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Assessing physical functioning on pain management programmes: the unique contribution of directly assessed physical performance measures and their relationship to self-reports

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Abstract

Physical functioning is a recommended outcome domain for pain management programmes. It can be assessed by self-report and by direct assessment of performance. Although physical performance measures may provide unique and useful information about patient functioning over and above self-report measures, it is not entirely clear which of the many possible performances to assess. This study investigated a battery of three directly assessed physical performance measures and their relationship to three currently used self-report measures of general health and functioning. The three performance measures were sensitive to treatment; patients performed significantly better on all three measures following completion of the pain management programme. The three performance measures were shown to represent a single underlying dimension, and there was a significant degree of overlap between them. The performance measures were shown to be relevant in explaining variation in the self-report measures, as well as to offer a clinically relevant different dimension of assessment to self-report. Future research could focus on developing performance-based measures that capture quality of movement and that are sensitive to relevant processes of therapeutic change.

Keywords

Chronic pain, physiotherapy, pain management programme, physical functioning, performance measures, self-report, assessment

Introduction

According to the British Pain Society (BPS), pain management programmes (PMPs) based on cognitive-behavioural principles are 'the treatment of choice for people with persistent pain which adversely affects their quality of life'[1] (p. 8). PMPs are multidisciplinary and aim to improve general health and functioning;[1] there is good evidence for their efficacy.[2,3] Notably, one of the important domains of functioning addressed within PMPs includes daily physical functioning.

The BPS and the Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials (IMMPACT) recommend assessing multiple domains of functioning when evaluating treatments for pain.[4–6] These recommendations were generated from discussion with people with chronic pain themselves, as well

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as through consensus of clinicians and researchers in the field. The outcome domains recommended by IMMPACT are pain intensity, physical functioning, emotional functioning and participant ratings of overall improvement.[4] IMMPACT's core recommended measures for clinical trials are all self-report measures.[4]

Physical functioning presents potentially useful assessment opportunities because unlike some domains it can be assessed both indirectly by self-report and directly by observational methods in a performance context. Indeed, the BPS includes a recommendation for the direct assessment of activity, as well as patients' self-report of physical functioning.[1] Directly assessed measures of physical functioning (also here termed 'performance measures') have been developed specifically for use on PMPs, although they are much less frequently used as outcome measures in clinical trials. In the early 1990s, one such battery of physical performance measures was developed and validated.[7] On the basis of that validation study, the authors recommended four measures: (1) 5-minute walking distance, (2) 1-minute stair climb, (3) 1-minute standing up and sitting down from a chair and (4) endurance for maintaining the arms horizontal.[7] The statistical properties of this battery have been examined and the measures demonstrate good to excellent inter-rater and test–retest reliability.[7] Other physical performance measures[8–14] have been developed and/or validated in chronic pain populations although only Harding et al.'s[7] battery was examined in this study as it is the battery currently in use at our centre.

Correlations between self-report and directly assessed physical performance measures in people with chronic pain have been investigated, and several studies have shown performance measures make a unique contribution to the prediction of self-reported physical functioning.[8,15,16] Findings generally indicate that self-report and performance tests are only moderately correlated.[8,15,16] For example, self-reported activity of daily living ability measured by the Fibromyalgia Impact Questionnaire[17] was, at most, weakly correlated with the Assessment of Motor and Process Skills (AMPS),[10] another performance-based measure.[11] Thus, self-report and performance measures may assess partially distinct aspects of physical functioning.

Various cognitive or emotional factors can influence self-reported physical functioning.[15,16,18–20] For example, depression may be associated with underestimations of ability or with difficulties with task initiation.[16] Of course, physical performance is also influenced by factors in addition to physical capacity,[8] although it has been suggested that the effect of such factors on physical performance measures is generally not as great as their effect on self-report.[15]

Direct performance and self-report measures of physical functioning may be important to include in tandem as they may show different sensitivity to treatment effects or patterns of change over time.[15] For example, Simmonds et al.[8] suggest the 5-minute walk is more sensitive than some other measures to treatment effects, which is important as these may be relatively modest. Also some stakeholders, such as those commissioning pain management services, may naturally find performance data more persuasive than self-reports or prefer performance data in combination with self-reports. Where time and resources allow, a more comprehensive assessment may be preferred.

Beyond their usefulness as an outcome measure in research, physical performance measures have clear clinical utility and can provide unique insights into the patient's functional abilities. Although not necessarily recorded and analysed, observations of the *quality* with which the person approaches the performance can help identify treatment targets. For example, when climbing the stairs, a person may be 'pushing through' the activity, displaying observable behaviours such as gritting their teeth or holding their breath. Equally, the quality of the movement may be cautious (such as moving very slowly and carefully, looking down at each step), guarded (such as shielding an area of the body), protective (such as not putting weight through one leg or holding the painful area) or adapted (such as going up the stairs sideways). Avoidance of the performance measure altogether also provides highly relevant clinical information. Of course, as with any method of measurement, physical performance measures do have limitations. In particular, the standardised performance measures while useful for research purposes may not highlight difficulties specific to each patient's context and goals. For example, speed of walking may be less important to some patients in their daily life than the distance they can walk. This is another good reason to triangulate methods using both self-report and direct assessment.

