ORIGINAL REPORT

RELATIONSHIP BETWEEN SUBJECTIVELY-RATED AND OBJECTIVELY-TESTED PHYSICAL FUNCTION ACROSS SIX DIFFERENT MEDICAL DIAGNOSES

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Objective: To quantify and compare associations and relationships between self-rated and tested assessments of mainly mobility-related physical function in different diagnoses.
***Design:* Six longitudinal cohort studies before and after inpatient rehabilitation.**
***Patients:* Patients with whiplash-associated disorder (*n* = 71), low back pain (*n* = 121), fibromyalgia (*n* = 84), lipoedema (*n* = 27), lymphoedema (*n* = 78), and post-acute coronary syndrome (*n* = 64).**
***Methods:* Physical function was measured with the self-rated Short-Form 36 Physical functioning (SF-36 PF) and with the tested 6-Min Walk Distance (6MWD) and assessed by correlation coefficients. Across the 6 cohorts, the relationship between the 2 scores was compared using the ratio between them.**
***Results:* The correlations between the 2 scores were mostly moderate to strong at baseline (up to r = 0.791), and weak to moderate for the changes to follow-up (up to r = 0.408). The ratios SF-36 PF to 6MWD were 1.143–1.590 at baseline and 0.930–3.310 for the changes, and depended on pain and mental health.**
***Conclusion:* Moderate to strong cross-sectional and moderate to weak longitudinal correlations were found between the 6MWD and the SF-36 PF. Pain and mental health should be considered when interpreting physical function. For a comprehensive assessment in clinical practice and research, the combination of self-rated and tested physical function measures is recommended.**

Key words: Patient-reported outcome measures; performance-based measurement; 6-min walk test; SF-36; walking.

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LAY ABSTRACT

This study compared 2 standard measurements of physical function in 6 different patient groups undergoing rehabilitation: whiplash-associated disorder, low back pain, fibromyalgia, lower limb lipoedema and lymphoedema, and post-acute coronary syndrome. All patients subjectively assessed their physical functioning with a questionnaire and were tested objectively by an assessor. The ratios of the 2 measurements depended on pain and mental health. Patients with less pain and better mental health self-rated their physical functioning more optimistically. Pain and mental health should therefore be considered when interpreting physical function measurements and especially when comparing different medical diagnoses. Treatment of pain and mental health may improve both subjectively and objectively rated physical function. One of the 2 assessments is sufficient for measuring physical function, but for a comprehensive assessment in clinical practice and research, the combination of self-rated and tested physical function measures is recommended.

Physical functioning is defined as "the ability to perform the basic actions that are essential for maintaining independence and carrying out more complex activities" (1). A certain level of physical functioning is needed for maintaining independence and independent living in the community and is associated with several physical and mental health-related factors (1, 2). Physical functioning is often limited by the consequences of medical diagnoses and is therefore of particular relevance in healthcare, pain medicine, physiotherapy, and rehabilitation (1). Walking is an important physical function and a regular component of various complex activities of daily living. It allows not only relocation from one place to another, but is an integral part of everyday activities, such as household chores, shopping, working, and social and recreational pursuits (1, 3). Walking also has the effect of lowering the rates of chronic diseases while entailing only a modest risk of injury; thus it also has an important role in disease prevention and public health (4).

Patient-reported outcome measurements (PROMs) and performance-based measures (PBMs) are commonly used and recommended in research and clinical practice to evaluate (physical) functioning (5–8). The quantification of walking/leg function is important for assessing outcomes and measuring changes when evaluating rehabilitative and physiotherapeutic interventions. A combination of the subjectively-rated PROMs and the objectively-tested PBMs is recommended for assessing physical functioning, as each provides important, but different and complementary, information (5, 6, 9, 10). Both measures are influenced by various cofactors, such as pain and mental health dimensions (11). Several studies have analysed the relationship between PROMs and PBMs in the evaluation of walking performance in different cohorts (8, 10–15). Some reported moderate to high (8, 11, 15), others weak to moderate correlations (13, 14, 16, 17). Most of these results were based on cross-sectional studies and all included only 1 distinct population.

The aims of the current study were: (*i*) to quantify the associations and relationships between a PROM (Medical Outcomes Study Short Form 36 Health Survey (SF-36) Physical functioning scale) and a PBM (6-Min Walk Distance test; 6MWD), focusing specifically on physical function both cross-sectionally and longitudinally; and (*ii*) to compare the results across 6 different diagnoses, including the association with the cofactors pain and mental health measured by the SF-36. This is, to our knowledge, the first study to compare the association between PROMs and PBMs in the assessment of physical function in 6 populations with different medical diagnoses before and after inpatient rehabilitation.

