Measurement of walking endurance and walking velocity with questionnaire: Validation of the walking impairment questionnaire in men and women with peripheral arterial disease

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Objectives: **The Walking Impairment Questionnaire (WIQ) was designed to measure community walking ability in patients with peripheral arterial disease (PAD) and intermittent claudication. We compared the WIQ scores to objective measures of walking in a heterogeneous group of patients with and without PAD.**

Methods: **The study was designed as a cross-sectional study, with the setting in an academic medical center. The subjects were patients with PAD (n = 145) who were identified from a noninvasive vascular laboratory at an academic medical center. The patients without PAD (n = 65) were identified from a general medicine practice. The average number of comorbidities was 2.03 for patients with PAD and 1.52 for patients without PAD. Among the patients with PAD, 28% had classical intermittent claudication symptoms and 55% had exertional leg symptoms other than claudication. The main outcome measures were the WIQ estimates of the patient-reported walking distance and walking speed on a scale of 0 to 100. Walking endurance was measured objectively with the 6-minute walk. Walking velocity was measured with a 4-m walk. PAD and PAD severity were defined with the ankle brachial index.**

Results: **The Spearman rank correlation coefficients (ρ) between the WIQ distance score and the 6-minute walk score were 0.557 among patients with PAD ($P < .001$) and 0.484 among patients without PAD ($P < .001$). The correlation coefficients between the WIQ speed score and the usual-paced 4-m walk score were 0.528 among patients with PAD ($P < .001$) and 0.524 among patients without PAD ($P < .001$). The correlations were not affected by the presence versus the absence of intermittent claudication, by PAD severity, or by the presence of 2 or more versus less than 2 comorbid illnesses. The WIQ scores in the highest and lowest quartiles were the most closely associated with the objective measures of function.**

Conclusion: **The WIQ is a valid measure of community walking ability in a heterogeneous group of patients with and without PAD. The WIQ discriminates best among patients in the highest and the lowest quartiles of walking speed and endurance. (J Vasc Surg 1998;28:1072-81.)**

Lower extremity peripheral arterial disease (PAD) is a common, chronic condition among older men and women.[1-3] Men and women with PAD have poorer walking endurance and slower walking speed than men and women without PAD.[4] Most investigators have used treadmill testing to assess walking capacity in PAD.[5] However, treadmill testing may not necessarily reflect walking ability during

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daily activities and may not be practical for some epidemiologic studies. Validated standardized measures of patient-reported walking capability are needed for large-scale studies that assess the natural history of community walking ability and the effects of specific interventions on functioning in PAD.

The Walking Impairment Questionnaire (WIQ) was developed for use as an independent measure of patient-perceived walking performance for patients with PAD and intermittent claudication.[5,6] The WIQ estimates walking distance, walking speed, and stair-climbing capacity in the community. In a previous study of 26 patients with intermittent claudication and no exercise-limiting comorbid diseases, the WIQ distance and speed scores correlated with the peak treadmill walking time and with the time to onset of intermittent claudication on the treadmill.[6] The WIQ walking distance and walking speed scores are responsive to interventions, such as lower-extremity revascularization and exercise training in patients with intermittent claudication.[6-9]

The primary aim of this study was the description of the correlations in a heterogeneous cohort of patients with PAD between the WIQ distance score and the 6-minute walk score and between the WIQ speed score and the 4-m walking velocity. The PAD participants included patients with and without intermittent claudication and patients with multiple comorbid illnesses. The secondary aims were the comparison of WIQ validity between the following: the patients who had PAD with intermittent claudication versus without intermittent claudication, the patients who had PAD with fewer than 2 comorbid illnesses versus 2 or more comorbid illnesses, and the patients who had PAD with mild to moderate disease versus severe disease. The results from the secondary specific aims will help determine whether the WIQ has greater validity within specific subsets of patients with PAD.

