[RESEARCH REPORT]

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Physical Therapists' Level of McKenzie Education, Functional Outcomes, and Utilization in Patients With Low Back Pain

Low back pain (LBP) is a common condition with a lifetime prevalence of approximately 70% in industrialized countries.[4] The 1-year prevalence of chronic, impairing LBP has risen significantly over the years, with continuing high levels of disability and related health care use.[20] Consequently, LBP is one of the most costly impairments among all medical conditions.[15,46] Use of physical therapy for patients with LBP is common,[18,21,25] and approximately 1 of 4 patients who attend outpatient rehabilitation clinics is treated for LBP.[13,30,54] Supervised and home exercise therapy customized to a patient's clinical presentation for LBP have been suggested as effective means to improve outcomes.[6,7,16,23,38,44,45] These therapy principles are important components of the McKenzie treatment-based classification system,[51] commonly used to treat patients with LBP.[3,19,26]

STUDY DESIGN: Longitudinal, prospective, observational cohort.

OBJECTIVE: To examine associations between McKenzie training, functional status (FS) at discharge, and number of physical therapy visits (utilization) in patients receiving physical therapy for low back pain.

BACKGROUND: The McKenzie method is commonly used in treating patients with low back pain.

METHODS: A McKenzie postgraduate educational program was initiated in a large outpatient physical therapy service. Functional status data were collected at intake and at discharge. Separate hierarchical linear mixed models were used to examine associations between physical therapists' McKenzie training level (none; Parts A, B, C, and D; and credentialed), FS score at discharge, and utilization, controlling for patient risk factors.

RESULTS: The final data set included 20 882 patients (mean ± SD age, 51 ± 16 years; 57% women) who completed FS surveys at both admission and discharge. Patients treated by physical therapists with any McKenzie training had better outcomes (additional 0.7 to 1.3 FS points; $P<.05$ to $<.001$) and fewer visits (0.6 to 0.9, $P<.001$) compared to patients treated by physical therapists with no training. For patients treated by therapists with no versus some McKenzie education, 65% versus 70% achieved at least the minimal clinically important improvement, respectively. There were no significant differences in outcomes or utilization by level of McKenzie training.

CONCLUSION: There was a slightly greater improvement of 0.7 to 1.3 points in FS at discharge in patients receiving physical therapy for low back pain by physical therapists who underwent McKenzie training. This difference was clinically important for an additional 5% of patients who achieved the minimal clinically important improvement when treated by therapists with some McKenzie training. Reduction in physical therapy utilization was 0.6 to 0.9 visits, with the fewest visits utilized by patients of physical therapists at the McKenzie Part D and credentialed levels. Together, these findings suggest improved cost-effectiveness at advanced McKenzie training levels. Ways to improve ongoing education and patient outcomes were proposed.

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The McKenzie postgraduate educational program consists of four 28-hour courses (Parts A through D) and a qualification credential examination. Parts A and B educational courses consist of (1) lecture format augmented by demonstration of examination and treatment by the instructor on several different volunteers and real-time patients experiencing lumbar (Part A) and cervical (Part B) pain, and (2) open discussions throughout the course to enhance the participants' understanding of the practical application of the McKenzie approach. Parts C and D are considered advanced training, with a

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major emphasis on problem solving and case studies, clinical reasoning for patient classification, and practicing manual spinal mobilization techniques. McKenzie instructors recommend a 1-year interval between the 3 main training stages (A and B, C, and D) to allow sufficient clinical experience. After all training levels are completed, a 1-day qualification credential examination, consisting of written and practical testing modules, is offered to demonstrate a basic level of competency in applying the McKenzie method.

Despite international and growing popularity of the McKenzie system for treating patients with LBP during everyday clinical practice, no studies have examined the impact of physical therapist level of education or certification on functional outcomes of patients with spinal impairments. Additionally, although previous reports exist on associations between McKenzie treatment and reduced downstream health care utilization[47] and improved cost-effectiveness ratio,[48] no reports exist on associations between McKenzie training and physical therapy utilization. Therefore, the purpose of the present study was to examine discharge functional status (FS) and physical therapy utilization of patients with LBP who were treated by physical therapists with 6 levels of McKenzie education (none; Parts A, B, C, and D; and credentialed).

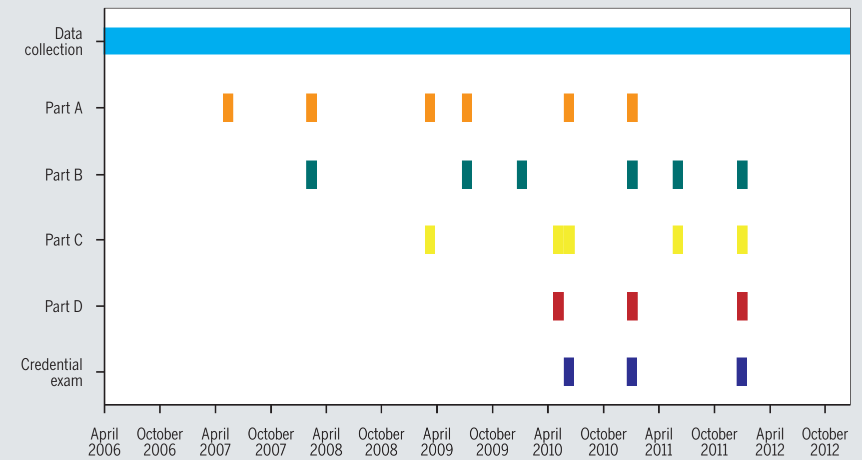

FIGURE. McKenzie educational process. Each box represents a McKenzie postgraduate course. Data collection refers to the data-collection period for the study, starting April 2006 and ending December 2012.