METHODS

Patients

Patients were recruited at the rehabilitation clinic "Rehaklinik" in Bad Zurzach, Switzerland. They were referred by their family physician or a medical specialist to a specialized inpatient rehabilitation intervention tailored to their main medical diagnosis. The 6 cohorts comprised: (*i*) patients with whiplash-associated disorders (WAD) ($n=71$) who participated in the Zurzach Interdisciplinary Cervical Spine (Halswirbelsäule) concept (ZIHKo) (16); (*ii*) patients with low back pain ($n=121$) and (*iii*) those with fibromyalgia ($n=84$) who were treated in the Zurzach Interdisciplinary Pain (Schmerz) Program (ZISP) (17); (*iv*) patients with lower limb lipoedema ($n=27$) and (*v*) those with lymphoedema ($n=78$) of the lower extremity who took part in a complex physical decongestive therapy programme (18); and (*vi*) patients, who, after hospital treatment for acute coronary syndrome, participated in a multidisciplinary cardiac rehabilitation programme (post-acute coronary syndrome (post-ACS); $n=64$) (19).

The inclusion criteria for each programme together with the details of medical treatment can be found in the published reports on the individual cohorts (16–19). Differences between the numbers of participants (n) included in the previous studies and in the current study are the result of the continuous recruitment of patients according to the inclusion criteria described in each publication. The study was approved by the ethics committee of Aarau, Canton Aargau, Switzerland (EK AG 2008/026) and written informed consent was obtained from all participants.

Measurements

Data were collected on the day of patients' admission to the clinic (baseline) before the start of their treatment, and before their discharge from the clinic at the end of the treatment (follow-up). Sociodemographic data were recorded at admission on a standardized form used in many previous studies (9, 16–20). Comorbidities were retrieved from the patient's medical history. To quantify physical function, the 6MWD was used as an "objective", examiner-guided measurement in combination with the "subjective" self-reported physical activity measurement, the SF-36 Physical functioning scale (Table I).

Physical function by 6-Min Walk Distance

The 6MWD test is a PBM that assesses physical functioning objectively; it is easy to perform and requires minimal equipment (7, 21). Initially, the 6MWD was developed for measuring cardiorespiratory fitness, but it is also an objective measurement of functional performance, integrating the response of all body systems involved in endurance walking (7, 21). The test is widely used to evaluate functional capacity and response to medical interventions in chronic respiratory diseases, rheumatic diseases, chronic pain trials, and other disorders (6, 7, 21). Its psychometric properties have been tested in different populations (7, 22–24). The 6MWD measures the distance walked on a flat, 100 m stretch. The patient is asked to walk as far as possible in 6 min. In this study, the test was conducted on a 100-m flat stretch marked out in a hallway, with marked 5-m intervals. No practice tests were performed to shorten the time required for the 6MWD.

Medical Outcomes Study Short-Form 36 Health Survey

The SF-36 rates health-related quality of life subjectively; it is a comprehensive measure, covering physical, mental and psychosocial dimensions (25). It is a commonly used and widely recommended generic patient-reported outcome measurement (PROM) for a variety of medical conditions (26, 27). The clinimetric quality of the SF-36 has been broadly tested and proven in various settings (26–28). The 36 items are categorized in 8 health domains, namely Bodily pain, Physical functioning, Role physical, General health, Vitality, Social functioning, Role emotional, and Mental health. In this study, the validated German version of the SF-36 scales Physical functioning, Bodily pain, and Mental health was used to quantify walking, pain, and mental health (Table I) (25, 29, 30).

Table I. Item content and construct of the outcome scales

Outcome scale	No. of items	Scale	Content/construct		Walking/ moving around	Activities of lower extremities excluding walking	ICF category (31)
6MWD	1	Continuous	6-Min Walk Distance: instructed, assisted, and timed by physiotherapists		×		b455 Exercise tolerance functions/d4501 Walking long distances
SF-36 Physical functioning	10	3 item levels	Instruction: The following questions are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?	Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports	(×)	(×)	d4552 Running/d4300 Lifting/ d9201 Sports
				Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	(×)	×	d430 Lifting and carrying objects/ d6403 Using household appliances/ d9201 Sports/d6402 Cleaning living area
				Lifting or carrying groceries	(×)	×	d430 Lifting and carrying objects
				Climbing several flights of stairs	×		d4551 Climbing
				Climbing one flight of stairs	×		d4551 Climbing
				Bending, kneeling, or stooping		×	d4101 Squatting/d4102 Kneeling/ d4105 Bending
				Walking more than one km	×		d4501 Walking long distances
				Walking several hundred m	×		d4501 Walking long distances
				Walking hundred meters	×		d4501 Walking long distances
				Bathing and dressing yourself		×	d510 Washing oneself/d540 Dressing
SF-36 Bodily pain	2	6 item levels	How much bodily pain have you had during the past 4 weeks?				b280 pain
		5 item levels	During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?		(×)	(×)	b280 pain
SF-36 Mental health	5	6 item levels	Instruction: These questions are about how you feel and how things have been with you during the last 4 weeks. For each question, please give the answer that comes closest to the way you have been feeling.	Have you been a very nervous person?			b152 Emotional functions (nervous)
				Have you felt so down in the dumps that nothing could cheer you up?			b152 Emotional functions (feel down)
				Have you felt calm and peaceful?			b1263 Psychic stability
				Have you felt downhearted and blue?			b1265 Optimism (blue)
				Have you been a happy person?			b152 Emotional functions

6MWD: 6-Min Walk Distance; SF-36: Short-Form 36; ICF: International Classification of Functioning, Disability and Health.