To our knowledge, previous studies have not assessed the validity of the WIQ as a measure of walking capability in a heterogeneous group of men and women, including patients who had PAD without intermittent claudication, patients who had PAD with multiple comorbid illnesses, and general medical patients without PAD. The validation of the WIQ in a heterogeneous group of patients is important because many patients with PAD have significant comorbid illnesses and because the recent data show that most men and women with PAD do not have the typical symptoms of intermittent claudication.[2,10,11]

METHODS

Subject identification and selection. The study protocol was approved by the Institutional Review Board. Consecutive patients aged 55 years and older who were diagnosed with PAD in the noninvasive vascular laboratory at Northwestern Memorial Hospital between January 1, 1996, and approximately November 1, 1996, were identified with computerized records. For a short time, the patients with PAD were recruited with the random selection of patients in our vascular surgery practice who had an ICD-9 code that was consistent with lower-extremity PAD. The patients without PAD were identified from among randomly selected men and women aged 55 years and older with appointments in general internal medicine at Northwestern Medical Faculty Foundation. The identified patients were mailed an informational letter, were telephoned within 2 to 4 weeks after the mailing, and were invited to return to the medical center for a study visit.

Inclusion criteria. The patients with PAD were men and women with an ankle brachial index of less than 0.90 at the time of their study visit. The patients without PAD were men and women with an ankle brachial index of ≥0.90 and <1.50.

Exclusion criteria. The following were exclusion criteria: 1, a Mini-Mental Status Examination score of less than 18 of 30 (n = 6)[12]; 2, nursing home residence (n = 7); 3, dependence on a wheelchair (n = 15); 4, foot or lower-extremity amputation (n = 25); 5, lower-extremity ulcers (n = 4); 6, the inability to communicate in English (n = 15); and 7, a life expectancy of less than 6 months (n = 24). These exclusion criteria were chosen because they would have interfered with the ability to obtain an accurate history or would have reduced the likelihood of follow-up or because they indicated extreme functional impairment. The patients who did not complete the WIQ were excluded, and the patients who completed neither the 6-minute walk nor the 4-m walks were excluded.

Walking Impairment Questionnaire. The full WIQ (Appendix) measures an individuals walking endurance (WIQ distance score), walking speed (WIQ speed score) and stair-climbing ability in the community (WIQ stair-climbing score).[6] The WIQ was developed to be administered by study investigators and requires approximately 5 minutes to complete. In the present study, the WIQ was mailed to the patients before their study visit. The study participants were asked to bring the completed questionnaire with them to their study visit, at which time the investigators reviewed the questionnaire for completeness.

In the WIQ distance score, the degree of difficulty in the walking of specific distances is ranked on a 0 to 4 Likert scale, in which 0 represents the inability to walk the distance and 4 represents no difficulty. A Likert scale is an ordinal scale of consecutive, equidistant, numerical values (ie, 0 to 4). The distances that are assessed in the WIQ range from walking indoors around the home to walking 5 blocks (1500 feet). In the walking speed component, the degree of difficulty walking is ranked on a 0 to 4 scale where speed is assessed for each of the following speeds: at the following speeds: 1, slowly; 2, average speed; 3, quickly; or 4, running or jogging 1 block. Zero represents the inability to walk the specified speed, and 4 represents no difficulty.

Scoring the Walking Impairment Questionnaire. For the WIQ distance score, each distance, expressed in feet, is multiplied by the Likert score that was selected for that distance. The products are summed and divided by the maximum possible score to obtain the percent score. For the WIQ speed score, each speed is given a "weight," which ranges from 1 mile per hour to 5 miles per hour and is multiplied by the corresponding Likert scale response. The products are summed and divided by the maximum possible score to obtain the WIQ speed score.

Ankle brachial index and intermittent claudication measurements. The ankle brachial index was measured on all patients with previously described methods.[2] Because the artery with the greatest obstruction was expected to have the greatest effect on the lower-extremity functioning, the lowest of the dorsalis pedis and posterior tibial vessels was used to calculate the ankle brachial index for each leg. The lowest leg ankle brachial index measurement was used in the analyses. The San Diego intermittent claudication questionnaire identified the patients with intermittent claudication,[11] which was defined as exertional calf symptoms that do not begin at rest, that worsen when walking uphill or when hurrying, and that resolve within 10 minutes of rest.

