Treadmill Measured vs. Questionnaire Estimated Changes in Walking Ability in Patients With Peripheral Artery Disease

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WHAT THIS STUDY ADDS

In patients with peripheral artery disease, the Walking Estimated-Limitation Calculated by History (WELCH) questionnaire score correlates with the treadmill maximal walking time. The changes in WELCH score tend to decrease more than the objective changes in walking impairment, particularly with a longer a test-retest interval. After revascularisation, a short-lived "honeymoon" (overestimation of the objectively measured change on the treadmill) is observed. For long test-retest intervals, self-reported worsening according to the WELCH score should probably be confirmed on the treadmill before a decision to revascularise is taken. Whether other questionnaires estimating walking impairment face the same issue remains to be determined.

ABSTRACT

Introduction: Determining the maximal walking time (MWT) using the treadmill test is the gold-standard method for evaluating walking capacity and treatment effect in patients with peripheral arterial disease (PAD). However, self-reported functional disability is important when assessing the quality of life. We compared changes in the Walking Estimated Limitation Calculated by History (WELCH) questionnaire scores with the MWT.

Methods: A transversal study was performed among patients with intermittent claudication. The treadmill test (3.2 km/h; 10% grade) and WELCH questionnaire were administered to all patients for objective evaluation of walking capacity. Given the log-normal distribution of these parameters in PAD patients, a log transformation was applied to the WELCH score (LnW) and maximal walking time (LnT). The responsiveness of the WELCH score was determined using mean changes and correlation coefficients of LnW and LnT changes. The effect of time on the "Estimated minus Real" (E-R) changes (LnW–change minus LnT–change) was assessed after categorization of patients into various test–retest intervals. Patients who underwent lower-limb revascularisation between the two tests and those who underwent medical treatment only were analysed.

Results: Correlation coefficients between LnW and LnT for tests 1 and 2 were $r = 0.514$ and $r = 0.503$, respectively ($P < 0.001$, for both). Correlation for LnW-change vs. LnT-change was 0.384 ($P < 0.001$). E-R was positive only early after surgery. E-R was negative for all test–retest intervals >1 year in revascularised and non-revascularised patients.

Conclusions: Changes in WELCH scores correlated with changes observed on the treadmill in patients with intermittent claudication. For long test-retest intervals, WELCH changes tended to

overestimate the worsening of walking impairment as compared with the measured difference observed in both revascularised and non-revascularised patients. A short-lived “honeymoon” (overestimation of the benefit for the shortest test-retest interval) was observed only in revascularised patients.

KEYWORDS: Peripheral artery disease; Walking impairment; Treadmill test; Questionnaire; Revascularisation

INTRODUCTION

Estimation of walking impairment through standard questionnaires is easy, can be routinely performed and scored, and is of major interest in patients with peripheral artery disease (PAD) and claudication.[1] Questionnaire scores are generally validated against different objective measurements of walking ability.[2-4] The effect of time between the two evaluations, specifically from the lower-limb revascularisation procedure upon the concordance of subjective to objective changes, has not been analysed. The "walking estimated limitation calculated by history" (WELCH) questionnaire[5] is a relatively simple tool to self-report walking limitations in PAD. It can be self-administered and compares favourably with previously proposed available tools.[2, 6] It is currently available in different languages and is easy to use in routine practice.[7-9] Correlation of between the WELCH score and objective measures of walking capacity ranges from 0.58 to 0.82,[6, 8, 9] and it is not impaired by age.[2] To date, the reliability and sensitivity to changes of the WELCH have not been studied extensively. The effect of the test-retest interval on WELCH changes compared with the changes in treadmill measured maximal walking time (MWT) is unknown.

This study determined whether the WELCH questionnaire was sensitive to changes in walking capacity and how the WELCH score changes compared with objectively measured MWT changes. Next, we aimed to determine whether the relationship between WELCH and MWT changes varied with the test-retest interval and if there was a difference between the two tests in patients that did not undergo revascularisation between the two estimates (medical treatment only) and in those subjected to arterial lower-limb revascularisation.

MATERIALS AND METHODS

A transversal study was performed among patients referred to our laboratory for walking test investigations. Most patients when primarily referred to us complained of claudication for months and most had previously benefited from optimal medical treatment for PAD. Retest visits were either based on the evaluation of residual limb or non-limb symptoms or sometimes on the surgeon's request for an objective evaluation of functional improvement. Eligibility included: age>18 years, the ability to walk on a treadmill, the ability to understand the study goals and instructions of the tests, and self-completed questionnaires. The study was approved by the Institutional Review Board and was registered on CNIL (*Commission Nationale Informatique et Liberté*). It was performed according to the International Ethics Standards and conforms to the Helsinki Declaration. Patients were aware that the results were being recorded during treadmill tests and that this investigation could be used for research purposes and were informed of their right to oppose. All investigators participating in the study were informed on how to perform the investigations, complete the files, and score the questionnaires. The study was registered with ClinicalTrials.gov Identifier: NCT01424020.