Physical function by the SF-36 Physical functioning scale

The SF-36 Physical functioning scale consists of 10 items and quantifies limitations in activities of daily living due to health problems (25). Overall, 5(–8) of the 10 items of the SF-36 Physical functioning scale ask the respondent about walking and moving around, specifying different walking distances and numbers of stairs (Table I). A further 4(–5) items involve lower extremity activities (excluding walking); for example, moving a table, kneeling, and dressing. Four items also comprise activities of the upper extremities and/or the back/trunk. Thus, the SF-36 Physical functioning scale is related to domains of activities and participation according to the International Classification of Functioning, Disability and Health (ICF) terminology including d4 (mobility), d5 (self-care), d6 (domestic life) and d9 (community, social and civic life) and most items are related with mobility (d4) (31).

SF-36 Bodily pain and SF-36 Mental health

The SF-36 Bodily pain scale consists of 2 items quantifying pain intensity and pain interference at home and at work. The SF-36 Mental health scale consists of 5 items measuring psychological distress; it has been demonstrated to have high validity in the measurement of depression (32).

An overview of the measurement scales, including details of item content in relation to walking/moving around or activities of the lower extremities, is provided in Table I.

Analysis

Descriptive statistics. Only complete data-sets were included for analysis in this study. All scores of the SF-36 health domains were scaled from 0 to 100 points, where 0 points indicates the greatest possible limita tion/depression/pain and 100 points represents no limitation/depression/pain at all; this is the original scaling of the SF-36 (25, 29, 30). The 6MWD was quantified in m. Based on the results of several population studies of healthy adults from various countries, all patients with test results of ≥800 m in the 6MWD were excluded from our investigation, because beyond that distance the persons tested were running not walking (33).

Descriptive score and walking distance data are presented at baseline (entry into the clinic), at the follow-up (discharge) 3–4 weeks after baseline, and for the difference between the 2 time-points. Parametric Pearson correlation coefficients were calculated between the SF-36 Physical functioning and the 6MWD and to quantify the agreement between the self-assessed and the tested physical function. This is also a measure of the construct overlap (5, 9, 15). The exclusion of zero from the 95% confidence interval (95% CI) means that the correlation is statistically different from zero with 95% confidence.

Relationship between subjective and objective physical function

The relationship between the self-rated (subjective) and the tested (objective) measures of physical function was expressed as the quotient or ratio of the SF-36 Physical functioning score divided by the 6MWD score divided by 10. This is a novel concept, designed for this study and not previously conceptualized in the literature. One point on the SF-36 Physical functioning scale reflects 10-m distance in the 6-min walk test if the quotient is 1.000 (or ratio 1:1). High ratios can be interpreted as indicating that individuals rated their walking ability/leg function relatively optimistically in relation to the 6MWD test distance, whereas low ratios reflected a relatively pessimistic rating. Outliers with ratios $>+50/<-50$ were excluded in order to achieve more balanced estimates. In each of the 6 cohorts, 0–3 outliers were excluded. The ratios across the 6 cohorts were compared pairwise by the *t*-test for statistical significance, which was defined by the 2-sided $p=0.05$ level consistent with the 95% CIs.

Across the 6 cohorts examined, the relationships between the Pearson correlations of the SF-36 Physical functioning to the 6MWD, the ratios SF-36 Physical functioning to the 6MWD, and the mean score levels of the 6MWD, SF-36 Physical functioning, SF-36 Bodily pain, and SF-36 Mental health were compared using Spearman rank correlation coefficients. The purpose was to detect associations with and/or interrelationships between the ratio of subjective/objective physical function and the Pearson correlation between subjective and objective physical function. This analysis was conducted for both the baseline scores and the change scores between baseline and follow-up. The non-parametric Spearman rank correlation was used because the 6 Pearson correlations, the ratios and the mean scores of pain and mental health did not represent a symmetrical distribution/normal distribution.