Although physical performance measures may provide unique and useful information about patient functioning over and above self-report measures, it is not entirely clear which of the many possible performances to assess. As the administration can be burdensome for both patient and clinician, careful selection of a relevant, efficient and sensitive set of performance measures is necessary. In our clinical experience, administering the three time-limited measures of the four recommended by Harding et al.[7] takes approximately 10–15 minutes per patient. This represents a significant amount of time if administered to an entire group of participants at the start and end of their PMP and at follow-up. For the same reasons, there are also cost implications as the measures are often administered by highly trained physiotherapists working on the PMP. Furthermore, there are ethical considerations in requiring participants to complete measures unless this can be shown to yield benefits. Taking these considerations together, it is important to understand the validity and clinical utility of physical performance measures as a type of psychometric instrument, particularly over and above self-report measures of physical functioning. Such information can inform refinements in these measures and the ways they are applied in the context of PMPs.

The aim of this study was to examine more closely the statistical properties of the three physical performance measures recommended by Harding et al.,[7] which are still in use at the interdisciplinary pain centre where they were developed. The specific aims were to investigate (1) the factor structure of the physical performance measures, (2) whether each separate item provides significant unique information, (3) the relative overlap between results from physical performances and results from current self-report questionnaires and (4) the role of physical performance change in relation to reported outcome change.

Method

Participants

Participants were recruited from 299 people (72.7% women) with chronic pain referred by a general practitioner or pain consultant to a speciality pain service in central London. All had been assessed by a psychologist and physiotherapist as suitable to attend a 4-week, residential, interdisciplinary, group-based PMP between August 2014 and October 2015. Inclusion criteria to attend the PMP included the following: pain duration of more than 6 months, pain was significantly disabling or distressing and that there was no plan for surgical or medical treatments that might impact the patient's participation in the PMP. Appropriate ethics and institutional approvals were obtained prior to the study. Written consent was given by the patients for their data to be used for research.

Participants ranged in age from 18 to 87 years (mean 45.27 years, standard deviation (*SD*) = 12.24). The majority (74.3%) of participants defined their ethnicity as White and 54% were unemployed because of pain. 29% lived with their partner and child/children and the mean number of years of education was 13.86(*SD* = 4.15; see Table 1 for further details). Overall, 43.2% of participants reported their pain as widespread, and the mean pain duration was 149.11 months (*SD* = 127.09; range: 4–703 months; see Table 1 for further details).

Table 1. Demographic and pain characteristics of the sample.

	% or mean (*SD*)
Age (years)	45.27 (12.24)
Years of education	13.86 (4.15)
Gender	
Male	27.3
Female	72.7
Ethnicity	
White	74.3
Black	10.9
Asian	6.3
Mixed	5.6
Other	2.9
Living status	
With a partner and children	29.0
Alone	25.2
With partner	23.1
With child/children	12.2
With other relatives	8.0
With friends/flatmates	2.4
Employment status	
Unemployed because of pain	54.4
Employed	28.4
Retired	9.1
Homemaker	5.6
Student	2.2
Carer	0.4
Pain duration (months)	149.11 (127.09; 4–703)
Pain location	
Lower back	37.2
Generalised	43.2
Lower limbs	8.8
Upper shoulder or upper limbs	3.2
Other	7.8

SD: standard deviation.

Procedure

As part of standard clinical procedure, participants completed three physical performance measures and a set of self-report questionnaires, including demographic questions regarding sex, ethnicity, age, living status, employment status, education, pain history and pain location. These were completed on the first and last day of treatment. Of the 299 patients commencing treatment during the timeframe of the study, a total of 286 patients consented to have their information used for research purposes. The questionnaires were checked at the time of completion to ensure minimal missing data.

Physical performance measures

Participants were invited to complete three performance-based measures of physical functioning: (1)

5-minute walk, (2) 1-minute sit–stand and (3) 1-minute stair climb.[7] Assessors were trained in standardised test administration and to give neutral responses with no encouragement or advice during testing. Participants were informed that the test was a measure of current function and to do only what was manageable. The three measures have been validated among patients with chronic health conditions[7,8] and have been used in outcome studies of interdisciplinary treatment programmes for chronic pain.[21–24]

5-minute walk. The 5-minute walk is a timed test of the number of metres a participant walks within 5 minutes up and down an empty 20-m-long corridor, with distance markers placed along the floor. Participants were asked to perform the walk test without walking aids, such as crutches or sticks, if they were willing to do so. They were given permission to use the walls for support or to sit down as needed. Any stops against the wall or chair were recorded although they were not used in the analysis. Patients were informed of the time elapsed on each lap or at each minute if laps were very slow. This was not qualitative feedback but was intended to reflect real-life situations where patients may be likely to refer to time to determine their capacity to carry out activities.

1-minute sit–stand. Standing up from a chair is a commonly performed daily activity. Measuring this just once would not provide information sufficient to differentiate patients. Using a standard upright chair with no armrests, this test measures the number of times participants stand up from sitting over a 1-minute period. Participants were asked to perform the test without aids, given permission to use their hands as they wanted, and informed of the time elapsed at half a minute.

1-minute stair climb. The 1-minute stair climb is a timed test of ascending and descending a flight of standard stairs with one handrail and an opposite wall within easy reach. A chair was available for resting if needed. The number of steps climbed in a 1-minute period was recorded. Again, participants were asked to perform the tests without aids, given permission to use their hands as they wanted, and informed of the time elapsed at half a minute

Self-report measures

Pain intensity. Participants rated their pain intensity on average over the last week on a standard scale from 0 (*no pain*) to 10 (*extremely intense pain*).