Six-minute walk and 4-m walks. The 6-minute walk predicts the mortality rate among the patients with congestive heart failure and predicts the maximal oxygen consumption rate among the patients with pulmonary disease.[13-17] Among the patients with intermittent claudication, the 6-minute walk performance correlates with the objectively measured physical activity levels.[18] The subjects walk up and down a 100-ft hallway for 6 minutes and are encouraged to complete as many laps as possible.[14] The distance that is achieved at the end of the 6 minutes is recorded. The 6-minute walk was added to the protocol 3 months after the data collection began and was performed for 126 patients with PAD and for 47 patients without PAD. The patients were timed walking a 4-m distance at their "usual" and "fastest" paces.[19] Among the patients with PAD, the ankle brachial index level independently predicts the 4-m walking velocity.[4]

Comorbidity ascertainment. With algorithms that were developed in the Women's Health and Aging Study, we combined the data from a medical record review, a primary care physician questionnaire, medications, and a patient self-report to ascertain and verify the comorbid diseases.[20] The comorbidities were those that were shown to affect functioning in previous epidemiologic studies and consisted of angina, spinal disk disease, hip or knee arthritis, congestive heart failure, diabetes mellitus, hip fracture, myocardial infarction, pulmonary disease, Parkinson's disease, stroke, and spinal stenosis.

A previous study that validated the WIQ excluded the patients who had PAD with exercise-limiting comorbid diseases.[6] To compare the validity of the WIQ between the patients with varying numbers of comorbid diseases, the patients were categorized into 1 of 2 groups—those patients with no or 1 comorbid disease and those patients with 2 or more comorbid illnesses.

Statistical analyses. The Spearman rank correlation coefficients were used to assess the relationship between the WIQ distance score and the 6-minute walk performance score and to describe the relationships between the WIQ speed score and the usual-paced and fast-paced 4-m walking velocities. Additional analyses were performed to determine whether the WIQ scores correlated more strongly with the objective measures of functioning in the specific subgroups of patients. For these comparisons, multiple linear regression analyses were used to compare the associations between the WIQ distance and the speed scores and between the corresponding objective measures of walking endurance and the walking speed. The objective measures of functioning were dependent variables. Comparisons were made between the following: 1, patients who had PAD with intermittent claudication versus without intermittent claudication; 2, patients with ankle brachial indices of <0.40 versus patients with ankle brachial indices of 0.40 to <0.90 versus patients with ankle brachial indices of 0.90 to 1.50; and 3, patients who had PAD with 2 or more comorbid illnesses versus with fewer than 2 comorbid illnesses. The latter 2 comparisons were made irrespective of intermittent claudication symptoms. The interactions between

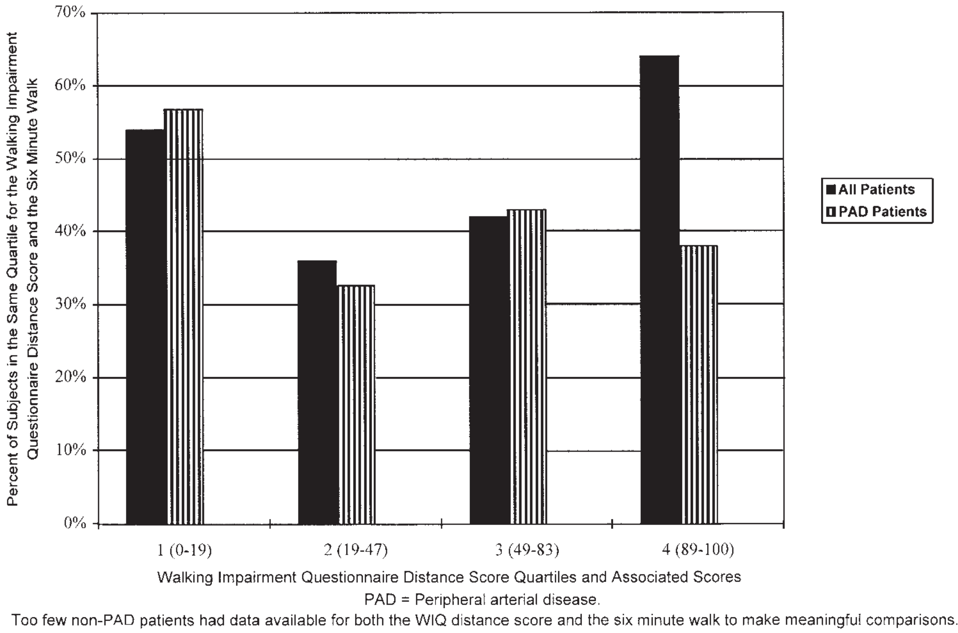

Fig 1. Percent of study patients in same quartile for Walking Impairment Questionnaire distance score and 6-minute walk.

these categories and the WIQ scores were examined for their relationships with the objective measures of functioning. For each comparison, an indicator variable to separate each group and the cross product term between the indicator variable and the WIQ score were included in the model to compare the slopes between the groups in each analysis. For each comparison, the reference group was rotated and the analyses were repeated to obtain the *P* values for each reference category within the comparisons.