A correlation determines the strength and direction of a relationship between 2 variables. Although there is no generally valid definition for the strength of correlation coefficients, a coefficient >0.75 can be considered an excellent, >0.50 a moderate to good, and >0.25 a fair association. A correlation coefficient between 0.00 and 0.25 indicates little or no relationship between variables (34). This classification addresses clinical relevance. Clinical relevance is a dependent complement to the statistical relevance of a correlation. Statistical significance is expressed if 0 is excluded by the 95% CI of the correlation coefficient, which is dependent on the sample size. On the other hand, the 95% CI is the interval estimate of the size of the true correlation with 95% confidence. Statistical significance is a necessary, but not sufficient, criteria for clinical relevance. The clinical relevance is expressed by the explained variance of 1 variable by the other, which is the square of the correlation, e.g. 25% if the correlation is 0.50.

High correlations in our analysis show, for example, whether the optimistic, self-rated level of physical function (the quotient) was dependent on the level of correlation (SF-36 Physical functioning to 6MWD) or on the baseline levels of function, pain or mental health (on the SF-36). The differences between 2 correlations were pairwise tested for statistical significance by the *t*-test using the z-transformation according to R.A. Fischer (35). All analyses were performed using the statistical software package IBM SPSS 28.01 for Windows® (SPSS Inc., Chicago, IL, USA).

RESULTS

Sociodemographic and disease relevant data

The sociodemographic characteristics and disease relevant data of the 6 patient cohorts are reported in Table II. The WAD cohort ($n=71$) were the youngest and had the fewest comorbidities and the lowest body mass index (BMI). Of the chronic pain patients, those with low back pain ($n=121$) had the lowest educational attainment level and included a sizeable proportion of individuals living alone. The fibromyalgia cohort ($n=84$) were predominately female and living with a partner or in a family; a large proportion were educated to vocational training level. All the patients with lipoedema ($n=27$) were female, had a high BMI, were predominately living alone and had a relatively high number of comorbidities. Similar characteristics were found in the lymphoedema cohort ($n=78$), which included a small proportion of males. The cohort with the post-ACS ($n=64$) were the oldest, were predominantly male and had the highest level of educational attainment and the largest proportion of patients with comorbidities.

Outcome, correlation, and ratio data

Baseline, follow-up and change scores of the 6MWD and SF-36 Physical functioning, Bodily pain, and

Table II. Sociodemographic and disease relevant data of cohorts

Diagnosis	Whiplash-associated disorder	Low back pain	Fibromyalgia	Lower limb lipoedema	Lower limb lymphoedema	Post-acute coronary syndrome
Intervention	Interdisciplinary inpatient pain programme ZIHKo	Interdisciplinary inpatient pain programme ZISP	Interdisciplinary inpatient pain programme ZISP	Comprehensive inpatient rehabilitation	Comprehensive inpatient rehabilitation	Comprehensive inpatient rehabilitation
Length of stay (days): mean (SD)	26.6 (3.0)	27.9 (1.5)	27.9 (0.4)	18.9 (2.9)	20.2 (4.9)	21.9 (6.1)
Patients (*n*)	71	121	84	27	78	64
Age (years): mean (SD)	40.7 (12.2)	49.0 (12.1)	48.5 (9.4)	50.8 (13.8)	59.4 (15.3)	65.9 (10.2)
Female (%)	64.8	61.2	88.1	100	78.2	21.9
BMI (kg/m^2): mean (SD)	25.9 (5.3)	27.3 (5.0)	27.5 (5.6)	40.5 (9.3)	30.5 (8.9)	26.2 (4.2)
Living alone (%)	19.7	28.1	15.5	55.6	33.3	40.6
Education (%)						
Compulsory schooling (8–9 years)	11.3	31.4	20.2	18.5	9.0	15.6
Vocational training	60.6	50.4	56.0	51.9	59.0	39.1
Upper secondary/ university	28.1	18.2	23.8	29.6	32.0	45.3
Comorbidities (%)						
0	14.1	9.9	3.6	3.7	5.1	3.1
1	22.5	23.1	7.1	14.8	15.4	6.3
2	22.5	23.1	20.2	14.8	10.3	10.9
3	16.9	18.2	15.5	14.8	24.4	15.6
≥4	24.0	25.7	53.6	51.9	44.8	64.1

n: number of cases; SD: standard deviation; BMI: body mass index: ZIHKo: Zurzach Interdisciplinary Cervical Spine (Halswirbelsäule) concept; ZISP: Zurzach Interdisciplinary Pain (Schmerz) Program.

Mental health scales are shown in Table III. At baseline (entry into the clinic), the distance walked in 6 min ranged from 364.5 m (SD 124.7 m) in the post-ACS group to 496.7 m (SD 116.9 m) in the WAD group. Baseline SF-36 Physical functioning scores were relatively high in the lymphoedema cohort (mean score 69.8) compared with the other cohorts, indicating relatively few limitations in physical functioning (100=no limitations). The WAD (59.7), lipoedema (53.0), and post-ACS cohorts (51.9) had similar scores, whereas those with low back pain (43.6) and fibromyalgia (45.1) scored lowest on physical functioning. Baseline SF-36 Bodily pain was somewhat associated with SF-36 Mental health, with the highest bodily pain intensity (18.0) and low mental health (49.6) in the WAD cohort and low pain intensity (60.8) and good mental health (76.7) in the cohort with post-ACS. Patients with fibromyalgia showed somewhat less bodily pain (20.1) compared with those with low back pain and WAD, but had a much higher mental health burden (39.8).