TABLE 1 THERAPISTS AND PATIENTS BY EDUCATION LEVEL AND DATA-COLLECTION PERIOD

McKenzie Education Level (Study Period)	Therapists, n	Patients With an FS Measure at Admission, n	Patients With FS Measures at Admission and Discharge, n	Completion Rate, %*
None (April 2006 to January 2011)	195	13574	7373	54
Part A (May 2007 to December 2012)	192†	6570	3745	57
Part B (March 2008 to December 2012)	172	7001	4166	60
Part C (March 2009 to December 2012)	105	4852	3016	62
Part D (May 2010 to December 2012)	63	2209	1332	60
CRD (June 2010 to December 2012)	29	2142	1250	58
Total	195	36348	20882	57

Abbreviations: CRD, credentialed; FS, functional status.
**Completion rate represents percent of patients with FS measures at admission and discharge divided by those with an FS measure at admission.*
†Three participating therapists did not provide data for Part A due to participating in Parts A and B consecutively, with not enough time between courses to see new patients who met the inclusion criteria.

METHODS

Design

We conducted a prospective, observational cohort study. Because normal treatment was not altered, patient informed consent was not required. The Maccabi Healthcare Services Institutional Review Board for the Protection of Human Subjects approved the project.

Database

Data were collected within the Maccabi health care system[11] from April 2006 to December 2012. Maccabi performs routine outcomes data collection as part of its normal treatment procedure, using a customized version of the Patient Inquiry software developed by Focus On Therapeutic Outcomes, Inc (FOTO), Knoxville, TN. Patient Inquiry is fully integrated into the Maccabi electronic medical record system, providing a wealth of patient demographic and health characteristics collected during routine practice.[11,59] Functional status was measured using FOTO's lumbar-specific computerized adaptive test (LCAT).[32,37,62]

McKenzie Educational Program

A McKenzie postgraduate educational program was initiated and included all 4

TABLE 2 Comparison of Patient Characteristics and Treatment-Related Variables for Patients With Complete (Selected) and Incomplete (Not Selected) FS Data*

Patient Characteristics	Complete (n = 20882, 57%)	Incomplete (n = 15466, 43%)	*P* Value†
Demographic characteristics			
Mean ± SD age, y	51.3 ± 16.4	49.7 ± 15.9	<.001‡§
Age group			<.001‡
18-44 y	37.2	40.6	
45-64 y	40.3	40.7	
65-74 y	14.7	12.1	
75+ y	7.8	6.6	
Women	56.9	58.9	<.001‡
Type of work/activity during the day			.003‡
Office	33.8	33.9	
Physical	13.0	14.2	
Combined	53.2	51.9	
Language used to answer the FS survey			<.001‡
Hebrew	68.7	73.7	
Russian	25.7	21.3	
English	3.0	2.5	
Arabic/Spanish	2.6	2.5	
Payer			<.001‡
Maccabi (HMO)	82.7	86.0	
Car insurance due to motor vehicle accident	13.4	9.8	
Social security due to work accident	3.8	4.1	
Other	0.1	0.1	
Specialty of referring doctor			.509
General practitioner	14.1	13.9	
Orthopaedic surgeon	64.1	63.7	
Other	21.8	22.4	

Table continues on page 928.

courses (Parts A, B, C, and D) and a qualification credential examination. Physical therapists self-elected to participate in McKenzie training, with a 1-year interval between the 3 main training stages (A and B, C, and D). Only Parts A and B were allowed to be taken consecutively. Multiple courses for each training level were available over the data-collection period, as described in the **FIGURE**.

Physical Therapists

Physical therapists who participated in any McKenzie postgraduate course (n = 237) and met the following inclusion criteria were included: no formal McKenzie education prior to study initiation; having worked at Maccabi for at least 1 year; at least 1 year of experience treating patients with LBP; participation in at least Part A level; an overall 40% completion rate or more, calculated as the number of patients who completed an episode of care, with FS assessed at both admission and discharge, divided by the number of those assessed at admission only[11]; and at least 30 patients in the data set with complete episodes. One hundred ninety-five (82%) physical therapists from 72 outpatient clinics throughout Israel, including all 5 districts defined nationally by geographical regions, met these criteria and were included in the final analysis. Forty-six percent of therapists worked in more than 1 clinic, either consecutively or simultaneously. The number of physical therapists who participated in each training level, as well as overall completion rates, are presented in **TABLE 1**.

Patients

The primary data set included episodes of care for patients who were treated by a single physical therapist throughout the episode of care, were 18 years old or older, had selected the lumbar area as their primary musculoskeletal impairment on admission to therapy, had independently completed the LCAT at admission, had 2 or more visits during their episode of care, and were discharged from therapy. The final data set included only episodes of care for patients who completed the LCAT both at admission and discharge from therapy. As each episode of care was analyzed separately, the term *patient* refers to each patient episode of care.