Completion of questionnaires

Each patient was provided a pen and reading glasses (if needed) and received oral instructions for completing the questionnaire on arrival at the laboratory. Each patient self-completed the questionnaires while in the waiting room of the laboratory before the walking test was performed. The questionnaire included: date of the visit, history and on-going treatments, name and surname, age, sex, body weight, stature, active smoking, and the WELCH in French. The WELCH is a four-item questionnaire that can be self-administered. The original questionnaire was developed in French but is currently available in various languages. In brief, the first three items refer to the maximal time that can be sustained when walking at different walking speeds. Answers to each item include proposals ranging from impossible (zero points) to 3 hours or more (7 points). The fourth and last item requires the patient to estimate his/her usual walking speed as compared to that of his/her siblings or of people of comparable age. Possible answers ranged from “much slower” (coefficient = 1) to “faster” (coefficient = 5). The WELCH score was calculated as follows. One is subtracted from the sum of the points of the three first items. The result of this subtraction was multiplied by the coefficient of item four. Assuming that patients can walk at least 30 seconds at a low speed, the final score ranges from zero (severe disability) to 100 (ability to walk faster than other people for at least 3 hours). Note that patients were never reminded of their answers to the previously completed WELCH questionnaires or their previous walking distance on the treadmill. A typical example of filling of the WELCH questionnaire is provided in Fig. 1.

Clinical data and investigations

Patients were admitted to the test room and their usual walking speed was measured between two lines drawn on the floor separated by 10 meters, which were traced on the floor between the waiting room and the testing room. As in our previous studies, patients unable to walk 10 m in less than 15 seconds were considered unable to walk 3.2 km/h on the treadmill and underwent a specific protocol on the treadmill;[10] they were excluded from the study. Technicians, nurses, or physicians supervised the completion of the questionnaires and completed any eventual incomplete items or clinical characteristics from the patient’s most recent file or by immediate measurement. We systematically recorded the WELCH score, presence/absence of lower limb revascularisation (bypass surgery or angioplasty) in the past or since the first visit for returning patients, age, sex, body weight, stature, and the ankle to brachial systolic pressure index (ABI).

Last, we retrieved the type of revascularization for the revascularised patients from their medical file or from contact with the surgeon (from patients referred from private practice physicians).

Treadmill test

To assess walking capacity, all patients performed a standardised constant load treadmill test under medical supervision, at a constant speed of 3.2 km/h, at a 10% incline progressively reached in 1 minute. For patients who were able to walk 15 minutes (900 sec) at a constant workload, at minute 15, the protocol was changed to an incremental load protocol with steps of 1-minute duration until exhaustion or pain limitation.[11] The treadmill tests were performed by 12-lead ECG monitoring. The test variable used during the treadmill test was the MWT, defined as the time that severe claudication pain forced cessation of exercise or as the time that the test was interrupted for medical reasons (severe cardiac arrhythmia, abnormal repolarization, etc.).

Data analysis

From the laboratory database, patients who had undergone at least two different consecutive tests were selected. For patients who had performed multiple tests, only the last two visits were analysed because of data accessibility. We previously reported that in patients with limiting claudication both MWTs treadmill constant load tests[12] and WELCH scores[6] show a log-normal distribution in PAD patients complaining of exertional limb pain. Subsequently, the MWT and WELCH scores were log-transformed for analysis and were referred to as LnT and LnW, respectively. Changes in MWT and WELCH scores were calculated as the difference in the LnT or LnW determined in the second test from the respective LnT and LnW determined at the first visit and were analysed for the whole population. From previous studies, we estimated the Spearman "*r*" coefficients of the correlation between LnT and LnW changes to be .30. This was determined from previous studies, which showed the correlation of the walking impairment questionnaire score to maximal walking distance was .33,[4] and because the correlation of the WELCH score and treadmill MWT was found to range from .58–.61;[6] thus, the resulting estimation of the correlation to be expected for WELCH and MWT changes was the square of the "*r*" correlation values: .34–.37. For the alpha two-tailed .05 and 80% power, the minimal observation number was 85.

Thereafter, patients were divided into two groups: patients who underwent medical treatment only between their two tests (non-revascularised group) and patients who had some form of lower limb revascularisation between their two tests (S group). In each group, time intervals were categorized into six test-retest intervals as follows: test-retest intervals ranging from 0 to <6 m, 6 m to <12 m, 1 to <2 y, 2 to <3 y, 3 to <4 y, and 4 y or more. For each test-retest interval, the median duration of the test-retest interval was recorded. Within each interval, the mean and SEM of the difference between LnW-changes and LnT-changes was calculated. This difference was noted as E-R. In practice, E-R was assumed to reflect overestimation of the benefit or underestimation of the impairment (positive difference) or inverse underestimation of the benefit or overestimation of the impairment (negative difference) of the subjective estimation of walking impairment evolution (WELCH questionnaire) as compared to the "real" objective evolution in the MWT between the two visits. We performed a database analysis, on the observation of at least six non-revascularised and revascularised patients, in each test-retest interval.

Statistical analysis

Results are presented as mean±SEM when normally distributed, as median [25°–75° centiles] when appropriate, and as percentages. The unpaired t-test, Mann-Whitney test, and Chi-squared test were used to compare non-revascularised and revascularised patients. ANOVA with Dunnett's post-hoc test was used to compare patients within different test-retest intervals with patients with the shortest (0 to <6 m) interval. Two-tailed paired t-tests were used for LnT and LnW to compare results of the first and second test, respectively. Correlation of the LnW-changes to LnT-changes was analysed for the whole population. Non-linear logarithmic models were chosen as apparent models that best fitted the values observed for mean E-R for the 6 test-retest intervals in non-revascularised and revascularised patients, respectively. Statistical analyses were performed using SPSS V15.0 (SPSS Inc. LEADTOOLS®, LEAD Technology Inc.). For all tests, a two-tailed p-value <.05 was used to indicate statistical significance.