After rehabilitation (follow-up), the highest 6MWD scores were found in the WAD group (544.9 m) and the shortest distance walked in the low back pain group (423.8 m). The fibromyalgia (51.5) and low back pain (51.5) groups had the lowest and identical scores in the SF-36 Physical functioning (=greatest limitation), whereas lymphoedema (76.3) showed the highest score (=least limitation). SF-36 Bodily pain and Mental health scores were lowest in the fibromyalgia (27.5/49.5) and low back pain (28.3/59.8) cohorts and highest in the post-ACS cohort (79.3/83.5).

A comparison of the score changes shows improvements in all measures. The greatest improvements in the 6MWD were measured in the post-ACS cohort (120.7 m); the smallest in the fibromyalgia group (27.3 m). The same pattern was seen in SF-36 Physical functioning and Bodily pain scales, with a change of 6.4, and 7.3, respectively, in the fibromyalgia cohort, and of 23.4 and 18.4, respectively, in the post-ACS cohort. The greatest improvement in SF-36 Mental health was observed in the WAD and lipoedema cohorts (both 11.5), the smallest in the patients with lymphoedema (6.6). The Pearson correlations (Table III) between the 6MWD and the SF-36 Physical functioning at baseline were all moderate, ranging from r=0.550 for low back pain to r=0.791 for lipoedema. The correlations of the score differences (changes) were weak to moderate, ranging from r=0.129 for lymphoedema to r=0.408 for fibromyalgia. Since 0=no correlation was excluded from the 95% CI, all Pearson correlations were statistically significant, except the correlations of the change in SF-36 Physical functioning to change in 6MWD in the lipoedema, lymphoedema and post-ACS groups. The ratio of the SF-36 Physical functioning score to the 6MWD at baseline (Table III) was lowest in fibromyalgia (1.143), and highest in lymphoedema (1.590). The ratio of the differences was highest in post-ACS (3.310) and lowest in low back pain (0.930).

Correlations across the six cohorts

The Spearman rank correlations across all 6 cohorts of the Pearson correlations of SF-36 Physical functioning baseline score to 6MWD at baseline, the ratios and the 6MWD and SF-36 scores at baseline are shown in Table IV. The Spearman rank correlation of the ratio SF-36 Physical functioning to 6MWD with SF-36 Bodily pain at baseline was r=0.714 and with SF-36

Table III. Outcome, correlation, and ratio data

Diagnosis		Whiplash-associated disorder	Low back pain	Fibromyalgia	Lower limb lipoedema	Lower limb lymphoedema	Post-acute coronary syndrome
Patients (*n*)		71	121	84	27	78	64
6MWD (m)	Baseline: mean (SD)	496.7 (116.9)	377.7 (134.4)	398.2 (131.3)	414.3 (136.9)	452.2 (120.2)	364.5 (124.7)
	Follow-up: mean (SD)	544.9 (117.3)	423.8 (148.2)	425.4 (131.4)	469.1 (127.8)	503.5 (115.1)	485.2 (113.8)
	Change: mean (SD)	48.2 (67.4)	46.1 (99.9)	27.3 (88.4)	54.8 (45.8)	51.3 (47.4)	120.7 (70.8)
SF-36 Physical functioning (score: 0–100)	Baseline: mean (SD)	59.7 (18.3)	43.6 (16.3)	45.1 (19.2)	53.0 (22.7)	69.8 (20.3)	51.9 (23.5)
	Follow-up: mean (SD)	68.2 (19.6)	51.5 (19.8)	51.5 (21.3)	63.3 (23.5)	76.3 (18.3)	75.3 (17.2)
	Change: mean (SD)	8.5 (12.4)	7.9 (16.1)	6.4 (16.0)	10.4 (13.0)	6.5 (11.5)	23.4 (20.1)
SF-36 Bodily pain (score: 0–100)	Baseline: mean (SD)	18.0 (13.3)	18.4 (13.0)	20.1 (12.6)	32.3 (21.4)	61.3 (27.3)	60.8 (28.6)
	Follow-up: mean (SD)	32.4 (17.8)	28.3 (14.4)	27.5 (16.1)	49.2 (22.0)	71.6 (27.9)	79.3 (23.2)
	Change: mean (SD)	14.4 (15.3)	9.8 (13.6)	7.3 (16.5)	16.9 (14.6)	10.2 (19.8)	18.4 (24.9)
SF-36 Mental health (score: 0–100)	Baseline: mean (SD)	49.6 (18.3)	49.8 (20.8)	39.8 (20.3)	60.0 (21.3)	69.4 (18.5)	76.7 (17.2)
	Follow-up: mean (SD)	61.1 (19.4)	59.8 (20.2)	49.5 (22.2)	71.5 (19.7)	76.0 (14.2)	83.5 (16.5)
	Change: mean (SD)	11.5 (13.0)	10.1 (18.7)	9.6 (14.5)	11.5 (16.1)	6.6 (14.0)	6.8 (15.4)
Pearson correlation (with 95% CI)	Baseline SF-36 PF to baseline 6MWD	0.686 (0.536, 0.791)	0.550 (0.410, 0.662)	0.680 (0.543, 0.779)	0.791 (0.577, 0.897)	0.607 (0.442, 0.729)	0.570 (0.374, 0.714)
	Change SF-36 PF to change 6MWD	0.284 (0.052, 0.484)	0.363 (0.196, 0.507)	0.408 (0.210, 0.571)	0.208 (–0.190, 0.542)	0.129 (–0.097, 0.341)	0.217 (–0.032, 0.438)
Ratio of SF-36 Physical functioning to 6MWD	Baseline: mean (SD)	1.205 (0.325)	1.289 (0.695)	1.143 (0.430)	1.287 (0.361)	1.590 (0.422)	1.484 (0.624)
	Change: mean (SD)	1.314 (4.589)	0.930 (7.779)	2.099 (6.242)	3.121 (5.592)	2.107 (5.718)	3.310 (5.907)