RESULTS

Of the 485 patients with PAD who were eligible by age and who were identified during 1996, 74 met 1 or more of the exclusion criteria. In addition, 274 patients either were deceased (n = 23), could not be reached (n = 61), refused participation (n = 82), were limited in transportation (n = 37), could not be scheduled during the enrollment period (n = 42), or did not attend their scheduled appointment (n = 29), which left 137 patients with PAD. An additional 21 patients with PAD were identified from among the general medicine participants with ankle brachial indices of <0.90, and 7 were selected randomly from among the patients visiting the vascular surgery practice in 1996. Of all of the subjects with PAD, 18 did not complete the WIQ and 1 did not complete the 6-minute walk or the 4-m walks, which left 146 PAD subjects.

Of the 162 randomly selected men and women from general medicine without ankle brachial indices of <0.90, 42 met exclusion criteria, 35 refused participation, 10 could not be reached, 1 was deceased, 4 did not attend scheduled appointments, and 2 did not complete the 6-minute or the 4-m walks, which yielded 68 patients. Completed WIQ forms were not received from 3 patients, which yielded 65 patients without PAD.

Patient characteristics. Table I shows the characteristics of the patients with PAD and of the patients in the control group. Of the patients with PAD and without PAD, 62% and 49%, respectively, had 1 or more comorbid illnesses ($P = .08$).

Bivariate correlations. Table I shows the average values and the standard deviations for the WIQ scores and the objective measures of functioning. The distance that was achieved in the 6-minute walk correlated significantly with the WIQ distance scores among the patients with PAD, the patients without PAD, and all of the patients combined, (Table I). Similar correlations were observed between the WIQ speed scores and the usual-paced and fast-paced 4-m walking velocities.

Fig 1 shows the percentage of all patients and of the patients with PAD who fell into the first, second, third, and fourth quartiles of both the WIQ distance score and the 6-minute walk. Approximately half of

Table I. Patient characteristics and correlations between Walking Impairment Questionnaire scores and objective measures of functioning among men and women aged 55 years and older

Characteristics	*Patients with PAD (ABI, <0.90) (n = 146)*	*Patients in control group (ABI, 0.90 to <1.50) (n = 65)*	*All patients (ABI, <1.50) (n = 211)*
Age (years)*	71.7 ± 9.8	67.9 ± 7.7	70.5 ± 9.4
Female sex	44.5%	46.2%	45.0%
ABI*	0.56 ± 0.20	1.06 ± 0.08	0.72 ± 29
Black race	17.1%	15.4%	16.6%
Number of comorbidities	2.03 ± 1.42	1.52 ± 1.42	1.87 ± 1.44
Diabetes mellitus*	28.1%	10.8%	22.7%
Heart failure*	15.8%	6.2%	12.8%
Myocardial infarction	21.2%	16.8%	19.9%
Angina*	29.5%	18.5%	26.1%
Previous lower-extremity revascularization*	37.7%	7.7%	28.4%
Leg symptoms*			
No exertional leg pain	16.4%	76.9%	35.1%
Intermittent claudication	28.1%	3.1%	20.4%
Leg symptoms other than claudication	55.5%	20.0%	44.5%
Claudication severity (0 to 5 scale, where 0 is worst score)*	2.13	3.24	2.47
Measurements			
WIQ distance score (0 to 100 scale)†	40.99 ± 30.74	78.97 ± 31.36	52.69 ± 35.51
WIQ speed score (0 to 100 scale)†	37.10 ± 26.70	63.89 ± 29.46	45.26 ± 30.20
WIQ stair-climbing score (0 to 100 scale)*	48.98 ± 29.6	70.13 ± 30.0	55.59 ± 31.2
6-minute walk (feet)†	1160 ± 365	1608 ± 340	1281 ± 410
Usual-paced 4-m walk (m/s)†	0.96 ± 0.28	1.09 ± 0.24	1.00 ± 0.28
Fast-paced 4-m walk (m/s)†	1.31 ± 0.42	1.49 ± 0.34	1.37 ± 0.40
Spearman rank correlation coefficients between WIQ scores and objective walking measures			
WIQ distance score and 6-minute walk†	0.557	0.484	0.665
WIQ speed score and usual-paced 4-m walk†	0.528	0.524	0.586
WIQ speed score and fast-paced 4-m walk†	0.56	0.515	0.593