RESULTS

This study included 346 consecutive patients with a mean age of 61.9 years; 87% were men. A flowchart of recruitment is presented in Fig. 2. Baseline characteristics of the study population are presented in Table 1. Among revascularised patients, 52 had an aortic and/or iliac angioplasty, 31 femoral and/or popliteal angioplasty, 14 aortic and/or iliac bypass surgery, and 12 a femoral and/or popliteal bypass surgery between their two tests. No significant difference was found between non-revascularised and revascularised patients relative to morphology or treatments. However, at baseline, both PAD (lower ABI) and walking impairment were more severe (lower WELCH score and lower maximal walking time on treadmill) in revascularised than in non-revascularised patients. The WELSH scores of the 346 patients were 20 (10-33) vs.

22 (10-39) Wilcoxon P = 0.27, based on the first and second test, respectively. Table 2 reports the major characteristics of the revascularised and non-revascularised patients as a function of test-retest interval.

No complications were noted during the walking test, although 153 (44.2%) and 149 (43.1%) of patients reported dyspnoea, fatigue, or chest pain during tests one and two, respectively. Fifty-nine of the patients studied at test 1 and 94 of the patients studied on test 2 reached the incremental phase of the treadmill test (MWT >900 s).

The correlation coefficient between LnW and LnT was $r = .514$ in test 1 and $r = .503$ in test 2, respectively ($p < .01$ for both) (Fig. 3). The correlation for LnW-change vs. LnT-change was .384 ($p < .01$).

The LnW and LnT values observed for the six test-retest intervals are shown in Fig. 4. On average, the revascularised patients showed an increase in walking time (LnT was 0.65 for the shortest Test-retest interval and 0.58 for the largest test-retest interval) after revascularisation, while the non-revascularised patients had minimal, if any, increase in walking time between their tests, irrelevant of the test-retest interval (LnT being slightly above or close to zero). Of note, in most patients, the first evaluation was performed while medical treatment was optimal and not when the diagnosis of PAD was determined. Therefore, non-revascularised patients generally presented stable, previously diagnosed, claudication. Only 18 patients were evaluated during the first test before the onset of medical therapy (start of antiplatelet and/or cholesterol lowering drugs) or before referral to a rehabilitation program. Furthermore, the change in self-reported evaluation of walking capacity (through the change in WELCH score) decreased with an increase in the test-retest interval. LnT started from 0.99 and decreased to −0.02 in revascularised patients and decreased from 0.01 to −0.53 in non-revascularised patients. As a result, the E-R difference (Fig. 5) was negative in all except one case and roughly decreased with an increase in the test-retest intervals. The only exception was for the shortest interval corresponding to the pre- and early post-revascularisation estimation in the non-revascularised group. This was the only group where the subjective estimation of changes by the patients (LnW of the Welch score) was, on average, higher than the objective measurement of changes (LnT of the MWT on the treadmill). Note that the SEM of the 2–3-year interval was large given the limited number of observations (n = 6).

DISCUSSION

The present study aimed to determine whether the WELCH questionnaire is sensitive to changes in walking capacity and how the WELCH score changes compared with objectively measured changes maximal walking time. We show that the WELCH score is as consistent in objective measurements as other more complex tools and is an easy-to-use instrument that can determine changes in the walking capacity of patients with PAD. The correlation coefficient that we identified ($r = .38$) may appear low; however, it is higher than the objective and subjective instruments of other studies. A previous study that assessed the effect of an intervention and observed a larger range of change found a correlation of changes in the treadmill distance with changes in the distance sub-scores of the walking impairment questionnaire ranging from $r = .31$ to $r = .34$.[13, 14] Comparable results were reported with Short-form-36 physical summary score changes of $r = .29$ or using the intermittent claudication questionnaire changes of 0.38.[13, 14]

The original observation of the effect of interval duration on the relationship between WELCH and MWT changes in non-revascularised and patients is of specific importance. The non-revascularised patients showed no major differences in walking capacity (change in LnT close to zero) for the various time intervals, while changes in LnT were >0 for all test-retest intervals in non-revascularised patients. While the shortest test-retest LnW interval was also close to zero, LnW decreased with longer test-retest intervals. Thus, the E-R decreased with the increase in the test-retest interval. We previously demonstrated that the WELCH was independent of age and our largest interval was only five years. Depression and anxiety are frequent symptoms in cardiovascular patients.[15-17] Whether mood changes could explain our results for long test-retest intervals remains to be determined. Overall, determining whether self-reported or treadmill-measured changes should prevail in the decision to revascularise a PAD patient is an open debate.

Another interesting observation is the initial transient overestimation (positive E-R) in revascularised patients. Conversely, "overestimation of the benefit" in revascularised patients could result from fear of a negative outcome before arterial revascularisation.[18] However, it is well known that initial excellent results one year after lower limb arterial revascularisation progressively worsen with time.[19] Subsequently, many patients become symptomatic again on a mid-term and long-term basis after arterial revascularisation, facing the same issues of chronic pain and disease as non-revascularised patients. Nonetheless, the positive E-R phenomenon is a short-lived honeymoon.