Pain interference. The Brief Pain Inventory–Interference Scale (BPIIS)[25] is a 7-item self-report measure of pain interference with seven domains of daily activity that include the following: general activity, mood, walking ability, normal work, relations with others, sleep and enjoyment of life. On this measure, patients report how much pain interfered with functioning over the past week on a scale of 0 (*does not interfere*) to 10 (*completely interferes*). Higher scores indicate greater interference of pain. The BPIIS has been well validated among patients with chronic pain.[26]

Functioning. The Work and Social Adjustment Scale (WSAS)[27] is a 5-item self-report measure assessing specific domains of functional impairment. Patients report how much their current condition impairs their ability to work, manage household activities, engage in social leisure activities, private leisure activities and relationships with others on a scale of 0 (*no impairment*) to 8 (*severe impairment*). Higher total scores indicate greater functional impairment. The WSAS has been validated and is widely used in research in chronic health conditions.[27]

Depression. The Patient Health Questionnaire (PHQ-9)[28] is a measure of depression based on standard *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (DSM-IV) criteria. It includes nine items, measuring symptom frequency over the last 2 weeks on a scale of 0 (*not at all*) to 3 (*nearly every day*). Higher total scores indicate greater symptom severity. The PHQ-9 has been well validated among patients with chronic health conditions.[28] Emotional functioning is one of the BPS and IMMPACT's core outcome domains.

Treatment

The PMP was delivered in a residential, interdisciplinary rehabilitation context by a team of psychologists, physiotherapists, occupational therapists, nurses and physicians using an Acceptance and Commitment Therapy (ACT)[29,30] approach. This approach seeks to develop processes and skills relating to psychological flexibility (PF):[31] openness to experiencing pain and unwanted feelings, present-moment awareness and values-oriented behaviour. Pain reduction was not an explicit focus of treatment. The emphasis of treatment was on experiential exercises, use of metaphor, mindfulness practice, cognitive defusion techniques and the application of these to values-based goals. These processes were used across disciplines in addition to goal-setting and education. Treatment was provided in groups over four full days per week for 4 weeks.

Data analysis

Data analyses were conducted using SPSS version 22. Means and SDs were computed for pre- and post-treatment scores. Paired sample t-tests were then computed to determine the statistical significance of changes from pre- to post-treatment. All of the variables in the analyses were considered to be normally distributed. Within-subjects effect sizes (Cohen's d) were computed as the difference between pre- and post-treatment means divided by the pooled SD. Effect sizes were interpreted, according to Cohen's[32] guidelines, as small (>0.20), medium (>0.50) or large (>0.80).

A factor analysis was conducted to identify the underlying factor structure of the three measures using direct oblimin rotation, as the factors were likely to be correlated. The Kaiser–Meyer–Olkin measure of sampling adequacy was interpreted as follows: mediocre (0.5–0.7), good (0.7–0.8), great (0.8–0.9) and superb (>0.9).[33] Bartlett's test was used to test whether correlations found were strong enough to make the analyses meaningful. To test the reliability of the factor analysis, Cronbach's α was computed.

Pearson correlations were computed to examine the associations between the three performance measures at pre-treatment in addition to their relationship with demographic variables and baseline self-report measures of functioning. Scatter plots for all variable pairs from the correlation analyses were examined for linearity. None of the variable pairs were considered to have significant nonlinear associations. Independent-samples t-tests were performed to examine differences in performance between genders.

To investigate the role of improvements in physical performance measures in relation to other treatment outcomes, residualised change scores were computed for all variables. Pearson correlations were then computed to examine the inter-relations between residualised change scores on all three physical performance measures and between residualised change scores on physical performance measures, the self-report outcome measure and demographic variables.

A hierarchical multiple linear regression was computed using pre-treatment measures of the 5-minute walk as the dependent variable and the other two physical performance measures as predictors to examine the shared and unique contributions of each measure. Further series of hierarchical regression analyses were then computed, first using pre-treatment scores and then residualised change scores, to examine the shared and unique contributions of physical performance variables to pain interference, functioning and depression. Relevant demographic variables and pain intensity were controlled for in the first two steps of each analysis, followed by all three physical performance variables in the final step of the regression equation. Only scores for physical performance variables that were significantly correlated with treatment outcomes in zero-order correlations were entered, simultaneously, into the equations as independent variables. To examine the shared and unique contribution of the physical performance measures to self-report measures of physical function only, a final regression analysis was performed as above, but with the psychosocial items of the BPIIS and WSAS removed. For this, three new dependent variables were created: (1) BPIIS walking ability item only; (2) BPIIS walking ability, general activity and work items; and (3) WSAS work and home management items.

Listwise deletion was used to address missing values on study variables. Therefore, the sample size varies slightly across the t-tests, correlations and regression analyses, depending on the variables being examined. Degrees of freedom and sample sizes are reported throughout the analyses to reflect these differences.

Results

Descriptives

In total, 28 (9.8%) participants did not complete the physical performance measures at end of treatment because they dropped out of treatment altogether. A further two people (0.7%) declined to complete the physical measures at end of treatment but did not drop out. Five people (1.7%) did not complete the physical measures at end of treatment but did not drop out or explicitly decline to complete the measures (e.g. these participants may have chosen not to attend the session in which measures were taken). By way of comparison, four people (1.4%) did not complete the questionnaire-based measures but did not drop out or specifically decline and two (0.7%) declined to complete the questionnaire.