PAD, Peripheral arterial disease; *ABI,* ankle brachial index; *WIQ,* Walking Impairment Questionnaire.
*$P < .05$ for comparisons between patients with and without peripheral arterial disease.
†Significant at $P < .001$.
For the 6-minute walk outcome only, data were available for 173 study patients (47 patients in the control group and 126 patients with peripheral arterial disease).
Claudication severity was assessed by asking, "In the last week, how much difficulty did you have walking because of pain, aching, or cramps in the calves?"

the patients without PAD had WIQ distance scores of 100, which made meaningful comparisons between the WIQ distance score and the 6-minute walk quartiles difficult. The first set of bars shows the proportion of all patients and the patients with PAD whose WIQ distance score and 6-minute walk performance were both within the first (lowest) quartile of the results for all patients and patients with PAD. The second set of bars shows the proportion of all patients and patients with PAD whose WIQ distance score and 6-minute walk performance were both within the second quartile. Fig 2 shows these associations for the WIQ speed score and the usual-paced 4-m walk for all patients, patients with PAD, and patients without PAD. The agreement between the quartiles of each WIQ score and the corresponding objective measurement was the highest for the patients in the first (lowest) and fourth (highest) quartiles of the WIQ distance and the WIQ speed scores. Of all the patients in the first (slowest) quartile of the WIQ distance score, 83% were in the first (slowest) or second (second-slowest) quartiles of the 6-minute walk. Of all the patients in the fastest quartile of the WIQ distance score, 83% were in the fastest or second-fastest quartiles of the 6-minute walk. Similar relationships were observed for the WIQ speed score. These data suggest that the WIQ scores most accurately reflect the objective measures of walking endurance and walking speed for patients with the poorest and best walking endurance and for patients with the slowest and fastest walking speeds.

WIQ correlations in men and women without intermittent claudication. The results of multiple linear regression show that, among the patients who had PAD with intermittent claudication, each

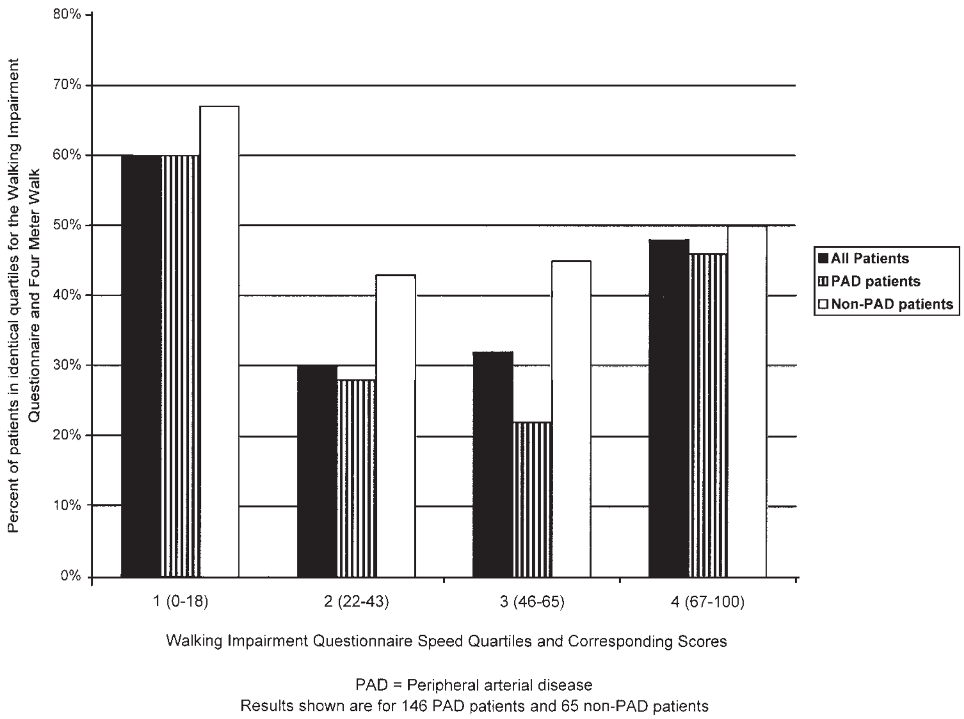

Fig 2. Percent of study patients in same quartile for Walking Impairment Questionnaire speed score and regular-paced 4-m walking velocity.