Determining the changes in walking ability and evolution of walking impairment in patients with PAD is of major importance in clinical routine trials and research trials. Laboratory investigations (among which treadmill testing is the recommended "gold standard"), are time consuming, and are not necessarily accessible to physicians in routine clinical settings. Furthermore, results are influenced by the protocols used and may not optimally reflect overall walking impairment. Although subjective, questionnaires are of interest when accounting for the perceived impact of PAD in a patient's life. Various disease-specific or non-disease-specific tools are available. The "walking impairment questionnaire", the "intermittent claudication questionnaire", the "claudication scale", and the « vascular quality of life" questionnaires are generally considered specific for patients with PAD.[13, 20-22] These questionnaires are long and impractical, with each including >14 items. A shorter version of the original 25-item the « vascular quality of life" is available, but it focuses on the impact of walking impairment on usual activities, rather than on the severity of walking impairment itself.[23] Among these tools, the walking impairment questionnaire is the most widely used tool with >150 references from a Medline search. Unfortunately, the questionnaire is lengthy, subject to errors when self-completed, and cannot be scored simply by mental calculations.[24, 25]

The fact that studied groups included different patients may represent an issue, with small clinical differences between the groups. A prospective study with repeated measurements would be a better approach; nevertheless, the feasibility of a prospective approach over a 4-year period is tentative due to technical and financial reasons. In this transversal observational study, no predefined visits were proposed according to a predefined interval to the patients. Thus, there may be a bias with patients referred to us for multiple tests that are not comparable to general PAD patients. A second issue involves the interval between tests that may slightly differ from the interval between revascularisation and the second visit in the revascularised group. This is only true for the largest test-retest interval because for the shortest intervals, the first visit generally preceded the revascularisation by approximately a few weeks. A third limitation is that we did not account for co-morbid conditions that may have occurred (or become exacerbated) between the interval of the two tests because the data submitted for analysis focused only on vascular diseases. It cannot be excluded that the self-reported limitation could be influenced by an underlying cause (vascular vs. non-vascular) of the walking impairment. To date, the WELCH survey has not been tested in non-vascular populations. Obviously, the difference in self-reported and measured changes observed with test-retest interval in the revascularised group could also depend on a deterioration of the revascularisation with time in successful vs. unsuccessful revascularisation procedures. Unfortunately, we did not have access to primary patency of revascularisation. Of interest is the fact that the MWT difference between test 2 and test 1 remained positive for revascularised patients, while the WELCH score difference was indeed positive for short test-retest intervals but decreased with larger intervals (Fig. 4). Furthermore, the time evolution in the self-reported vs. measured changes observed in the non-revascularised patients (Fig. 5) was similar to that of the revascularised patients, despite apparently comparable ABIs for the non-revascularised groups. Thus, it appears that the evolutions of differences in changes are unrelated to haemodynamic changes

CONCLUSION

The WELCH questionnaire is a valid tool to detect changes in the daily walking ability of patients with intermittent claudication. The self-reported WELCH score tends to decrease more than an objective measurement of walking impairment, especially if the test-retest interval is long. After revascularisation, a short-lived "honeymoon" (overestimation of the objectively measured change on the treadmill) may be observed. This honeymoon appears to last <1 year, after which revascularised patients follow the same evolution as non-revascularised patients for large test-retest intervals.

In PAD patients, a self-reported worsening identified using the WELCH score during two consecutive visits >1 year apart should probably be systematically confirmed on a treadmill, before a decision to revascularise is taken. Whether other questionnaires aiming at estimating walking impairment face the same issue remains to be determined.

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TABLES

Table 1. Baseline characteristics of the study population

Study population	No revascularisation	Revascularisation	P-value
Number of subjects	237	109	-
Age, mean (SD)	61.6 (9.3)	62.5 (9.6)	.400
Men, %	86.9	87.3	.952
Body mass index, mean (SD)	27.1 (4.4)	27.1 (4.6)	.891

Antiplatelet drugs	88.3	89.8	.638
Antihypertensive drugs	75.1	69.3	.293
Cholesterol-lowering drugs	79.9	81.6	.679
Anti-diabetic agents	24.7	26.6	.734
History of previous lower limb bypass	41.2	32.0	.101
Resting ankle-brachial index, mean (SD)	0.80 (0.22)	0.73 (0.21)	.004
Current smoker, %	34.9	36.6	.762
WELCH	22 [12-36]	18 [10-28]	.005
LnW	2.98 (0.84)	2.72 (0.84)	.005
Maximal walking time (s)	324 [209-756]	213 [150-345]	.001
LnT	5.90 (0.81)	5.51 (0.66)	.001

Results are mean (SD: Standard deviation) or Median [25-75 centiles] or percentages; WELCH = Walking estimated limitation calculated by history; LnW = logarithmic value of WELCH score; LnT = logarithmic value of walking time on treadmill

Table 2. Major characteristics of patients in each of the test-retest intervals of non-revascularised (medically treated) and revascularised patients. Ankle-brachial index (ABI) is the value at first visit