Of the total sample of 286 participants (excluding those for whom the data are missing), 58 (20.7%) used walking aids at pre-treatment and 37 (15%) at end of treatment. These participants participated in completing the measures for clinical reasons, but their data were excluded from the subsequent analyses. Subsequent analyses were performed on participants who had completed *all* three physical performance measures at pre-treatment and at end of treatment *and* who did not use a walking aid either at pre-treatment or at post-treatment (as per the original protocol).[7] Thus, the final sample size was 183 participants (74.9% female).

Treatment effect

Paired-samples t-tests and effect sizes were calculated for physical performance scores at pre- and post-treatment (see Table 2). T-test analyses showed statistically significant improvements in all three physical performance measures from pre- to post-treatment ($p < 0.01$).

Table 2. Means (standard deviations) and effect sizes for performance measures at pre-and post-treatment.

	Pre-treatment and post-treatment (n = 183)			
	Pre mean (*SD*)	Post mean (*SD*)	t-tests	Cohen's d
5-minute walk	211.62 (107.93)	263.31 (109.45)	*t*(182) = **−8.98****	−0.48
1-minute sit–stand	9.37 (5.57)	13.13 (6.44)	*t*(182) = **−12.97****	−0.63
1-minute stairs	47.74 (24.94)	60.69 (28.78)	*t*(182) = **−8.94****	−0.48

SD: standard deviation.
**p < 0.01.

Table 3. Correlations between physical performance measures and self-report measures of patient functioning at pre-treatment.

	Correlations (Pearson; n = 133)					
	5-minute walk	1-minute sit–stand	1-minute stairs	BPIIS	WSAS	PHQ-9
5-minute walk	1	**0.69****	**0.79****	**−0.30****	**−0.31****	**−0.18***
1-minute sit–stand	**0.69****	1	**0.77****	**−0.29****	**−0.21***	**−0.24****
1-minute stairs	**0.79****	**0.77****	1	**−0.24****	**−0.24***	**−0.23****

BPIIS: Brief Pain Inventory–Interference Scale; WSAS: Work and Social Adjustment Scale; PHQ: Patient Health Questionnaire.
*p < 0.05; **p < 0.01.

Table 4. Correlations between physical performance measures and relevant demographic and pain variables at pre-treatment.

	Correlations (Pearson; n = 156)			
	Age	Years of education	Months of pain	Pain intensity during last week
5-minute walk	**−0.20***	0.01	−0.07	**−0.21****
1-minute sit–stand	−0.15	0.08	−0.06	**−0.28****
1-minute stairs	**−0.18***	−0.02	−0.11	**−0.25****

*p < 0.05; **p < 0.01.

Exploratory factor analysis

Factor analysis was performed on pre-treatment scores for the three physical performance measures (n = 183) to identify the underlying factor structure using direct oblimin rotation. The item set was appropriate for factor analysis: Kaiser–Meyer–Olkin = 0.72; Bartlett's test of Sphericity χ^2 (3) = 359.36, $p < 0.01$. One factor emerged with an eigenvalue greater than 1; this factor accounted for 83.57% of the variance. The scree plot also supported a one-factor structure. All three items strongly loaded onto the factor and the factor loadings were of a comparable magnitude (0.789–0.890).

Reliability analyses

Internal consistency reliability analysis was conducted on standardised values for the performance measures. Cronbach's α was 0.90, indicating excellent internal reliability.

Correlation analyses and associations between demographic factors and performance measures

At pre-treatment, all three physical performance measures significantly correlated with each other and with the self-report measures of functioning (BPIIS, WSAS and PHQ-9), in the expected direction (see Table 3). Correlation analyses were also performed between the three performance measures and the following demographic and pain variables: age, years of education, duration of pain and average pain intensity in the last week (see Table 4). The only significant correlations included age and average pain intensity during the last week. Independent-samples t-tests indicated that there was no significant difference in performance between men and women (all p-values > 0.20).

In the pre- to post-treatment change analyses, changes in all three physical performance measures significantly correlated with each other, in the expected

Table 5. Correlations between physical performance measures change scores and changes in self-report measures of functioning.

	Correlations (Pearson; n = 117)					
	Δ5-minute walk	Δ1-minute sit–stand	Δ1-minute stairs	ΔBPIIS	ΔWSAS	ΔPHQ-9
Δ5-minute walk	1	**0.53****	**0.54****	**−0.37****	**−0.36****	**−0.31****
Δ1-minute sit–stand	**0.53****	1	**0.58****	−0.18 (p = 0.052)	**−0.28****	**−0.25****
Δ1-minute stairs	**0.54****	**0.58****	1	**−0.31****	**−0.29****	**−0.29****

BPIIS: Brief Pain Inventory–Interference Scale; WSAS: Work and Social Adjustment Scale; PHQ: Patient Health Questionnaire.
*p < 0.05; **p < 0.01.

Table 6. Correlations between physical performance measures change scores and relevant demographic and pain variables.

	Correlations (Pearson; n = 154)			
	Age	Years of education	Months of pain	Δ Pain intensity during last week
Δ5-minute walk	0.00	**−0.19***	−0.09	−0.11
Δ1-minute sit–stand	0.03	−0.11	−0.15	−0.10
Δ1-minute stairs	0.03	**−0.22****	0.08	−0.04

*p < 0.05; **p < 0.01.