Data Collection

Patient Characteristics Patient characteristics known[12] or hypothesized to be associated with FS outcomes were collected using the Maccabi integrated electronic medical record and electronic outcomes system, as described elsewhere.[11,13] Demographic data for this study included age, sex, type of work/activities during the day, language used to answer the FS survey, type of payer, and specialty of referring doctor. Health characteristics data included patient-reported FS at admission to therapy, symptom acuity in days from onset of the lumbar impairment, surgical history related to the lumbar impairment being treated, exercise history prior to the start of the impairment, use of medication at the start of the treatment episode in relation to the lumbar impairment, pre-existing chronic medical conditions (comorbidities),[13] and continuous use of medication prescribed for chronic use and recorded as having been purchased (**TABLE 2**).[13]

Treatment-Related Process Educational

TABLE 2 Comparison of Patient Characteristics and Treatment-Related Variables for Patients With Complete (Selected) and Incomplete (Not Selected) FS Data* (continued)

Patient Characteristics	Complete (n = 20882, 57%)	Incomplete (n = 15466, 43%)	*P* Value†
General health characteristics			
Mean ± SD FS at admission	46.8 ± 12.7	46.0 ± 12.7	<.001‡§
Acuity as days from lumbar impairment onset			<.001‡
Acute (0-21 d)	17.1	15.9	
Subacute (22-90 d)	32.1	29.4	
Chronic (91 d or more)	50.8	54.7	
Surgical history related to the lumbar impairment			.039‡
None	6.5	7.0	
1 or more	93.5	93.0	
Exercise history prior to the lumbar impairment			<.001‡
At least 3 times a week	29.5	26.2	
Once or twice a week	18.1	17.2	
Seldom or never	52.4	56.6	
Medication use related to the lumbar impairment	44.2	45.0	.130
Mean ± SD comorbidities	1.4 ± 1.5	1.3 ± 1.5	<.001‡§
Comorbidities			
Hypertension	34.6	31.1	<.001‡
Hypercholesterolemia/hyperlipidemia	11.7	11.6	.764
Cardiovascular	13.3	12.3	.003‡
Diabetes	12.0	11.8	.623
Tobacco use disorder	7.8	9.0	<.001‡
Oncologic disease	5.3	4.8	.047‡
Underweight‖	2.2	2.0	.218
Overweight‖	25.8	24. 2	.001‡
Obesity: body mass index ≥30 kg/m^2	23.7	24.7	.035‡
Hypothyroidism	2.5	2.9	.020‡
Osteoporosis	2.9	2.8	.434
Asthma	2.5	3.1	.001‡
Depression	2.3	2.3	.974

Table continues on page 929.

level of the treating physical therapist (no education; Parts A, B, C, and D; and credentialed) was determined at the time of each patient's admission to therapy. Variables related to timing and access to physical therapy included the days of waiting from the date of referral to physical therapy to admission to physical therapy, which is known to be an important predictor of functional outcomes[13,21,25]; the duration of the episode of care in days; and the number of visits per episode of care. These variables were entered into the models that predicted FS (**TABLE 2**).

FS Outcomes Functional status was assessed at discharge using the LCAT, which quantifies FS specific to patients with lumbar spine syndromes.[32,37,62] Functional status scores ranged from 0 (low) to 100 (high functioning) on a linear metric.[32,37] During the development of the computerized adaptive tests by FOTO, which was not part of the methodology of this research, items were cocalibrated into a conceptually and statistically unidimensional scale using the methods of item response theory.[60] The items were administered using a computerized adaptive test application[61] described in detail elsewhere.[32] Using item response theory and computerized adaptive tests to collect outcomes data in routine clinical work is a relatively new concept, but small- and large-scale applications have been described.[10,28,31,37,41] The FS measures estimated by the LCAT were supported for adequate internal consistency reliability (α = .92)[32]; construct validity[32,37]; predictive validity[34]; sensitivity to change[33,37]; responsiveness[33,37]; interpretability using levels of minimal detectable change (MDC), minimal clinically important improvement (MCII), and a functional staging model[62]; and usability.[13,63] The LCAT FS measures are based on a rating-scale item response theory model appropriate for regression techniques that assumes linearity of continuous data.[65] Before the LCAT was implemented at Maccabi, items were translated into Hebrew, Russian, and Arabic following published procedures.[43] The Spanish translation existed in the original software.

Statistical Analysis

Descriptive Analyses The descriptive statistics were frequencies for categorical variables and the average and standard deviation for continuous measures. Because only those patients with FS at admission and discharge and not those with intake data alone were included in the analysis, a selection bias might have been introduced. Comparisons between these 2 groups of patients were performed for all patient characteristics and treatment-related variables described above. Chi-square tests were used for comparisons of categorical data, and Student t tests or analyses of variance for comparisons of continuous data. The alpha level was set at .05. For patients with FS at admission and discharge, unadjusted (crude) FS scores and number of visits by physical therapist educational levels were also compared for descriptive purposes.

Risk Adjustment Associations between variables describing demographic and health characteristics at admission to physical therapy, including level of McKenzie education of the treating physical therapist, with each patient's FS score at discharge were assessed in 2 steps.

First, due to the exploratory nature of the study, a stepwise R^2 selection procedure for ordinary least-squares regressions was performed, allowing independent variables to enter and leave the model. Only variables with frequencies equal to or greater than 2% of the sample were allowed to enter the model, excluding low-frequency comorbidities (eg, cerebrovascular accident, dementia) and chronic medications (eg, corticosteroids, anti-Parkinson's).[13,14] Arabic and Spanish languages used to answer the LCAT were collapsed to pass the 2% threshold. We created the most parsimonious models by allowing only significant variables to remain.[39] Variables entered the model if the significance level of their *t* score was less than 0.05 (entry value) and were removed if significance was greater than 0.1 (removal value). Variables entering the model were checked for multicollinearity; no correlation was greater than 0.6.[13,14]