	Test-retest interval	Number of subjects	Age, mean	Men, %	BMI (kg/m^2)	Ankle-brachial index	ABI change	Current smoker
No revascularisation	0 to <6 m	47	60.0 (9.9)	74.5	26.2 (4.2)	0.78 (0.24)	0.01 (0.18)	36.2
	6 to <12 m	57	63.3 (8.5)	78.9	27.9 (4.6)	0.82 (0.20)	−0.01 (0.19)	22.9
	1 to <2 y	69	62.4 (8.9)	92.7	27.6 (4.2)	0.80 (0.24)	−0.04 (0.19)	27.5
	2 to <3 y	35	61.8 (10.7)	94.2	26.3 (4.7)	0.84 (0.19)	−0.05 (0.22)	14.3
	3 to <4 y	19	60.6 (8.5)	100	26.6 (3.8)	0.82 (0.17)	0.01 (0.15)	31.6
	4 y or more	10	56.7 (10.1)	100	26.8 (4.7)	0.68 (0.15)	−0.01 (0.14)	10.0
Lower limb revascularisation	0 to <6 m	34	60.5 (10.7)	76.4	26.6 (4.1)	0.68 (0.17)	0.19 (0.22)	32.4
	6 to <12 m	33	64.0 (8.5)	90.1	27.4 (4.8)	0.75 (0.20)	0.17 (0.27)	21.2
	1 to < 2 y	18	63.4 (10.0)	100	25.8 (4.7)	0.70 (0.28)	0.03 (0.21)	38.9
	2 to < 3 y	6	59.7 (8.8)	100	27.9 (4.3)	0.87 (0.24)	0.07 (0.26)	16.7
	3 to < 4 y	10	65.9 (8.1)	100	26.3 (3.1)	0.74 (0.16)	0.11 (0.12)	30.0
	4 y or more	8	64.5 (11.3)	100	30.2 (6.4)	0.83 (0.32)	0.03 (0.23)	12.5

Results are expressed as mean (standard deviation (SD)) or percentage; BMI, body mass index; no significant change for any variable from the first group on non-revascularised and revascularised patients except for sex.

FIGURE LEGENDS

Fig. 1: English version of the WELCH questionnaire with example of scoring

Fig. 2: Flowchart of database analysis and resulting study population

Fig. 3: Scatterplot of logarithmic transformed changes in WELCH score (LnW) and maximal walking time (LnT) in the first (test 1) and second (test 2) tests, in patients who received medical treatment (non-revascularised) or underwent revascularisation (revascularised) between tests one and two.

Fig. 4: Mean logarithmic transformed WELCH score (LnW) and maximal walking time (LnT) observed for the six test-retest intervals in patients who received medical treatment (non-revascularised : non-S) or revascularisation (S) between tests one and two.

Fig. 5: Changes (test 2-test 1) in logarithmic transformed WELCH scores (LnW) and maximal walking time (LnT) observed for the six test-retest intervals. *R* is the Spearman coefficient of correlation of the regression analysis of average LnW-changes and LnT changes. The grey zone is the "honeymoon period" during which the self-reported difference was superior to the measured difference in the treadmill test for patients with lower limb revascularisation. Each point indicates the mean and standard error of mean.

Please answer each of the following 4 items by placing an "X" in the box that best describes your situation. Please mark only one box per item. If you never perform an activity, estimate what it would be like if you did perform it. For the first 3 items, if you think that you would not be able to perform a specified task for at least 30 seconds without stopping to rest, please answer "impossible".

For each of the three following activities, how long can you perform the task easily on level ground & without stopping when …

1/ … walking slowly (slower than usual speed of relatives, friends, or other people of your own age)?

Impossible	30 seconds	1 minute	3 minutes	10 minutes	30 minutes	1 hour	3 hours or more
☐	☐	☐	☐	☐	X	☐	☐
0	1	2	3	4	**5**	6	7

2/ … walking normally (same as usual speed of relatives, friends, or other people of your own age)?

Impossible	30 seconds	1 minute	3 minutes	10 minutes	30 minutes	1 hour	3 hours or more
☐	☐	X	☐	☐	☐	☐	☐
0	1	**2**	3	4	5	6	7

3/ … walking quickly (faster than usual speed of relatives, friends, or other people of your own age)?