n: number of cases; SD: standard deviation; follow-up: measurement at the end of the rehabilitation; change: difference follow-up – baseline score; 6MWD: 6-Min Walk Distance test; m: metres; SF-36 PF: SF-36 Physical functioning; Ratio: SF-36 Physical functioning score /(6MWD/10); Scaling of the SF-36 scores: 0 = greatest possible limitation/pain/depression, 100 = no limitation/pain/depression at all; Pearson correlation (with 95% CI): If zero = no correlation is excluded from the 95% confidence interval (95% CI), there is statistical significance on the 1-sided type I error $p = 0.025$.

Mental health at baseline was r = 0.886. Moderately correlated with the Pearson correlation of SF-36 Physical functioning baseline score to 6MWD at baseline were the 6MWD with r = 0.657 and the SF-36 Physical functioning with r = 0.486. SF-36 Physical functioning correlated with r = 0.771 to the 6MWD at baseline.

Table V presents the Spearman rank correlations of the score changes between baseline and follow-up across the 6 cohorts. In contrast to the baseline correlations in Table IV, the score changes of SF-36 Mental health correlated weakly with the Pearson correlation of SF-36 Physical functioning to 6MWD score changes, whereas the correlation of SF-36 Bodily pain score changes was moderate (r = –0.600). The 6MWD and the SF-36 Physical functioning score changes both correlated with the score change of SF-36 Bodily pain with r = 0.943. The SF-36 Physical functioning score change also correlated strongly with the 6MWD score change (r = 0.829). The change in the 6MWD correlated with the Pearson correlation of SF-36 Physical functioning to 6MWD score changes with r = –0.771.

Pairwise significance testing of the correlations and the ratios (subjective to objective physical function) across the six cohorts

At baseline, the correlation of lower limb lipoedema was significantly higher than in low back pain ($p = 0.037$) (Table SI). All other pairwise comparisons showed no significant differences. In the score changes, lower limb lymphoedema showed the lowest correlation and was in trend significantly lower than the highest correlation in fibromyalgia ($p = 0.052$) (Table SII). All other comparisons were pairwise comparable. All the group comparisons between the ratios of the SF-36 Physical functioning to the 6MWD in lower limb lymphoedema were statistically significant, as were 2 in post-ACS at baseline ($p = 0.054$ to < 0.001) (Table SIII). In the score changes, the ratios were significantly

Table IV. Spearman rank correlations across the 6 cohorts of the ratio Short-Form 36 (SF-36)/6-Min Walk Distance (6MWD), and the means of the 6MWD and the SF-36 scores at baseline

	Pearson correlation of SF-36 Physical functioning baseline score to 6MWD at baseline	Ratio of SF-36 Physical functioning score at baseline/ (6MWD at baseline/10)	6MWD	SF-36 Physical functioning	SF-36 Bodily pain	SF-36 Mental health
Pearson correlation of SF-36 Physical functioning baseline score to 6MWD at baseline	1.000	–0.543	0.657	0.486	–0.143	–0.314
Ratio of SF-36 Physical functioning score at baseline/ (6MWD at baseline/10)		1.000	–0.200	0.314	0.714	0.886*
6MWD			1.000	0.771	–0.200	–0.314
SF-36 Physical functioning				1.000	0.371	0.314
SF-36 Bodily pain					1.000	0.771
SF-36 Mental health						1.000

*Significant at the 0.05 level (2-sided).

