($p = 0.042$). The trend was that each measure worsened with an increase in metabolic syndrome components.

Health-related quality of life was lower with an increase in metabolic syndrome components (Table IV) for the domains of physical function ($p = 0.039$), role limitations due to physical problems ($p = 0.016$), bodily pain ($p = 0.041$), general health ($p = 0.042$), and vitality ($p = 0.031$).

As shown in Table V, following vascular occlusion, differences among groups were found for the percentage increase in calf blood flow from rest to hyperemia ($p = 0.043$), and the percentage increase in calf $TcPO_2$ from rest to hyperemia ($p = 0.043$). In both cases, the values in the patients with five metabolic syndrome components were lower than those with three components.

Metabolic Syndrome Components Predictive of Outcome Measures

For measures obtained during standardized treadmill tests, abdominal obesity was the only metabolic syndrome component that was a predictor for ICD ($p = 0.019$), ACD ($p = 0.015$), peak oxygen uptake ($p = 0.030$), walking economy ($p = 0.009$), fractional utilization ($p < 0.001$) (Table II). Elevated fasting glucose was the only metabolic syndrome component that was a predictor for ischemic window following the graded treadmill test ($p = 0.029$), and ischemic window following the walking economy test ($p = 0.017$).

For measures of physical function and physical activity shown in Table III, abdominal obesity was the metabolic syndrome component that was a predictor for 6-minute walk pain-free distance (p = 0.047), 6-minute walk total distance (p = 0.006), physical activity scale (p = 0.029), and monitored daily physical activity (p = 0.046), whereas elevated fasting glucose was the predictor for WIQ distance (p = 0.014), WIQ speed (p = 0.011), WIQ stair climbing (p = 0.039), and self-perceived health (p < 0.001).

Elevated fasting glucose was the predictor for the health-related quality of life domains (Table IV) of physical function (p = 0.045), role limitations due to physical problems (p = 0.015), bodily pain (p = 0.037), role limitations due to emotional problems (p = 0.025), and vitality (p = 0.027). Both elevated fasting glucose (p < 0.001) and abdominal obesity (p = 0.038) were predictors for the domain of general health.

For peripheral hemodynamic measures in Table V, elevated fasting glucose was the predictor for the percentage increase in calf blood flow (p = 0.021), whereas both elevated fasting glucose (p = 0.019) and abdominal obesity (p = 0.047) were predictors for the percentage increase in calf blood flow.

DISCUSSION

The major findings of this investigation were: (1) patients limited by intermittent claudication who had more components of metabolic syndrome had shorter claudication distances, lower cardiopulmonary function, impaired ambulatory function, lower physical activity, lower health-related quality of life, and diminished peripheral circulation than patients with fewer components of metabolic syndrome, and (2) abdominal obesity was the predictor of exercise performance and physical activity, whereas elevated fasting glucose was the predictor of peripheral circulation, self-perceived walking ability and health, and health-related quality of life.

The ambulatory dysfunction of PAD patients limited by intermittent claudication is exacerbated by having a greater burden of metabolic syndrome. Patients with all five component of metabolic syndrome experienced ICD and ACD sooner than those with only three components, and they had greater impairments in peak oxygen uptake, walking economy, and fractional utilization as well. Thus, a greater burden of metabolic syndrome worsens claudication and cardiopulmonary fitness in patients limited by intermittent claudication, independent of BMI, weight, and obesity. The adjustment for these factors indicates that the impaired exercise performance of patients with five components of metabolic syndrome was not merely related to the added burden of walking due to their greater body mass.[32,33] Rather, the clustering of risk factors that comprise the metabolic syndrome, particularly abdominal obesity, negatively impacts exercise performance of patients with PAD. These data support previous findings that metabolic syndrome impairs ICD and ACD in patients with intermittent claudication,[16,17] and lowers cardiopulmonary fitness in adult men and women[34] and in patients with intermittent claudication.[16] Consequently, PAD patients with metabolic syndrome may have difficulty completing activities of daily living requiring relatively high intensities, and this trend may become more prominent with a progressive increase in metabolic syndrome burden.

In addition to their poorer exercise performance during standardized treadmill tests, PAD patients with all five components of metabolic syndrome had a more rapid rate of claudication pain during the less intensive 6-minute walk test than in those with only three components. Abdominal obesity was the metabolic syndrome component that was a predictor of exercise performance during the 6-minute walk test, which is consistent with the findings for the treadmill performance measures. Furthermore, those with the greatest burden of metabolic syndrome also had lower self-perceived ability to climb stairs. These greater impairments in ambulation in patients with all five components of metabolic syndrome resulted in lower self-perceived health and lower health-related quality of life scores on all domains except for role limitations due to emotional problems, mental health, and social functioning.

Metabolic syndrome diminishes the peripheral circulation of PAD patients limited by intermittent claudication,[16,17] and this trend increases as the number of components of metabolic syndrome increase. Patients with all five components of metabolic syndrome had greater calf ischemia and lower calf blood flow in response to vascular occlusion than those with only three components of metabolic syndrome, as well as greater ischemic window values following standardized treadmill exercise. Elevated fasting glucose was the metabolic syndrome component that was a predictor of these peripheral circulation measures, suggesting that insulin resistance plays a role in the ischemic response of PAD patients limited by intermittent claudication.