increase of 10 units in WIQ distance score was associated with an additional 68.7 ft achieved in the 6-minute walk (Table II). Among the patients who had PAD without intermittent claudication, the relationship between the WIQ distance score and the 6-minute walk was nearly identical to that reported for the patients who had PAD with intermittent claudication. For the patients who had PAD with intermittent claudication, each increase of 10 units in the WIQ distance score was associated with an increase of 0.046 m/s and 0.069 m/s in the usual-paced and fast-paced 4-m walks, respectively. As shown in Table II, the coefficients for the WIQ speed scores as predictors of usual and fastest 4-m walking velocities were slightly larger among the patients who had PAD without intermittent claudication than among the patients who had PAD with intermittent claudication, but the interaction term was not significant.

Walking Impairment Questionnaire correlations according to ankle brachial index category and number of comorbid illnesses. The relationships between the WIQ distance score and the 6-minute walk performance were not significantly different between the patients with severe PAD, mild-to-moderate PAD, and no PAD (Table III). Similarly, the associations between the WIQ walking speed scores and the 4-m walking velocities did not differ by PAD severity. As shown in Table IV, the associations between the WIQ scores and the objective measures of functioning did not significantly differ between the patients who had PAD with 2 or more comorbid diseases versus those with fewer than 2 comorbid diseases.

DISCUSSION

The development of valid instruments for estimating walking velocity and walking endurance is important for researchers when it is impractical or impossible to objectively measure walking speed and endurance. The WIQ is a brief, simple measure of patient-reported walking ability that may be practical in large-scale epidemiologic studies and in the clinical setting. In a previous study that validated the WIQ, patients who had PAD without intermittent claudication and patients who had PAD with severe comorbid illnesses that limited exercise capacity were excluded.[6] Because most patients with PAD do not have the typical symptoms of intermittent claudication[1,2,10,11] and because many patients with PAD have significant comorbid illnesses,[22] the results from the previous studies may not be generalizable to the majority of patients with PAD who do

Table II. Multiple linear regression of objective measures of functioning on Walking Impairment Questionnaire scores among men and women with peripheral arterial disease by presence of intermittent claudication symptoms*

	Regression coefficient†	*P value*	*P value for interaction term‡*
6-minute walk on WIQ (feet)			
PAD with intermittent claudication	68.7	<.001	—
PAD unassociated with intermittent claudication	67.7	<.001	.965
Regular-paced 4-m walk on WIQ speed score (m/s)			
PAD with intermittent claudication	0.046	<.001	—
PAD unassociated with intermittent claudication	0.058	<.001	.5
Fast-paced 4-m walk on WIQ speed score (m/s)			
PAD with intermittent claudication	0.069	<.001	—
PAD unassociated with intermittent claudication	0.093	<.001	.35

WIQ, Walking Impairment Questionnaire; *PAD,* peripheral arterial disease.
*An indicator variable to separate the 2 peripheral arterial disease groups (patients with intermittent claudication and patients without intermittent claudication) and the cross product term between the indicator variable and the Walking Impairment Questionnaire score were included in the model to compare the slope between the 2 peripheral arterial disease groups. An additional analysis was performed to obtain the *P* value that corresponded to the regression coefficient for the reference peripheral arterial disease group.
†Results are reported per 10 Walking Impairment Questionnaire score units.
‡*P* value for comparison of slope between the 2 peripheral arterial disease groups. This comparison was performed with the indicator variable and the cross product term of the indicator variable and Walking Impairment Questionnaire score.