Table 7. Regression analysis of 5-minute walk in relation to the other two physical performance measures at pre-treatment.

Model	Predictors	Coefficients – standardised beta	ΔR^2	F change
5-minute walk				
1	1-minute sit–stand	**0.13***	0.67	*F*(2, 180) = **185.07****
	1-minute stairs	**0.71****		

*p < 0.05; **p < 0.01.

direction (see Table 5). Correlation analyses were performed on changes in the three performance measures and the following demographic variables: age, years of education, duration of pain and change in average pain in the last week. The only significant correlations included years of education (see Table 6). Again, t-tests on differences in performance between men and women were all non-significant. Correlation analyses with the performance measures change scores, and changes in the BPIIS, WSAS and PHQ-9 (see Table 5) showed changes in the 5-minute walk and 1-minute stair significantly correlated with changes in all self-report measures of functioning. Changes in 1-minute sit–stand significantly correlated with changes in all self-report measures of functioning, except the BPIIS.

Regression analyses

First, a multiple regression using standard simultaneous entry was carried out with the 5-minute walk as the dependent variable and the other two performance measures as predictors to examine the amount of shared variance between the measures (see Table 7). The 1-minute sit–stand and 1-minute stairs significantly predicted performance on the 5-minute walk and explained 67.3% of the variance.

Three further multiple regression analyses using a hierarchical entry method were carried out to assess the contribution of the three physical performance measures to self-report measures of patient functioning, after the contribution of age and average pain intensity during the last week had been taken into account (see Table 8). The dependent variables in the analyses were the BPIIS, WSAS and PHQ-9. Multicollinearity was not a concern (variance inflation factor (VIF) <10 and tolerance statistic <0.1). The proportion of variance explained by the three physical performance measures together was significant for pain interference (BPIIS) and functioning as measured by the WSAS. The proportion of variance explained by the physical measures together was generally small (5–9%). Examination of the beta weights from the final

Table 8. Regression analyses of patient functioning in relation to age, pain intensity and physical performance measures at pre-treatment (n = 133).

Model	Predictors	Coefficients – standardised beta	ΔR²	F change
BPIIS				
1	Age	−0.002	0.02	F(1, 179) = 3.09
2	Pain intensity last week	**0.39****	0.19	F(1, 178) = **42.55****
3	5-minute walk	−0.21 (p = 0.077)	0.05	F(3, 175) = **3.55***
	1-minute sit–stand	−0.09		
	1-minute stairs	0.06		
WSAS[a]				
1	Age	−0.004	0.003	F(1, 133) = 0.46
2	Pain intensity last week	0.05	0.01	F(1, 132) = 1.18
3	5-minute walk	**−0.32***	0.09	F(3, 129) = **4.34****
	1-minute sit–stand	0.04		
	1-minute stairs	−0.02		
PHQ-9				
1	Age	−0.05	0.002	F(1,175) = 0.42
2	Pain intensity last week	**0.32****	0.12	F(1,174) = **23.86****
3	5-minute walk	0.06	0.03	F(3,171) = 2.20
	1-minute sit–stand	0.05		
	1-minute stairs	−0.27 (p = 0.056)		

BPIIS: Brief Pain Inventory–Interference Scale; WSAS: Work and Social Adjustment Scale; PHQ: Patient Health Questionnaire.
aThe lower n on this measure is likely due to missing data on an item related to employment.
*p < 0.05; **p < 0.01.

regression equation indicated that only the 5-minute walk uniquely predicted the WSAS. None of the performance measures were significant unique predictors of the other self-report measures in the final regression equation.

The regressions were repeated to assess the contribution of changes in the three physical performance measures to changes in patient functioning as measured by self-report, after the contribution of years of education (as this correlation was significant, see Table 6) and change scores for average pain intensity during the last week had been taken into account (see Table 9).

The proportion of variance explained by the three physical performance measures together was significant for all outcomes. The proportion of variance explained by the physical measures together ranged from 8% to 12%. The 5-minute walk uniquely predicted all three outcomes. The 1-minute sit–stand and the 1-minute stairs did not uniquely predict any of the self-report outcomes.

A final analysis was performed by removing the psychosocial items of the BPIIS and WSAS. Unsurprisingly, compared to correlations with the full measures (described previously), correlations between the physical performance measures and the more physical subsets of BPIIS and WSAS were higher with the greater physical item content (ranging from −0.23 to −0.50) and were lower when only the psychosocial items were included (−0.17–−0.25). The multiple regressions were repeated with these new dependent variables (see Table 10). The proportion of variance explained by the three physical performance measures was significant for all outcomes. The proportion of variance explained by the physical measures together increased from 9% to 17%. The 5-minute walk uniquely predicted all outcomes in the final equations of the regression analyses. As before, the 1-minute sit–stand and the 1-minute stairs did not uniquely predict any of the self-report outcomes. (For interest, multiple regressions were performed on the remaining psychosocial items of the BPIIS and WSAS. None of the physical performance measures individually predicted the dependent variables any longer. All three physical performance measures together were only predictive of the WSAS psychosocial subset ($\Delta R^2 = 0.045$), although this was no longer significant when missing data were excluded pairwise.)