The clinical relevance of this study is that PAD patients limited by intermittent claudication who have all five components of metabolic syndrome have the greatest ambulatory dysfunction. Consequently, the additive burden of having all of the metabolic syndrome components places patients limited by intermittent claudication at greatest risk for living a functionally dependent lifestyle and for subsequent mobility loss[26] than patients who have fewer components of metabolic syndrome. Although all components of metabolic syndrome should be treated, the clinical management of abdominal obesity and elevated fasting glucose may be particularly important in modifying physical function and peripheral circulation in patients with intermittent claudication. In speculation, some of the beneficial aspects of exercise rehabilitation in these patients[35] may result from adaptations in metabolic syndrome. Future intervention trials are needed to extend the preliminary findings of the current study.

There are several limitations to this study. The cross-sectional design comparing patients with three, four, and five components of metabolic syndrome does not allow causality be established, as it is possible that those with five components had the most impaired intermittent claudication, physical function, health-related quality of life, and peripheral circulation prior to having all components of metabolic syndrome. Another limitation is that the location of the arterial lesions was not determined, thus preventing group comparison on the distribution of lesion location. Additionally, the results are generalizable to PAD patients with a history of leg pain and who are limited by leg pain during a standardized treadmill test, regardless of whether the leg pain is typical or atypical of intermittent claudication. Thus, the present findings cannot be generalized to patients with asymptomatic PAD or to those who are limited in their exercise performance by other significant co-morbid conditions. Another limitation is that the majority of participants were veterans, and consequently men comprised approximately 80% of the sample. However, African-Americans were well represented in this sample, as well as patients with typical risk factors for PAD including smoking, diabetes, hypertension, dyslipidemia, and obesity. Thus, in patients limited by leg pain, the findings of the present study are generalizable to the large proportion with numerous co-morbid conditions.

In conclusion, PAD patients with more metabolic syndrome components have worsened intermittent claudication, physical function, health-related quality of life, and peripheral circulation. Furthermore, abdominal obesity and elevated fasting glucose are the metabolic syndrome components that are most predictive of these outcome measures. Aggressively treating these metabolic syndrome components may be particularly important in managing symptomatology and long-term prognosis of PAD patients.

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Table I

Clinical characteristics of peripheral arterial disease patients with either three, four, or five components of metabolic syndrome (MS). Values are means (SD) and percentages.

Variables	3 MS Components (N = 48)	4 MS Components (N = 45)	5 MS Components (N = 40)	Group Difference (P Value)
Age (years)	69 (5)	68 (7)	66 (7)	0.137
Weight (kg)	82.3 (16.2)	87.5 (13.8)*	95.9 (14.7)*†	< 0.001
Body Mass Index	28.1 (4.6)	30.5 (4.2)*	32.7 (4.2)*†	< 0.001
Ankle/Brachial Index	0.65 (0.25)	0.70 (0.25)	0.69 (0.22)	0.498
Duration of IC (years)	4.8 (4.3)	5.7 (5.6)	4.9 (3.9)	0.376
Sex (% Men)	83	78	80	0.495
Race (% Caucasian)	62	63	58	0.512
Current Smoking (%)	34	35	30	0.857
Elevated Fasting Glucose (%)	57	66	100*†	< 0.001
Elevated Blood Pressure (%)	59	88*	100*†	< 0.001
Elevated triglycerides (%)	74	87	100*†	< 0.001
Reduced HDL Cholesterol (%)	68	90*	100*	< 0.001
Abdominal Obesity (%)	38	90*	100*	< 0.001
Obesity (%)	26	54*	73*†	< 0.001

IC = intermittent claudication. Obesity was defined as having a body mass index ≥ 30 kg / m^2.

*Different than 3 MS Component group (p < 0.05) using Tukey test.

†Different than the 4 MS Component group (p < 0.05) using Tukey test.

Table II

Treadmill measurements of peripheral arterial disease patients with either three, four, or five components of metabolic syndrome (MS).

Variables	3 MS Components	4 MS Components	5 MS Components	Group Difference (P Value)	Predictors (P Value)
ICD (meters)	201 (165)	125 (76)*	81 (58)*†	0.022	AO (0.019)
ACD (meters)	411 (221)	322 (151)*	251 (148)*†	0.039	AO (0.015)
Peak Oxygen Uptake (ml.kg^{-1}·min^{-1})	15.1 (3.2)	13.1 (2.6)*	12.9 (2.7)*	0.041	AO (0.030)
Walking Economy (ml.kg^{-1}·min^{-1})	11.8 (1.9)	12.0 (2.7)	12.3 (2.8)*	0.045	AO (0.009)
Fractional Utilization (%)	78 (17)	92 (18)*	95 (15)*	0.026	AO (< 0.001)
IW following Graded Treadmill Test (AUC)	153 (137)	194 (143)	217 (160)*	0.035	EFG (0.029)
IW following Walking Economy Test (AUC)	77 (79)	125 (104)*	128 (101)*	0.026	EFG (0.017)

Values are adjusted for age, ankle/brachial index, body mass index, current smoking, duration of intermittent claudication, obesity, race, sex and weight, and are presented as means (SD).