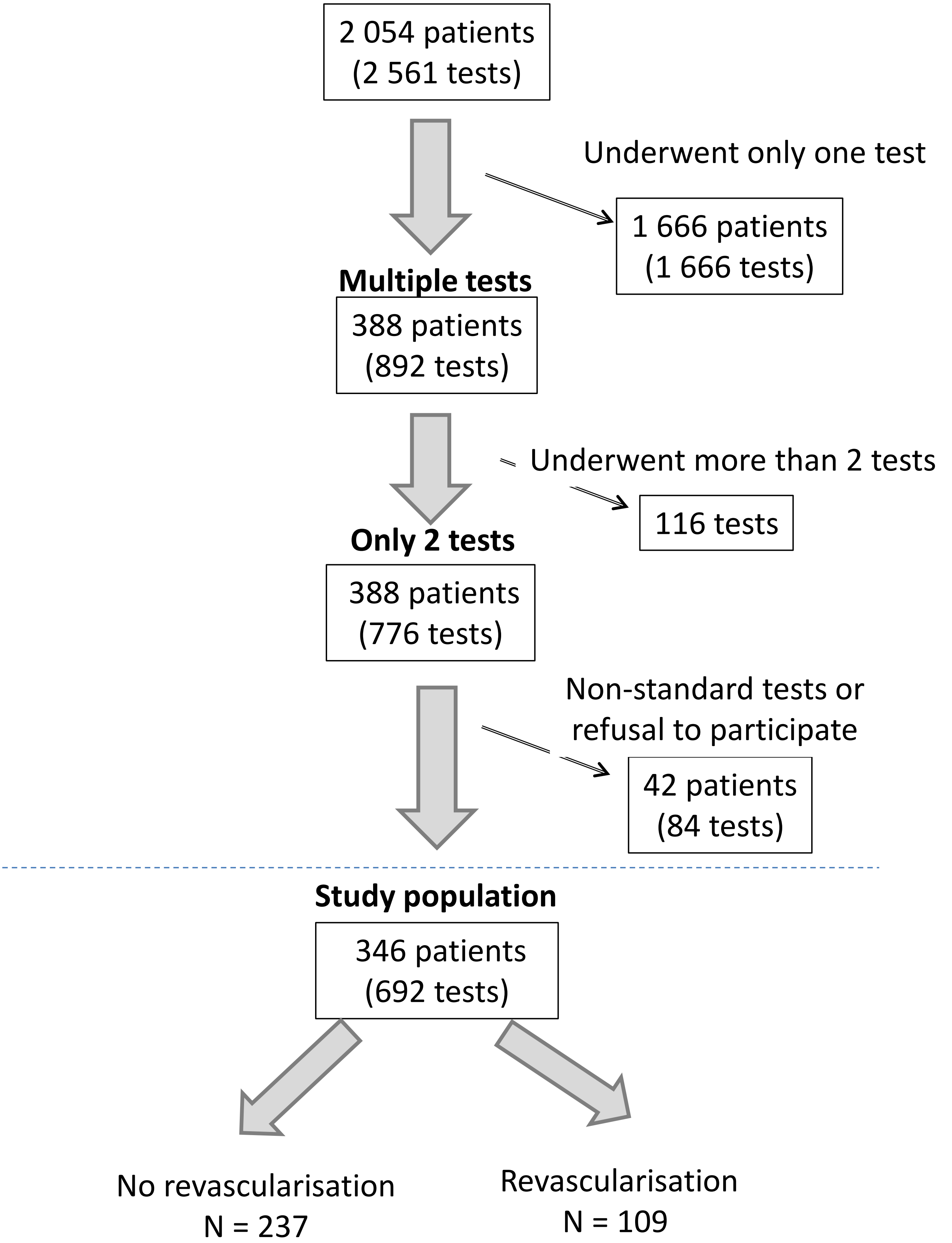
Impossible	30 seconds	1 minute	3 minutes	10 minutes	30 minutes	1 hour	3 hours or more
X	☐	☐	☐	☐	☐	☐	☐
0	1	2	3	4	5	6	7

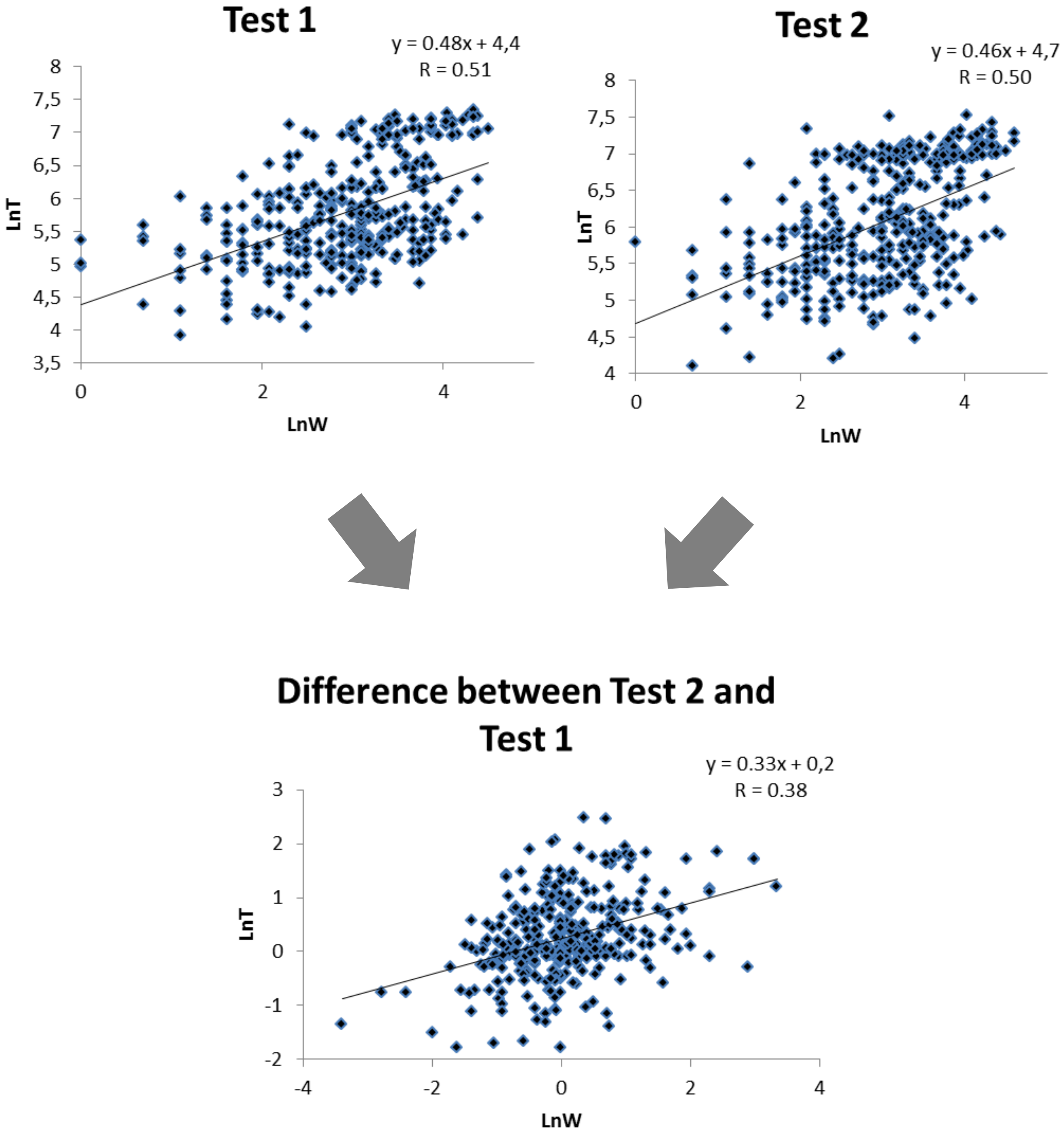
Compared to the usual walking speed of your relatives, friends, or people of your own age, do you think that you personally usually walk … (Tick only one box)