Discussion

The purpose of this study was to examine directly assessed measures of physical functioning developed for use on PMPs in relation to currently used self-report measures. To summarise the findings, the performance measures were demonstrated to offer a clinically relevant assessment that is partially distinct to self-report measures of general health and functioning (BPIIS, WSAS and PHQ-9). The factor structure

Table 9. Regression analyses of pre- to post-treatment changes in patient functioning in relation to years of education, changes in average pain intensity and changes in physical performance measures (n = 133).

Model	Predictors	Coefficients – standardised beta	ΔR^2	F change
ΔBPIIS				
1	Years of education	0.08	0.02	$F(1, 174) = 2.65$
2	ΔPain intensity last week	**0.40****	0.20	$F(1, 173) =$ **44.20****
3	Δ5-minute walk	**−0.23****	0.08	$F(3, 170) =$ **6.00****
	Δ1-minute sit–stand	0.04		
	Δ1-minute stairs	−0.12		
ΔWSAS				
1	Years of education	−0.02	0.002	$F(1, 117) = 0.24$
2	ΔPain intensity last week	**0.34****	0.14	$F(1, 116) =$ **18.45****
3	Δ5-minute walk	**−0.25***	0.12	$F(3, 113) =$ **5.93****
	Δ1-minute sit–stand	−0.08		
	Δ1-minute stairs	−0.07		
ΔPHQ-9				
1	Years of education	0.10	0.02	$F(1, 170) = 2.85$
2	ΔPain intensity last week	**0.35****	0.16	$F(1, 169) =$ **32.82****
3	Δ5-minute walk	**−0.18***	0.08	$F(3, 166) =$ **5.81****
	Δ1-minute sit–stand	−0.13		
	Δ1-minute stairs	−0.02		

BPIIS: Brief Pain Inventory–Interference Scale; WSAS: Work and Social Adjustment Scale; PHQ: Patient Health Questionnaire.
*$p < 0.05$; **$p < 0.01$.

Table 10. Regression analyses of self-reported patient functioning in relation to age, pain intensity and physical performance measures using the physical activity items at pre-treatment.

Model	Predictors	Coefficients – standardised beta	ΔR^2	F change
BPIIS (walking ability item only)				
1	Age	0.03	0.03	$F(1, 180) =$ **5.15***
2	Pain intensity last week	**0.22****	0.10	$F(1, 179) =$ **21.54****
3	5-minute walk	**−0.32****	0.17	$F(3, 176) =$ **14.43****
	1-minute sit–stand	−0.06		
	1-minute stairs	−0.08		
BPIIS (general activity, walking ability and work items only)				
1	Age	0.02	0.03	$F(1, 180) =$ **4.62***
2	Pain intensity last week	**0.33****	0.17	$F(1, 179) =$ **36.55****
3	5-minute walk	**−0.27***	0.10	$F(3, 176) =$ **8.13****
	1-minute sit–stand	−0.11		
	1-minute stairs	0.02		
WSAS (work and home management items)				
1	Age	−0.02	0.01	$F(1, 178) = 1.33$
2	Pain intensity last week	**0.15***	0.05	$F(1, 177) =$ **8.47****
3	5-minute walk	**−0.35****	0.09	$F(3, 174) =$ **6.00****
	1-minute sit–stand	0.03		
	1-minute stairs	0.02		

BPIIS: Brief Pain Inventory–Interference Scale; WSAS: Work and Social Adjustment Scale.
*$p < 0.05$; **$p < 0.01$.

of the physical performance measures shows that the three performance measures represent one single underlying dimension with excellent internal consistency. In addition, the regression analysis on the three physical measures using the 5-minute walk as the dependent variable demonstrated that 67.3% of variance in the 5-minute walk test can be explained by the other two performance measures. Taken together, these analyses provide evidence that there is a high degree of overlap between the three physical performance measures. Such overlap could provide justification for assessing only one or two of the measures, if time and resource constraints required this.

All three physical performance measures significantly correlated with the self-report measures of functioning (BPIIS, WSAS and PHQ-9) in the expected direction. However, the magnitude of these correlations was not so high as to suggest redundancy. Multiple regressions showed that together the physical measures significantly predicted variance in self-report outcomes. However, only the 5-minute walk demonstrated a significant unique contribution. It is likely that the high degree of overlap between the performance measures limited their ability to each contribute unique variance to the prediction of self-report measures.

All three physical performance measures showed statistically significant improvements following treatment with moderate effect sizes following a PMP. Correlation and regression analyses for the pre- to post-treatment change scores showed a similar pattern of results found in the pre-treatment analyses. For example, increases in distance walked scores pre–post treatment were correlated with a decrease in BPIIS scores pre–post treatment. The proportion of variance explained was also significant when change scores pre–post treatment were examined. The 5-minute walk consistently showed the largest overlap with self-reports in multivariate analyses, whereas the 1-minute sit–stand and 1-minute stair tests did not uniquely predict any of these. The correlation between number of years of education and pre–post changes in the performance measures was small. This finding is consistent with a recent systematic review that found evidence that number of years of education is a predictor of treatment effect in patients having therapist-delivered interventions for low back pain.[34]

The results of this study extend the original analysis[7] of the three performance measures by describing (1) their factor structure and (2) their relationship with commonly used current self-report measures. The results are consistent with previous studies in recognising that directly assessed physical performance measures in people with chronic pain can make a unique contribution to the prediction of self-reported physical functioning, and extend these findings by examining multiple regression analyses in addition to zero-order correlations.[8,15,16] Taken together, the results of this study provide further evidence that multi-method approaches demonstrate a more comprehensive assessment of physical functioning and that analysing data on both performance and self-report measures provides different but related information.