Second, several types of hierarchical linear mixed models were constructed, which employed all the significant variables identified in the earlier models, to account for both patient risk factors and possible nonrandom clustering of patients. Three different models were examined to account for nonrandom clustering of (1) patients nested within physical therapists only (physical therapist being the random factor), (2) patients nested within clinics only (clinic being the random factor), and (3) a multilevel model with patients nested within physical therapists who were nested within clinics. All 3 models were compared for model fit using the Schwarz[58] Bayesian information criterion. The model of patients nested within physical therapists only had the lowest Bayesian information criterion, indicating best model fit, and was selected for final analysis.[58] The importance of each covariate was determined by its *t* score. Data on FS at admission, age, number of comorbidities, and number of visits per treatment episode (FS model only) were allowed to enter the model as continuous measures. For categorical

TABLE 2 Comparison of Patient Characteristics and Treatment-Related Variables for Patients With Complete (Selected) and Incomplete (Not Selected) FS Data* (continued)

Patient Characteristics	Complete (n = 20882, 57%)	Incomplete (n = 15466, 43%)	*P* Value†
General health characteristics (continued)			
Chronic use of medications			
Hypercholesterolemia/hyperlipidemia	32.1	29.2	<.001‡
Cardiovascular disease	32.0	28.8	<.001‡
Antithrombotic	21.0	18.9	<.001‡
Antidepressants	14.3	15.5	.001‡
Asthma	8.6	9.1	.086
Osteoporosis	7.7	6.9	.005‡
Sedatives	8.8	8.9	.789
Hypothyroidism	7.4	7.6	.488
Antidiabetic	8.2	8.5	.413
Hormone replacement therapy	6.7	6.2	.043‡
Prostate conditions	6.6	5.5	<.001‡
Anticonvulsants/muscle relaxants	5.5	6.0	.054
Treatment-related variables			
Mean ± SD waiting days from referral to physical therapy admission	32.6 ± 34.3	32.7 ± 38.5	.827§
Waiting-day group			<.001‡
0-7 d	16.1	16.2	
8-14 d	12.5	11.9	
15-30 d	25.0	24.5	
More than 30 d	40.2	39.0	
Missing data	6.2	8.4	
Mean ± SD duration per episode of care, d	50.3 ± 43.6	34.4 ± 45.1	<.001‡§
Mean ± SD visits per episode of care, n	6.6 ± 3.8	4.7 ± 3.6	<.001‡§
McKenzie educational level			<.001‡
No education	35.3	40.0	
Part A	17.9	18.3	
Part B	20.0	18.3	
Part C	14.4	11.9	
Part D	6.4	5.7	
Credentialed	6.0	5.8	

Abbreviations: BMI, body mass index; FS, functional status; HMO, health maintenance organization.
**Patient characteristics at admission to physical therapy and treatment-related variables allowed to enter the regression model for those with FS at admission and discharge (selected) versus those with FS at admission only (not selected). Values are percent unless otherwise indicated.*
†P values are a result of chi-square tests unless otherwise indicated.
‡Significant P values at α = .05.
§P values are a result of t tests.
‖Underweight, BMI less than 19 kg/m² for ages 18 to 64; BMI less than 22 kg/m² for ages 65 to 74; BMI less than 23 kg/m² for ages 75+. Overweight, BMI of 25 kg/m² to less than 30 kg/m² for ages 18 to 64; BMI of 27 kg/m² to less than 30 kg/m² for ages 65+.

TABLE 3 UNADJUSTED OUTCOMES MEASURES*

	McKenzie Educational Level							
	Overall (n = 20 882, 100%)	None (n = 7373, 35.3%)	A (n = 3745, 17.9%)	B (n = 4166, 20.0%)	C (n = 3016, 14.4%)	D (n = 1332, 6.4%)	CRD (n = 1250, 6.0%)	P Value†
Unadjusted FS‡								
FS at admission	46.8 ± 12.7 (46.7, 47.0)	47.6 ± 12.1 (47.3, 47.8)	47.2 ± 13.0 (46.8, 47.6)	46.6 ± 12.7 (46.2, 47.0)	46.5 ± 13.2 (46.1, 47.0)	44.6 ± 13.6 (43.9, 45.4)	45.3 ± 13.3 (44.5, 46.0)	<.001§
FS change	11.9 ± 13.3 (11.7, 12.0)	10.9 ± 12.9 (10.6, 11.2)	12.0 ± 13.5 (11.5, 12.4)	12.0 ± 13.0 (11.6, 12.4)	12.7 ± 13.7 (12.3, 13.2)	13.0 ± 13.4 (12.2, 13.7)	13.2 ± 14.2 (12.4, 14.0)	<.001§
FS at discharge	58.7 ± 14.6 (58.5, 58.9)	58.5 ± 14.2 (58.2, 58.8)	59.2 ± 14.5 (58.7, 59.6)	58.6 ± 14.7 (58.2, 59.1)	59.3 ± 15.1 (58.7, 59.8)	57.6 ± 15.3 (56.8, 58.4)	58.5 ± 15.6 (57.6, 59.4)	.003§
Unadjusted utilization								
Visits, n	6.6 ± 3.8 (6.5, 6.6)	7.0 ± 4.0 (6.9, 7.1)	6.4 ± 3.7 (6.3, 6.5)	6.5 ± 3.8 (6.3, 6.6)	6.2 ± 3.4 (6.1, 6.4)	6.1 ± 3.3 (5.9, 6.3)	6.2 ± 3.7 (5.9, 6.4)	<.001§

Abbreviations: CRD, credentialed; FS, functional status.
**Unadjusted (crude) outcomes measures for patients with complete episodes. Values are mean ± SD (95% confidence interval) unless otherwise indicated.*
†P values are a result of analysis of variance for comparisons by educational levels.
‡Higher FS scores represent higher level of functioning.
§Significant P values at α = .05.

data, the category with the largest sample size was set as the reference. All analyses were performed with SPSS statistical software (Version 20; SPSS Inc, Chicago, IL).