Table III. Multiple linear regression of objective measures of functioning on Walking Impairment Questionnaire scores among men and women with peripheral arterial disease by disease severity*

ABI category	*Regression coefficient†*	*P value*	*P value for comparison between groups‡*
6-minute walk on WIQ (feet)			
ABI, 0.90 to 1.50	6.73	<.001	—
ABI, 0.40 to <0.90	7.41	<.001	.65
ABI, <0.40	5.93	.03	.86
Regular-paced 4-m walk on WIQ speed score (m/s)			
ABI, 0.90 to 1.50	0.0046	<.001	—
ABI, 0.40 to <0.90	0.0058	<.001	.37
ABI, <0.40	0.0023	.23	.28
Fast-paced 4-m walk (m/s) on WIQ speed score			
ABI, 0.90 to 1.50	0.0067	<.001	—
ABI, 0.40 to <0.90	0.0095	<.001	.23
ABI, <0.40	0.0049	.081	.57

ABI, Ankle brachial index; *WIQ,* Walking Impairment Questionnaire.
*Two indicator variable to separate the 3 groups (patients with ankle brachial index 0.90 to 1.50, patients with ankle brachial index 0.40 to 0.90, and patients with ankle brachial index <0.4) and the cross product terms between the indicator variable and the WIQ score were included in the model to compare slopes between the 3 groups. An additional analysis was performed to obtain the *P* value that corresponded to the regression coefficient for the reference peripheral arterial disease group.
†Results are reported per 10 Walking Impairment Questionnaire score units.
‡*P* value for comparison of slope between the 3 groups. This comparison was performed with the indicator variable and the cross product term of the indicator variable and the Walking Impairment Questionnaire score.

not have intermittent claudication or significant comorbid disease.

Summary of findings. Our data suggest that the WIQ is a useful measure of walking endurance and walking speed in a diverse group of patients with PAD and in general medical patients without PAD. The WIQ distance score was highly correlated with the objectively measured walking endurance, as measured with the 6-minute walk. The WIQ speed score correlated highly with the objectively measured walking velocity. These correlations did not significantly differ between the patients with PAD and the general medical patients, between the patients with PAD with intermittent claudication versus those without intermittent claudication, or between the patients with PAD with fewer than 2 comorbid illnesses versus 2 or more comorbid illnesses. However, our data show that the WIQ distance and speed scores most accurately reflect the objective measures of functioning among the patients with the lowest and highest

Table IV. Multiple linear regression of objective measures of functioning on Walking Impairment Questionnaire scores among men and women with peripheral arterial disease by presence of comorbid illness*

	Regression coefficient†	*P value*	*P value for interaction term‡*
6-minute walk on WIQ (feet)			
PAD and fewer than 2 comorbid diseases	6.042	<.001	—
PAD and 2 or more comorbidities	6.739	<.001	.512
Regular-paced 4-m walk (m/s) on WIQ speed score			
PAD and fewer than 2 comorbid diseases	0.005	<.001	—
PAD and 2 or more comorbidities	0.006	<.001	.765
Fast-paced 4-m walk (m/s) on WIQ speed score			
PAD and fewer than 2 comorbid diseases	0.007	.002	—
PAD and 2 or more comorbidities	0.009	<.001	.422

WIQ, Walking Impairment Questionnaire; *PAD,* peripheral arterial disease.
*An indicator variable to separate the 2 peripheral arterial disease groups (patients with 0 or 1 comorbid illnesses and patients with 2 or more comorbid illnesses) and the cross product term between the indicator variable and the Walking Impairment Questionnaire score were included in the model to compare the slope between the 2 peripheral arterial disease groups. An additional analysis was performed to obtain the *P* value that corresponded to the regression coefficient for the reference peripheral arterial disease group.
†Results are reported per 10 Walking Impairment Questionnaire score units.
‡*P* value for comparison of slope between the 2 peripheral arterial disease groups. This comparison was performed with the indicator variable and the cross product term of the indicator variable and the Walking Impairment Questionnaire score.

WIQ distance and speed scores. In our population, the WIQ distance score was the most accurate for the patients with WIQ distance scores between 0 and 19 or between 89 and 100. The WIQ speed score was the most accurate for patients with WIQ speed scores between 0 and 18 or between 67 and 100.

Our results show that the correlation between the WIQ and the objective measures of walking is not perfect. This lack of perfect correlation most likely reflects the WIQ's sensitivity to the patients' perceptions of their walking endurance and speed. The patient-specific factors, such as depressed mood and perception of optimal walking speed and endurance, are likely to affect the responses to the WIQ.