There are several limitations to all measures, whether self-report or performance. Importantly, these measures are all a small snapshot in time and context and do not necessarily reflect how a person functions in different situations, particularly outside a treatment environment. As such, the generalisability and real-world utility of these measures may be limited. Future research is needed to examine the generalisability of the current findings to other assessment and treatment contexts, such as outpatient physiotherapy clinics where patients receive less intensive rehabilitation than that delivered in this study. In addition, there are both internal and external influences that can alter the reliability of the test. For example, performing a test on a first day of the programme when the person is unsure of the task and does not know the therapist or the environment is fundamentally different to a final day measure where there is familiarity with both the therapist and the test. Interestingly, work by Smeets et al.[12] showed that task experience on physical performance measures, including those under investigation in this study, did not significantly influence test–retest differences. Another limitation of this study is that although the performance measures (walking, standing from a chair and climbing stairs) are functional activities, they are not necessarily relevant to every patient, or specific enough, or a measure of the day-to-day activities that people with chronic pain struggle with most. For example, these measures might not capture functional limitations relevant to a person with an upper limb condition. Moreover, a person may manage each task individually and not normally carry out three tasks in sequence. Future measures could be considered that explore more specific issues related to each individual, one example being the Patient-Specific Functional Scale.[35]

Despite these limitations, the measures investigated in this study reflect activities that are common for many people, and they did show change pre–post treatment. In these ways, they appear relevant within the clinical context of a PMP. Changes in behaviour such as walking further and doing more stairs can represent a helpful feedback mechanism, creating a ‘context of improvement’, a demonstrated experience that pain and functioning have not stayed the same. However, the performance measures examined in this study do not assess the *processes* mediating these experienced changes. It would appear to be an even more potent therapeutic experience if the treatment participants could see that they improved and to also see by what means.

Recent developments in psychological approaches to chronic pain place a key emphasis on the processes by which treatment-related change occurs. For example, current treatments based on the PF model and ACT help people make meaningful changes by skilling them to carry out values-based activities in the presence of pain and distress.[29–31] People with chronic pain are taught skills in openness to experiences (including painful sensations and emotions) and awareness so that they can make active and conscious choices regarding their actions. Such dimensions are captured by ACT self-report process measures such as the Committed Action Questionnaire[36,37] and the Chronic Pain Acceptance Questionnaire.[38] Changes in these dimensions are not captured in the physical performance measures examined in this study. For example, someone might walk at the same speed before and after treatment. Before treatment, they might be desperately waiting for the task to be over, whereas after treatment they are more mindful, open and connected to the task and the discomfort that may accompany it. Or someone might choose simply not to do a task because it is not values-consistent in preference of an activity that is values-consistent. These changes would not be captured by measures of only time or amount. Creating a physical performance measure that is sensitive to treatment process is likely to be beneficial and aid treatment development in future. Even so, such a measure, sensitive to both the form and 'functions' of behaviour, is difficult to conceive.

In conclusion, this study confirms that the three individual physical performance measures assess similar aspects of physical functioning and that it appears useful to assess and report on these in conjunction with currently used self-report measures. Should time and resource constraints require it, there are justifications for reducing the number of physical measures performed as there is a degree of overlap between the three examined here. Recognising the limitations to measuring physical functioning in vivo, it is recommended that a performance measure is developed that captures quality of movement, is sensitive to treatment process and can be used in tandem with self-report.

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References

1. British Pain Society. Guidelines for pain management programmes for adults. *Report, British Pain Society, London, UK*, 2013.
2. Kamper SJ, Apeldoorn AT, Chiarotto A, et al. Multidisciplinary bio-psycho-social rehabilitation for chronic low back pain. *Cochrane Database Syst Rev* 2014; 9: CD000963.
3. Williams A, Eccleston C and Morley S. Psychological therapies for the management of chronic pain (excluding headache) in adults. *Cochrane Database Syst Rev* 2012; 11: CD007407.
4. Dworkin RH, Turk DC, Farrar JT, et al. Core outcome measures for chronic pain clinical trials: IMMPACT recommendations. *Pain* 2005; 113: 9–19.
5. Turk DC, Dworkin RH, Allen RR, et al. Core outcome domains for chronic pain clinical trials: IMMPACT recommendations. *Pain* 2003; 106: 337–345.
6. Turk DC, Dworkin RH, Revicki D, et al. Identifying important outcome domains for chronic pain clinical trials: an IMMPACT survey of people with pain. *Pain* 2008; 137: 276–285.
7. Harding VR, Williams AC, Richardson PH, et al. The development of a battery of measures for assessing physical functioning of chronic pain patients. *Pain* 1994; 58: 367–375.
8. Simmonds MJ, Olson SL, Jones S, et al. Psychometric characteristics and clinical usefulness of physical performance tests in patients with low back pain. *Spine* 1998; 23(22): 2412–2421.
9. Novy DM, Simmonds M and Lee CE. Physical performance tasks: what are the underlying constructs? *Arch Phys Med Rehabil* 2002; 83: 44–47.
10. Fisher AG. *Assessment of motor and process skills: development, standardisation, and administration manual*, vol. 1. Fort Collins, CO: Three Star Press, 2006.
11. Waehrens EE, Amris K and Fisher AG. Performance-based assessment of activities of daily living (ADL) ability among women with chronic widespread pain. *Pain* 2010; 150: 535–541.
12. Smeets RJ, Hijdra HJ, Kester AD, et al. The usability of six physical performance tasks in a rehabilitation population with chronic low back pain. *Clin Rehabil* 2006; 20: 989–998.
13. Mayer TG, Barnes D, Kishino ND, et al. Progressive isoinertial lifting evaluation. I. A standardized protocol and normative database. *Spine* 1988; 13(9): 993–997.
14. Mayer TG, Barnes D, Nichols G, et al. Progressive isoinertial lifting evaluation. II. A comparison with isokinetic lifting in a disabled chronic low-back pain industrial population. *Spine* 1988; 13(9): 998–1002.
15. Lee CE, Simmonds M, Novy DM, et al. Self-reports and clinician-measured physical function among patients with low back pain: a comparison. *Arch Phys Med Rehabil* 2001; 82(2): 227–231.
16. Wittink H, Rogers W, Sukiennik A, et al. Physical functioning: self-report and performance measures are related but distinct. *Spine* 2003; 28(20): 2407–2413.
17. Burckhardt CS, Clark SR and Bennett RM. The fibromyalgia impact questionnaire: development and validation. *J Rheumatol* 1991; 18: 728–733.
18. Lacker JM, Carosella AM and Feuerstein M. Pain expectancies, pain, and functional self-efficacy expectancies as determinants of disability in patients with chronic low back disorders. *J Consult Clin Psychol* 1996; 64: 212–220.