RESULTS

Physical Therapists

THE PHYSICAL THERAPISTS (N = 195) included in the study had a mean ± SD age of 42 ± 9 years (range, 28-65 years). Sixty-seven percent were women, with an average ± SD professional experience, including clinical experience treating patients with LBP, of 13 ± 7 years (range, 7-46 years). Eighty-eight percent had earned a bachelors degree in physical therapy and 11% had earned an advanced masters degree. Only 1 physical therapist had obtained a doctoral degree.

Patient Sample

The primary data set included 36 348 patients who completed the LCAT at admission. Of these, 11 208 (31%) dropped out of treatment before discharge, 20 882 (57%) completed the LCAT at discharge and were included in the final analysis,[11] and 4258 (12%) completed treatment but did not complete the LCAT at discharge. A comparison of patients with complete (included in the final analysis) or incomplete (not included in the final analysis) outcomes data for demographic and health characteristics at admission to physical therapy and treatment-related variables is presented in **TABLE 2**.

FS Outcomes and Utilization by McKenzie Educational Levels Unadjusted (crude) mean FS at admission and discharge and number of visits per episode of care (with 95% confidence intervals) by McKenzie educational levels are presented in **TABLE 3**. Physical therapists with more advanced McKenzie educational training were admitting patients with significantly lower FS at admission and had higher (10%-21%) FS change scores compared to physical therapists who had less training. The unadjusted number of visits per episode of care was lower for patients treated by physical therapists with any McKenzie education compared to those with no training, and up to 11% to 13% lower for those treated by physical therapists with a McKenzie education level of Part C and above.

Risk-Adjusted FS Outcomes The stepwise R^2 selection procedure for ordinary least-squares regressions predicting FS at discharge and the number of physical therapy visits explained 36% and 6% of the dependent variables' variance, respectively. Results from the hierarchical linear mixed models predicting FS at discharge and number of physical therapy visits are presented in **TABLES 4** and **5**, respectively.

Significant predictors of FS at discharge were all consistent with previous reports.[12,13] Lower FS at admission was the strongest predictor of lower FS at discharge. Additional patient risk factors associated with lower FS at discharge included older age, female sex, office-oriented daily activity compared with activity involving both office and physical work, choosing to answer the FS survey in Hebrew compared with Russian or English, being covered by a motor vehicle or work compensation payer compared with the regular Maccabi coverage, being referred to physical therapy by an orthopaedic surgeon compared with general practitioners or other referral sources, having a lumbar impairment for more than 3 weeks, a history of 1 or more surgeries related to the lumbar impairment, no history of physi-

TABLE 4 Hierarchical Linear Mixed Model With Patients Nested Within Therapists*

Significant Predictors of FS at Discharge (Reference)	β†	t‡	P Value
Intercept	20.7 (18.7, 22.6)	20.4	<.001
Demographic characteristics			
Age (continuous), y	−0.03 (−0.04, −0.02)	−4.6	<.001
Women (men)	−1.2 (−1.5, −0.8)	−6.4	<.001
Type of work/activity during the day (combined)			
Office	0.5 (0.2, 0.9)	2.9	.004
Physical	0.5 (−0.1, 1.0)	1.7	.087
Language used to answer the FS survey (Hebrew)			
Russian	1.4 (1.0, 1.8)	6.6	<.001
English	1.8 (0.9, 2.8)	3.7	<.001
Arabic/Spanish	−0.2 (−1.3, 0.9)	−0.3	.735
Payer (Maccabi)			
Motor vehicle accident	−4.1 (−4.6, −3.6)	−15.4	<.001
Work accident	−4.7 (−5.5, −3.8)	−10.5	<.001
Other	−0.8 (−5.4, 3.8)	−0.3	.728
Specialty of referring doctor (orthopaedic)			
General practitioner	1.1 (0.6, 1.5)	4.4	<.001
Other	0.5 (0.1, 0.9)	2.4	.018
General health characteristics			
FS at admission (continuous)§	0.6 (0.6, 0.6)	79.0	<.001
Acuity as days from lumbar impairment onset (chronic: more than 3 mo)			
Acute (0-21 d)	6.0 (5.5, 6.5)	23.2	<.001
Subacute (22-90 d)	3.3 (3.0, 3.7)	17.6	<.001
No surgical history (1 or more)	3.2 (2.5, 3.8)	9.5	<.001
Exercise history prior to the lumbar impairment (seldom or never)			
At least 3 times a week	1.9 (1.5, 2.3)	9.7	<.001
Once or twice a week	1.4 (0.9, 1.8)	6.1	<.001
No related medication use at intake (1 or more)	1.0 (0.6, 1.3)	5.5	<.001

Table continues on page 932.

cal exercises performed at least once or twice a week, using medications related to the lumbar impairment, having a cardiovascular condition or obesity (body mass index greater than 30 kg/m²), and chronic use of specific medication groups. Treatment-related variables found to be associated with lower FS outcomes were 8 or more waiting days from referral to physical therapy admission and higher number of visits per episode of care. After controlling for patient risk factors and treatment-related confounders, all educational levels were significantly associated with an additional 0.7 to 1.3 FS points at discharge compared to no McKenzie education, with no significant differences between educational levels. The random factor (physical therapist) was significant and explained only 2.2% of the variance in FS at discharge.