Table V. Spearman rank correlations across the 6 cohorts of the ratio Short-Form 36 (SF-36)/6-Min Walk Distance (6MWD), and the 6MWD and the SF-36 mean score changes (Follow-up score – baseline score)

	Pearson correlation of SF-36 Physical functioning score change to 6MWD score change	Ratio of SF-36 Physical functioning score change to 6MWD score change	Change 6MWD	Change SF-36 Physical functioning	Change SF-36 Bodily pain	Change SF-36 Mental health
Pearson correlation of SF-36 Physical functioning score change to 6MWD score change	1.000	–0.600	–0.771	–0.371	–0.600	0.200
Ratio of SF-36 Physical functioning score change to 6MWD score change		1.000	0.829*	0.543	0.714	–0.257
Change 6MWD			1.000	0.829*	0.943**	–0.086
Change SF-36 Physical functioning				1.000	0.943**	0.314
Change SF-36 Bodily pain					1.000	0.143
Change SF-36 Mental health						1.000

Change: Follow-up score – baseline score; 6MWD: 6-Min Walk Distance test; *Significant at the 0.05 level (2-sided); **Significant at the 0.01 level (2-sided).

higher than those of the WAD ($p=0.023$) and low back pain ($p=0.027$) (Table SIV).

DISCUSSION

This is the first study to compare the relationship between a self-report or subjective measure of walking/leg function (the SF-36 Physical functioning) and a tested or objective assessment of walking performance (the 6MWD) in 6 different cohorts undergoing specific inpatient rehabilitation. The correlations between the 2 measures were mostly moderate to strong at baseline, and weak to moderate for the baseline to follow-up differences (change). The ratios of the SF-36 Physical functioning to the 6MWD at baseline ranged from 1.143 (baseline; fibromyalgia) to 3.310 (change; post-ACS).

SF-36 Physical functioning to 6MWD ratios

The SF-36 Physical functioning to 6MWD ratios indicated that 1 point on the subjectively rated SF-36 Physical functioning scale corresponded to different objectively measured walking distances in the 6 populations studied. An objectively tested 10-m walking distance was self-rated at baseline at 1.143 points on the SF-36 Physical functioning scale in fibromyalgia and at 1.590 points in lymphoedema. In other words, fibromyalgia patients rated their walking ability/leg function relatively pessimistically and lymphoedema patients relatively optimistically. This is consistent with the relatively pessimistic self-rating of pain and function in patients with fibromyalgia reported in our previous studies (36, 37).

Influence of pain and mental health

The ratios in lymphoedema at baseline and in post-ACS at both baseline and follow-up were much higher than in the other 4 cohorts. Both the lymphoedema and post-ACS cohorts were also characterized by having the lowest pain levels (highest scores on the SF-36 Bodily pain scale). Across all 6 cohorts, pessimistically self-assessed physical function was associated ($r=0.714$) with more severe pain at baseline. Furthermore, those with lymphoedema and post-ACS also had the best mental health, whereas a pessimistic self-assessment of physical function was associated with poorer mental health at baseline ($r=0.886$). Neither pain level nor mental health was the primary reason for the referral of lymphoedema and post-ACS patients for rehabilitation. In contrast, the 4 cohorts with chronic pain diagnoses (WAD, low back pain, fibromyalgia, and lipoedema) showed much higher pain intensities (a difference of 30–40 score points on the SF-36 Bodily pain scale at baseline) and their self-assessed physical function before and after rehabilitation was more pessimistic.

A comparable study in patients with knee osteoarthritis showed that self-assessed function was more dependent on pain and mental health than the knee performance test and was influenced especially by thoughts, emotions, expectations and further cognitive aspects (11). This is consistent with our results that better mental health and less pain were associated with higher ratios between self-assessed and tested walking performance. In low back pain, it was consistently found that mental health exerted a stronger influence on the subjectively-rated PROMs than on physical performance (10). The interdependence of pain and depression (32) and the 2 strong correlations of pain and mental health to the ratios suggest that pain and mental health should be taken into consideration when interpreting the 6MWD in clinical practice or research.

Comparative studies

No previous study has, to our knowledge, assessed and compared the relationship between self-rated and tested physical function across a range of medical diagnoses. Nevertheless, several studies have analysed this relationship in single cohorts, mostly cross-sectionally. In fibromyalgia, the cross-sectional correlation of the 6MWD with the SF-36 Physical functioning scale was fair ($r=0.49$), but lower compared with the current results (r=0.680) (38). In a cardiac rehabilitation population, the 6MWD was moderately correlated with the SF-36 Physical functioning scale (r=0.624), a finding comparable to the current results at baseline (r=0.568) (39).