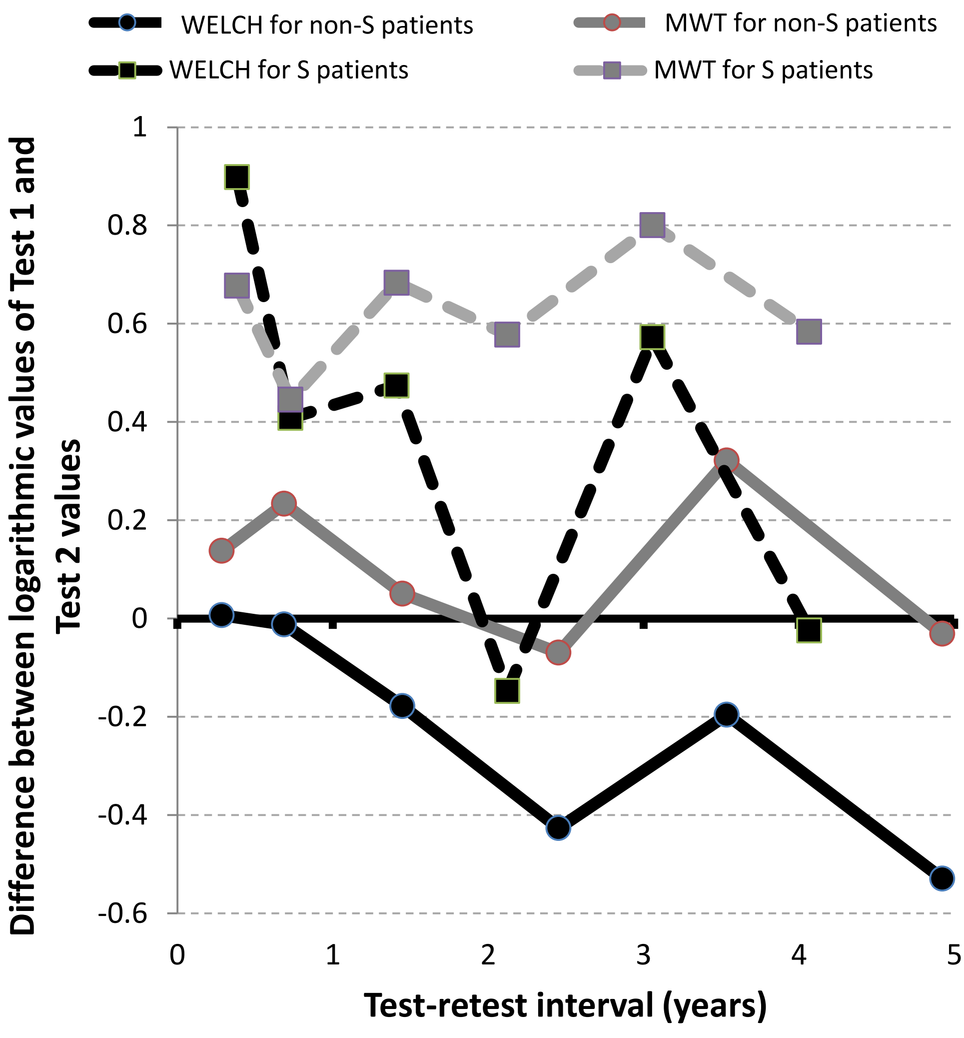
much slower	☐	1
moderately slower	☐	2
a bit slower	X	**3**
at the same speed	☐	4
faster	☐	5

THANK YOU: You should have 1 box per item ticked... please check.