Significant predictors of higher number of visits per episode of care were similar to those that predicted lower FS outcomes and included older age, female sex, selecting to answer the FS survey in Hebrew compared with Russian, being covered by a motor vehicle or work compensation payer compared with the regular Maccabi coverage, having lower FS at admission, a history of 1 or more surgeries related to the lumbar impairment, and using medications related to the lumbar impairment. However, having no exercise history, more comorbidities, and more than 30 waiting days from referral to physical therapy admission were associated with fewer visits per episode of care. After controlling for these risk factors, all McKenzie educational levels were significantly associated with fewer (0.6-0.9) visits compared with no McKenzie education. No significant differences in adjusted number of visits were identified between educational levels, with the lowest coefficient (−0.94) found at the credential level. The random factor (physical therapist) was significant and explained 8.7% of the variance in number of physical therapy visits.

DISCUSSION

We examined associations between 6 different levels of McKenzie postgraduate training (no education; Parts A, B, C, and D; and credentialed), with risk-adjusted FS at discharge and number of visits per episode, for adult patients receiving physical therapy for LBP. Results suggest that patients of physical therapists who had completed any postgraduate McKenzie education had better FS outcomes compared to patients of physical therapists with no McKenzie training. However, differences in risk-adjusted FS outcomes for physical therapists at different levels of training were similar, with overlapping confidence intervals for the size of the effect (beta coefficient) (**TABLE 4**). Thus, there seemed to be no additional benefit in FS outcomes for physical therapists who completed the full McKenzie educational program or achieved credentialed status.

However, a significant decrease (11%-13%) in number of visits occurred for a McKenzie education level of Part C and above, as well as a significant decrease (7%-9%) for a basic McKenzie education level of Parts A and B (**TABLE 3**). Also, the lower number of visits during the episode of care was associated with better FS outcomes (**TABLE 4**), after adjusting for sig-

TABLE 4 Hierarchical Linear Mixed Model With Patients Nested Within Therapists* (continued)

Significant Predictors of FS at Discharge (Reference)	β†	t‡	P Value
Comorbidities			
Cardiovascular	−0.9 (−1.4, −0.4)	-3.3	.001
Obesity: BMI ≥30 kg/m^2	−0.5 (−0.9, −0.2)	-2.7	.006
Chronic use of medications			
Anticonvulsants/muscle relaxants	−1.8 (−2.5, −1.1)	-4.9	<.001
Antidepressants	−1.5 (−2.0, −1.1)	-6.3	<.001
Antidiabetic	−0.9 (−1.5, −0.3)	-2.8	.005
Osteoporosis treatment	−1.7 (−2.4, −1.1)	-5.3	<.001
Prostate conditions	−0.9 (−1.6, −0.2)	-2.6	.011
Treatment-related variables			
Waiting days from referral to physical therapy admission (>30 d)			
0-7 d	1.6 (1.1, 2.2)	6.0	<.001
8-14 d	0.2 (−0.3, 0.7)	0.7	.485
15-30 d	0.1 (−0.3, 0.6)	0.7	.507
Missing data	0.4 (−0.5, 1.2)	0.8	.422
Visits per episode of care (continuous), n	−0.2 (−0.3, −0.2)	-9.5	<.001
McKenzie educational level (no education)			
Part A	0.7 (0.2, 1.2)	2.9	.004
Part B	1.0 (0.5, 1.5)	4.0	<.001
Part C	1.3 (0.7, 1.8)	4.4	<.001
Part D	0.8 (0.02, 1.6)	2.0	.043
Credentialed	1.2 (0.4, 2.0)	2.8	.005

Abbreviations: BMI, body mass index; FS, functional status.
**Associations between level of McKenzie education and FS at discharge, controlling for patient characteristics at admission and treatment-related processes. Number of patients, n = 20 882. Random factor: treating therapists (n = 195). Significance set at P<.001. Variance explained, 2.2%.*
†Coefficient indicating the amount of expected change in discharge FS given a 1-unit change in the value of the variable, given that all other variables in the model are held constant. Values in parentheses are 95% confidence interval.
‡t values indicate the importance of each independent variable for predicting discharge FS (dependent variable).
§Higher FS scores represent higher level of functioning.

nificant patient risk factors. These results replicate previous findings in patients with spinal impairments[13] and are consistent with data from Fritz et al[22] in patients receiving physical therapy for LBP, with better clinical outcomes associated with fewer physical therapy visits. These relationships may or may not be causal. It is likely that physical therapists believe that fewer visits are indicated when patients are improving more rapidly. This view has been acknowledged previously in medical care in general[53] and has been supported by pay-for-performance simulations in outpatient therapy.[30] Lower physical therapy visit utilization, after controlling for patient and treatment-related risk factors, suggests that direct physical therapy costs may be lower in patients treated for LBP by physical therapists who have attended the McKenzie postgraduate program (Parts A through D), with the fewest visits utilized by patients of physical therapists at the McKenzie Part D and credentialed levels. From a health services perspective, even a decrease of less than 1 visit per episode of care has important consequences. Patients treated due to lumbar impairments are the largest patient group attending physical therapy, representing about 20% of Maccabi's physical therapy case load,[13] or approximately 30 000 episodes of care yearly. Potential overall direct-cost savings associated with a decreased utilization of 0.5 to 1 visit per episode of care out of an average of 7 visits would result in approximately 1.5% to 3% improvement in the overall physical therapy service efficiency. Our study included only patients with LBP. We did not examine the impact of McKenzie training on outcomes or efficiency of patients with neck pain or other orthopaedic impairments. Therefore, we cannot generalize our findings to the care of patients with cervical[50] or peripheral[57] joint impairments. For example, because the McKenzie system is also applicable to patients with cervical impairments, who represent 15% of the physical therapy service's case load at Maccabi,[13] we believe that further study of the impact of McKenzie education on patients with cervical impairments is warranted.