Previous work on the Walking Impairment Questionnaire. In a previous study of patients with intermittent claudication, Regensteiner et al[6] assessed the correlation between the WIQ distance and speed scores and the treadmill walking time among 26 patients with intermittent claudication who underwent either lower-extremity revascularization, exercise, or no intervention. The patients with exercise-limiting comorbid diseases, such as angina, heart failure, chronic obstructive pulmonary disease, or arthritis, were excluded. Among all of the claudication patients, the peak treadmill walking time correlated with the WIQ distance score (Pearson coefficient = 0.58; $P < .05$) and the WIQ speed score (Pearson coefficient = 0.67; $P < .05$). The WIQ speed and distance scores also correlated with the time to onset of claudication on the treadmill.[6] The correlation coefficients that were obtained by Regensteiner et al[6] are comparable with those that are reported here for a more diverse group of patients with PAD and for patients without PAD. Our work reported here adds to the previous data in the following ways: 1, by validating the WIQ distance and speed scores in a larger and more heterogeneous group of patients with PAD; 2, by validating the WIQ scores among the general medical patients; and 3, by validating the WIQ speed score against the objectively measured walking velocity.

Study limitations. A large proportion of identified patients with and without PAD in our study refused or were unable to participate. Additional data that were collected from potentially eligible patients with PAD who declined study participation show that the average ankle brachial index of the participating patients with PAD from the noninvasive vascular laboratory was 0.55 as compared with 0.54 for a 50% randomly selected subset of patients with PAD from the noninvasive vascular laboratory who were potentially eligible but did not participate. The average age of the participating patients with PAD from the vascular laboratory was 72 years, and 43% of the patients were women, as compared to 75 years and 54% women for the non-participating patients with PAD from the noninvasive vascular laboratory. These data suggest that the participating patients with PAD are reasonably comparable with the non-participants with PAD who were identified from the noninvasive vascular laboratory. Nonetheless, we cannot be certain that these relationships would have been similar among the potentially eligible non-participants.

Although the WIQ scores were not validated against the treadmill testing in this study, the 4-m walk and the 6-minute walk are both objective measures of functioning that have been validated previously.[16-22] Recent studies have validated the 6-minute walk and the 4-m walks among patients with PAD.[4,18]

CONCLUSION

These data suggest that the WIQ is a meaningful tool with which to estimate the walking ability in PAD and general medical patients with or without significant comorbid illness and with or without intermittent claudication. These data may be helpful to investigators conducting large scale studies in which the objective measurement of walking velocity and walking endurance is impractical. The WIQ may be a useful measure of walking in other populations without PAD, such as patients with arthritis or patients who undergo orthopedic procedures. The WIQ also may be a useful tool for the assessment of walking ability by clinicians. Further study is necessary to determine whether the WIQ scores can be used to predict important outcomes, such as mobility loss or the progression of PAD to rest pain and gangrene.

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APPENDIX. WALKING IMPAIRMENT QUESTIONNAIRE

Walking distance: Report the degree of physical difficulty that best describes how hard it was for you to walk on level ground without stopping to rest for each of the following distances during the last week:

	Degree of difficulty				
Distance	*None*	*Slight*	*Some*	*Much*	*Unable*
1. Walking indoors (ie, around the home)	4	3	2	1	0
2. Walking 50 feet?	4	3	2	1	0
3. Walking 150 feet? (1/2 block)	4	3	2	1	0
4. Walking 300 feet? (1 block)	4	3	2	1	0
5. Walking 600 feet? (2 blocks)	4	3	2	1	0
6. Walking 900 feet? (3 blocks)	4	3	2	1	0
7. Walking 1500 feet? (5 blocks)	4	3	2	1	0

Walking speed: Report the degree of physical difficulty that best describes how hard it was for you to walk one city block on level ground at each of these speeds without stopping to rest during the last week:

	Degree of difficulty				
Stairs	*None*	*Slight*	*Some*	*Much*	*Unable*
1. Walking 1 block slowly?	4	3	2	1	0
2. Walking 1 block at an average speed?	4	3	2	1	0
3. Walking 1 block quickly?	4	3	2	1	0
4. Running or jogging 1 block?	4	3	2	1	0

Stair climbing: For each of these questions, report the degree of physical difficulty that best describes how hard it was for you to climb stairs without stopping to rest during the past week:

	Degree of difficulty				
Stairs	*None*	*Slight*	*Some*	*Much*	*Unable*
1. Climbing 1 flight of stairs	4	3	2	1	0
2. Climbing 2 flights of stairs	4	3	2	1	0
3. Climbing 3 flights of stairs	4	3	2	1	0