ACD = absolute claudication distance, AO = abdominal obesity, EFG = elevated fasting glucose, ICD = initial claudication distance, IW = ischemic window.

*Different than 3 MS Component group ($p < 0.05$) using Tukey test.

†Different than the 4 MS Component group ($p < 0.05$) using Tukey test.

Table III

Physical function, self-reported health, and physical activity level of peripheral arterial disease patients with either three, four, or five components of metabolic syndrome (MS).

Variables	3 MS Components	4 MS Components	5 MS Components	Group Difference (p value)	Predictors (p value)
6-Minute Walk Pain-Free Distance (meters)	205 (124)	167 (113)*	128 (97)*	0.024	AO (0.047)
6-Minute Walk Distance (meters)	371 (82)	344 (90)*	295 (92)*	0.044	AO (0.006)
WIQ Distance Score (%)	33 (29)	29 (31)	27 (30)*	0.069	EFG (0.014)
WIQ Speed Score (%)	32 (24)	26 (27)	24 (22)*	0.057	EFG (0.011)
WIQ Stair Climbing Score (%)	36 (31)	33 (30)*	31 (27)*	0.021	EFG (0.039)
Short Physical Performance Battery (units)	10.1 (1.2)	10.0 (1.2)	9.7 (1.4)	0.178	None
Self-Perceived Health (%)	73 (18)	64 (20)*	64 (17)*	< 0.001	EFG (< 0.001)
Physical Activity Scale (units)	1.4 (1.0)	1.1 (1.0)*	1.0 (1.0)*	0.015	AO (0.029)
Daily Physical Activity (kcal/day)	343 (184)	317 (160)	295 (140)*	0.042	AO (0.046)

Values are adjusted for age, ankle/brachial index, body mass index, current smoking, duration of intermittent claudication, obesity, race, sex and weight, and are presented as means (SD).

AO = abdominal obesity, EFG = fasting glucose, WIQ = walking impairment questionnaire.

*Different than 3 MS Component group ($p < 0.05$) using Tukey test.

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Table IV

Health-related quality of life measurements of peripheral arterial disease patients with either three, four, or five components of metabolic syndrome (MS).

Variables	3 MS Components	4 MS Components	5 MS Components	Group Difference (p value)	Predictors (P Value)
Physical Function Score (%)	48 (26)	46 (20)	42 (20)*	0.039	EFG (0.045)
Role Limitations – Physical Score (%)	56 (41)	37 (41)*	24 (39)*	0.016	EFG (0.015)
Bodily Pain Score (%)	58 (23)	43 (19)*	41 (16)*	0.041	EFG (0.037)
General Health Score (%)	53 (20)	46 (23)*	45 (21)*	0.042	EFG (< 0.001 AO (0.038)
Social Function Score (%)	72 (22)	72 (28)	71 (21)	0.722	None
Role Limitations – Emotional Score (%)	66 (39)	55 (44)	36 (38)*	0.071	EFG (0.025)
Mental Health Score (%)	80 (16)	81 (16)	72 (18)	0.352	None
Vitality Score (%)	63 (15)	52 (16)	41 (25)*	0.031	EFG (0.027)

Values are adjusted for age, ankle/brachial index, body mass index, current smoking, duration of intermittent claudication, obesity, race, sex and weight, and are presented as means (SD).

AO = abdominal obesity, EFG = fasting glucose.

* Different than 3 MS Component group ($p < 0.05$) using Tukey test.

Table V

Peripheral hemodynamic measurements of peripheral arterial disease patients with either three, four, or five components of metabolic syndrome (MS).

Variables	3 MS Components	4 MS Components	5 MS Components	Group Difference (p value)	Predictors (P Value)
Calf Blood Flow: Rest (%/min)	3.73 (1.61)	3.68 (1.52)	3.57 (1.30)	0.068	None
Calf Blood Flow: Hyperemia (%/min)	8.94 (3.71)	8.82 (4.27)	8.24 (4.00)	0.589	None
Change in Calf Blood Flow from Rest to Hyperemia (%)	180 (153)	137 (111)	129 (108)*	0.043	EFG (0.021)
Calf $TcPO_2$ Rest (mmHg)	38 (19)	38 (17)	33 (15)	0.082	None
Calf $TcPO_2$ Hyperemia (mmHg)	24 (20)	20 (16)	17 (16)	0.087	None
Change in Calf $TcPO_2$ from Rest to Hyperemia (%)	−37 (38)	−47 (42)	−48 (52)*	0.043	EFG (0.019) AO (0.047)

Values are adjusted for age, ankle/brachial index, body mass index, current smoking, duration of intermittent claudication, obesity, race, sex and weight, and are presented as means (SD).

AO = abdominal obesity, EFG = fasting glucose.

* Different than 3 MS Component group ($p < 0.05$) using Tukey test.