The primary purpose of continuing education programs, such as the McKenzie postgraduate training examined in our study, is to impact knowledge and practice behaviors to improve patient outcomes in an efficient manner.[8] Recent clinical practice guidelines and systematic reviews suggest that individually tailored and supervised exercise programs that promote long-term patient adherence to self-exercise are the most effective strategy to improve patient functional outcomes.[16,38] Although such exercise strategies are basic tenets underlying the McKenzie approach, FS outcomes improved only slightly after the full postgraduate McKenzie educational program. The magnitude of this improvement compared with no McKenzie education was approximately 1 to 2 unadjusted FS points, corresponding to only 20% to 40% of the 5 FS points representing the MCII at the individual level, and 12.5% to 25% of the 8-point MDC reported previously for the LCAT.[62] However, there were small, statistically significant differences ($P<.001$) (data not shown) in the proportion of patients who achieved the MCII and MDC during treatment. For patients treated by therapists with no versus some

McKenzie education, 55% versus 60% achieved at least the MDC, respectively, and 65% versus 70% achieved at least the MCII, respectively.

The following discussion points may help in the understanding of the present study's results. First, the study did not identify which educational levels of the McKenzie continuing education program would impact clinical practice behavior. It has been reported that the least effective and most common educational methods in general practice are lecture-format teaching and unsolicited printed materials.[8] Prior research suggests that traditional continuing education emphasizing short-term intensive courses with no follow-up or individualized outreach, and passive education in general, is ineffective and unlikely to result in behavior change.[27] However, a longitudinal education approach that includes interactive learning in small groups (audit circles)[42] and ongoing follow-up training sessions has resulted in better patient care and outcomes compared with traditional, short-term intensive courses only.[5,9] McKenzie courses try to minimize the lecture format, emphasize interactive learning and in vivo case presentations by McKenzie instructors, and include some follow-up by design (consecutive courses over time). Yet, no specific format for long-term, postcourse implementation is suggested. Further study is needed to determine whether addition of more active training components to the McKenzie educational program during and after courses would enhance changes in clinician behaviors and patient outcomes.

Second, the regression model of the present study, though robust, did not include additional potential confounders, such as patients' psychosocial status[35,36,64] and therapist-patient working alliance,[40,52] because these variables were not available. There is increasing evidence that the therapist-patient therapeutic relationship contributes significantly to improving patient outcomes.[17,24,49] In a recent systematic review, the authors reported a positive influence of the therapist-patient working alliance and patient outcomes for musculoskeletal conditions treated in physical therapy practice.[29] In addition, Resnik and Hart[55] reported previously that the best treatment outcomes have been achieved by physical therapists demonstrating attributes characterized by use of reflection, collaborative clinical reasoning, and promotion of patient empowerment. Future research

TABLE 5 HIERARCHICAL LINEAR MIXED MODEL WITH PATIENTS NESTED WITHIN THERAPISTS*

Significant Predictors of Number of Visits (Reference)	β†	t‡	P Value
Intercept	8.5 (8.1, 8.9)	40.8	<.001
Demographic characteristics			
Age (continuous), y	0.02 (0.02, 0.02)	10.1	<.001
Women (men)	0.4 (0.3, 0.5)	8.1	<.001
Language used to answer the FS survey (Hebrew)			
Russian	−0.2 (−0.3, 0.0)	−2.6	.009
English	0.0 (−0.3, 0.3)	−0.1	.938
Arabic/Spanish	0.0 (−0.3, 0.3)	0.1	.934
Payer (Maccabi)			
Motor vehicle accident	1.1 (0.9, 1.3)	14.1	<.001
Work accident	0.5 (0.3, 0.8)	4.0	<.001
Other	−0.8 (−2.2, 0.6)	−1.2	.247
General health characteristics			
FS at admission (continuous)§	−0.03 (−0.03, −0.03)	−12.4	<.001
No surgical history (1 or more)	−0.2 (−0.43, −0.04)	−2.4	.018
Exercise history prior to the lumbar impairment (seldom or never)			
At least 3 times a week	0.1 (0.02, 0.25)	2.3	.022
Once or twice a week	0.2 (0.03, 0.29)	2.4	.019
No related medication use at intake	−0.2 (−0.3, −0.1)	−3.3	.001
Comorbidities (continuous), n	−0.1 (−0.11, −0.03)	−3.4	.001
Treatment-related variables			
Waiting days from referral to physical therapy admission (>30 d)			
0-7 d	0.3 (0.1, 0.4)	3.5	<.001
8-14 d	0.2 (0.1, 0.4)	2.9	.004
15-30 d	0.2 (0.0, 0.3)	2.5	.014
Missing data	0.0 (−0.3, 0.3)	0.0	.977
FS at discharge (continuous)§	−0.02 (−0.02, −0.02)	−10.1	<.001
McKenzie educational level (no education)			
Part A	−0.56 (−0.71, −0.41)	−7.4	<.001
Part B	−0.70 (−0.85, −0.55)	−9.2	<.001
Part C	−0.81 (−0.99, −0.64)	−9.1	<.001
Part D	−0.90 (−1.14, −0.66)	−7.4	<.001
Credentialed	−0.94 (−1.20, −0.68)	−7.1	<.001