In a study of women with severe lipoedema the ratios of the SF-36 Physical functioning to the 6MWD were calculated on the basis of the baseline results (40). In the 3 groups of this randomized controlled trial, the ratios ranged from 0.901 to 1.029, all smaller than in our lipoedema group at baseline (ratio=1.268). In a randomized controlled trial of lower extremity lymphoedema, the baseline ratio calculated by the results reported at baseline were 1.200 (intervention group) and 1.327 (control group), which were comparable to the current results of 1.580 at baseline. This can be explained by the fact that that study only reported medians of right-skewed distributions of the 6MWD (being in the denominator of the ratio), which are therefore supposed to be higher than the means, which were used to calculate the ratios of the current study (41). However, the ratios calculated in the 2 studies mentioned are not directly comparable to ours on account of the different inclusion criteria: more advanced disease stages in lipoedema (40) and aqua-lymphatic therapy in the maintenance phase (41).

In studies of acute and chronic low back pain, mostly weak to moderate cross-sectional correlations (ranging from r=0.269 to r=0.489) were reported between self-rated physical functioning assessed by the SF-36 Physical functioning, SF-36 Physical Component Summary, or the Roland Morris Disability Questionnaire, and PBMs, such as a treadmill test, 5-minute walk, Functional Capacity Evaluation, accelerometers, or a physical performance test battery (10, 12–14). The different constructs of those instruments preclude direct comparison. No corresponding literature was found reporting results on the 6MWD and SF-36 in WAD.

SF-36 scale Physical functioning

Although the title of the SF-36 scale "Physical functioning" suggests that it measures physical functioning in general, it includes items related to several activity and participation domains of the ICF (31). Although mobility (d4), self-care (d5), domestic life (d6), and community, social and civic life (d9) are included, most are related to mobility and also include other aspects of activity and participation in 4 of the 10 items in addition (31). The constructs of the SF-36 Physical functioning scale and the 6MWD therefore partly diverge, with expected correlations clearly below 1.0. However, the content and construct overlap is large. The interpretation that weak correlations are caused by a lack of content validity of the 6MWD and PROMs is not therefore evident and cannot be supported by our data (11, 15). Both constructs are, of course, influenced by other dimensions, such as pain and mental health. For example, changes on the SF-36 Bodily pain scale were strongly correlated with those on SF-36 Physical functioning and in the 6MWD (r=0.943).

Strengths and limitations

The comparison of 6 different cohorts treated in the same rehabilitation clinic is a strength of this study. The identical administrative, clinical, and research procedures combined with the same evidence-based and interdisciplinary treatment approach comprising active therapies and coping strategies increase the comparability of the different cohorts. An additional strength is the inclusion of longitudinal data as well as the calculation of the ratios, which allows comparison of different medical diagnoses. The use of the same validated outcome measures across all cohorts and the inclusion of pain and mental health in the analysis are further strengths of this study.

This study has several limitations. The most important limitation is that the construct of the SF-36 Physical functioning scale and the 6MWD partly differ, as outlined above. A further limitation is the wide disparity in the numbers of participants in the populations compared. However, in this naturalistic and observational study setting, the different cohort sizes reflect the number of patients admitted to each of these treatment programmes. Another limitation is the limited generalizability of the findings, arising from the use of the SF-36 and the 6MWD as examples of subjective measurements or PROMs and objective measurements or PBMs. Furthermore, although recommended in the literature, no device-based assessment method, e.g. step-count by accelerometers, to supplement PROMs and PBMs was used in this study (6).

Conclusion

Moderate to strong cross-sectional and moderate to weak longitudinal correlations between the "objective" 6MWD and the "subjective" SF-36 Physical functioning were found in 6 different diagnostic cohorts, as expected from the substantial construct overlap of the 2 parameters. The therapist's and patient's awareness of this association characterizes the clinical relevance of our findings. Differences between the cohorts were influenced by pain and mental health. The ratios of the 6MWD to the SF-36 Physical functioning depended on pain and mental health; lower pain intensities and better mental health resulted in a more optimistically self-rated walking ability/leg function.

Based on these results, 1 of the 2 measures is sufficient for assessing physical function, but for a comprehensive assessment in clinical work and research, the combination of self-rated, subjective, and tested, objective measures of physical function is recommended. The interpretation of both constructs should include pain and mental health. Treatment of pain and mental health may improve both subjectively and objectively rated physical function. However, the 6MWD and the SF-36 Physical functioning are dominated by mobility including walking ability and leg function although other contents of activity and participation are included in the construct of the 2 measures. Further research, especially across different diagnoses, will improve understanding of the relationship between subjectively rated and objectively tested measures and influencing factors.

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The study was approved by the ethics committee of Aarau, Canton Aargau, Switzerland (EK AG 2008/026) and written informed consent was obtained from all study participants. The study was conducted in accordance with the Declaration of Helsinki.

The authors have no conflicts of interest to declare.

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