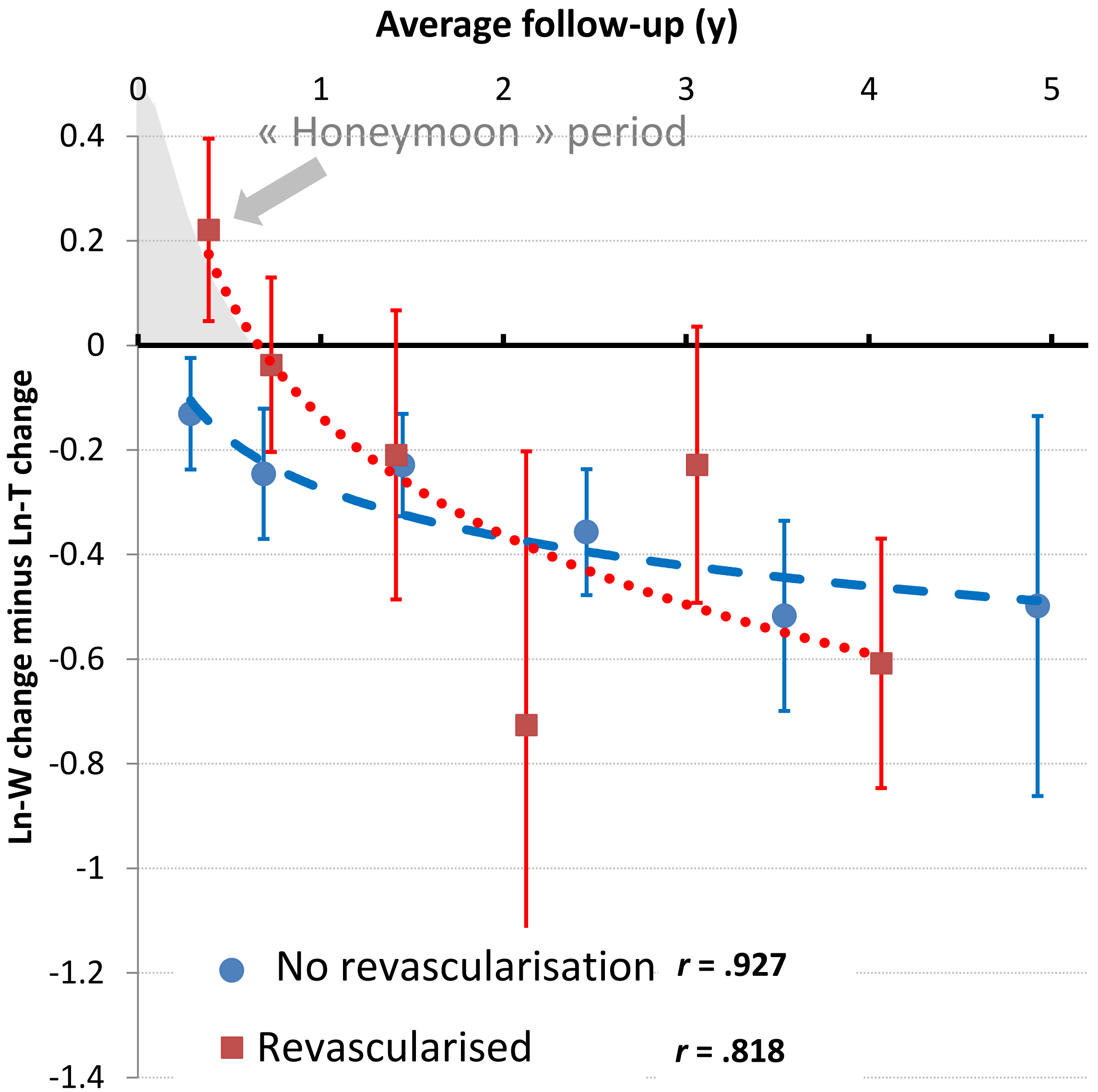
WELCH score = [(5 + 2 + 0)-1] ·3 = 18


2 054 patients
(2 561 tests)
Underwent only one test
1 666 patients
(1 666 tests)
Multiple tests
388 patients
(892 tests)
Underwent more than 2 tests
116 tests
Only 2 tests
388 patients
(776 tests)
Non-standard tests or
refusal to participate
42 patients
(84 tests)
Study population
346 patients
(692 tests)
No revascularisation
N = 237
Revascularisation
N = 109


Test 1
y = 0.48x + 4,4
R = 0.51
LnT
LnW
8
7,5
7
6,5
6
5,5
5
4,5
4
3,5
0
2
4
Test 2
y = 0.46x + 4,7
R = 0.50
LnT
LnW
8
7,5
7
6,5
6
5,5
5
4,5
4
0
2
4
Difference between Test 2 and Test 1
y = 0.33x + 0,2
R = 0.38
LnT
LnW
3
2
1
0
-1
-2
-4
-2
0
2
4



WELCH for non-S patients
MWT for non-S patients
WELCH for S patients
MWT for S patients
Difference between logarithmic values of Test 1 and Test 2 values
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
0
1
2
3
4
5
Test-retest interval (years)



Average follow-up (y)
0
1
2
3
4
5
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
« Honeymoon » period
Ln-W change minus Ln-T change
No revascularisation
r = .927
Revascularised
r = .818