19. Kaplan GM, Wurtele SK and Gillis D. Maximal effort during functional capacity evaluations: an examination of psychological factors. *Arch Phys Med Rehabil* 1996; 77: 161–164.
20. Smeets REM, Van Geel AC, Kester AD, et al. Physical capacity tasks in chronic low back pain: what is the contributing role of cardiovascular capacity, pain and psychological factors. *Disabil Rehabil* 2007; 29(7): 577–586.
21. Vowles KE, Witkiewitz K, Sowden G, et al. Acceptance and commitment therapy for chronic pain: evidence of mediation and clinically significant change following an abbreviated interdisciplinary program of rehabilitation. *J Pain* 2014; 15(1): 101–113.
22. McCracken LM, Vowles KE and Eccleston C. Acceptance-based treatment for persons with complex, long standing chronic pain: a preliminary analysis of treatment outcome in comparison to a waiting phase. *Behav Res Ther* 2005; 43: 1335–1346.
23. Vowles KE and McCracken LM. Acceptance and values-based action in chronic pain: a study of treatment effectiveness and process. *J Consult Clin Psychol* 2008; 76: 397–407.
24. Smith JG, Knight L, Stewart A, et al. Clinical effectiveness of a residential pain management programme–comparing a large recent sample with previously published outcome data. *Br J Pain* 2016; 10(1): 46–58.
25. Cleeland CS and Ryan KM. Pain assessment: global use of the Brief Pain Inventory. *Ann Acad Med Singapore* 1994; 23(2): 129–138.
26. Tan G, Jensen M, Thornby JI, et al. Validation of the Brief Pain Inventory for chronic nonmalignant pain. *J Pain* 2004; 5(2): 133–137.
27. Mundt JC, Marks IM, Shear MK, et al. The Work and Social Adjustment Scale: a simple measure of impairment in functioning. *Br J Psychiatry* 2002; 180(5): 461–464.
28. Kroenke K, Spitzer RL and Williams JB. The PHQ-9. *J Gen Intern Med* 2001; 16(9): 606–613.
29. Hayes SC, Strosahl KD and Wilson KG. *Acceptance and commitment therapy: an experiential approach to behavior change*. New York: Guilford Press, 1999.
30. Hayes SC, Strosahl KD and Wilson KG. *Acceptance and commitment therapy: the process and practice of mindful change*. 2nd ed. New York: Guilford Press, 2012.
31. McCracken LM and Vowles KE. Psychological flexibility and traditional pain management strategies in relation to patient functioning with chronic pain: an examination of a revised instrument. *J Pain* 2007; 8(9): 700–707.
32. Cohen J. A power primer. *Psychol Bull* 1992; 112: 155–159.
33. Hutcheson GD and Sofroniou N. *The multivariate social scientist: introductory statistics using generalized linear models*. London: SAGE, 1999.
34. Gurung T, Ellard DR, Mistry D, et al. Identifying potential moderators for response to treatment in low back pain: a systematic review. *Physiotherapy* 2015; 101: 243–251.
35. Stratford P, Gill C, Westaway M, et al. Assessing disability and change on individual patients: a report of a patient specific measure. *Physiother Can* 1995; 47: 258–263.
36. McCracken LM. Committed action: an application of the psychological flexibility model to activity patterns in chronic pain. *J Pain* 2013; 14(8): 828–835.
37. McCracken LM, Chilcot J and Norton S. Further development in the assessment of psychological flexibility: a shortened Committed Action Questionnaire (CAQ-8). *Eur J Pain* 2015; 19(5): 677–685.
38. McCracken LM, Vowles KE and Eccleston C. Acceptance of chronic pain: component analysis and a revised assessment method. *Pain* 2004; 107(1–2): 159–166.