Abbreviation: FS, functional status.
**Associations between level of McKenzie education and utilization (number of visits), controlling for patient characteristics at admission and treatment-related processes. Number of patients, 20 882. Random factor: treating therapists (n = 195). Significance set at P<.001. Variance explained, 8.7%.*
†Coefficient indicating the amount of expected change in discharge FS given a 1-unit change in the value of the variable, given that all other variables in the model are held constant. Values in parentheses are 95% confidence interval.
‡t values indicate the importance of each independent variable for predicting discharge FS (dependent variable).
§Higher FS scores represent higher level of functioning.

is recommended to determine the explanatory power of a therapist-patient working alliance when predicting functional outcomes and examining whether the McKenzie postgraduate program may positively influence this alliance.

The present study assessed change of risk-adjusted FS outcomes in patients treated by physical therapists who completed different levels of the McKenzie educational program. However, the study did not evaluate whether the outcomes of individual physical therapists improved with training. Additional studies are needed to examine individual-level physical therapist change, and to better understand the factors that predict how specific physical therapists would change their behavior following continuing education. Such knowledge may help design clinician-specific postgraduate educational processes to improve efficiency of continuing education in physical therapy.

Limitations

Use of observational data has the advantage of representing what happens in real clinical practice but may introduce patient selection bias. The current study examined this limitation by investigating the completion rate, which was 57% overall (**TABLE 1**). This completion rate includes the 31% dropout rate found in this study, similar to a previous report.[11] Thus, our analytic sample included 83% (57/69) of patients who did not drop out of treatment and who thus could potentially provide complete discharge data. Our comparison of patients selected or not selected for final analysis (**TABLE 2**) showed some imbalances in group characteristics. Some characteristics would presumably bias the outcomes in favor of the selected group, and some would bias the outcomes in favor of the group not selected. For example, patients selected were older and therefore expected to have lower outcomes than patients not selected for final analysis.[13,55,56] On the other hand, selected patients had a slightly lower rate of chronicity, which would favor them achieving higher outcomes.[2,13] Although completion rate was slightly higher at training levels Part B and above (**TABLE 1**), it was very stable across training levels. These results suggest a negligible potential selection bias. Additionally, we have no reason to believe that this potential bias would differ by level of McKenzie education.

The observational design of this study precludes conclusions about the causal factors related to better patient functional outcomes or fewer visits. It may be that physical therapists who seek postgraduate training, such as McKenzie or other forms of continuing education, are likely to achieve better outcomes based on their level of professional commitment or attentiveness to their own development and not on the specific type of training they choose to pursue. Also, it is unknown whether our results are generalizable to other countries with differing physical therapy education. Additional research is needed to explore the most beneficial methods for continuing education.

This study was not entirely prospective, as the first 2 years of data were collected prior to the ethics application and approval.

Finally, additional known or unknown potential risk factors might have contributed to potential confounding. For example, information on education, socioeconomic levels, or psychosocial factors known to be associated with FS outcomes[1,35] was not collected. Also, although the authors are not aware of any formal continuing professional education relevant to LBP available to staff during the study period, nonformal education occurring commonly during everyday clinical practice might have occurred, possibly contaminating the results. Additionally, because there was no true control or comparison group that remained untrained throughout the full study period, some physical therapists might have had better outcomes over time due to the passage of time and general experience, regardless of whether they completed McKenzie courses. However, as described in the **FIGURE**, there were 6 Part A courses available throughout the study period. Therefore, patients treated by therapists with no McKenzie education were treated during most of the study period, which controlled partially for a possible time confounder. However, some confounding related to time might have influenced the results.

CONCLUSION

In conclusion, risk-adjusted functional outcomes in patients receiving physical therapy for the treatment of lumbar impairments were 0.7 to 1.3 FS points higher for patients treated by physical therapists who completed any level of McKenzie postgraduate education compared with those treated by therapists with no McKenzie education. This difference was clinically important for an additional 5% of patients who achieved the MCII if treated by therapists with some McKenzie training. Patients treated by physical therapists who had McKenzie training had 0.6 to 0.9 fewer physical therapy visits, with the fewest visits received by patients of physical therapists who had completed Part D and credentialing. These relatively modest improvements at a patient level represent a 1.5% to 3% improved efficiency of the overall Maccabi physical therapy health service. Enhancement of active ongoing education and promotion of future studies to understand which physical therapist characteristics are associated with improved patient outcomes were proposed to improve efficacy of continuing education programs. ◉

KEY POINTS

FINDINGS: This observational study found that patients with lumbar impairments who were treated by physical therapists with basic McKenzie training (Part A) had better functional outcomes than those treated by physical therapists with no McKenzie training. The level of McKenzie training was not associated with functional outcomes but did predict fewer physical therapy visits.

IMPLICATIONS: McKenzie education may lead to a small improvement in outcomes over a shorter episode of care.
CAUTION: This study used observational data and could not control for all possible confounding variables. Complete follow-up data were available for only 57% of patients.

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REFERENCES

1. Atlas SJ, Tosteson TD, Hanscom B, et al. What is different about workers' compensation patients? Socioeconomic predictors of baseline disability status among patients with lumbar radiculopathy. *Spine (Phila Pa 1976)*. 2007;32:2019-2026. http://dx.doi.org/10.1097/BRS.0b013e318133d69b
2. Badke MB, Boissonnault WG. Changes in disability following physical therapy intervention for patients with low back pain: dependence on symptom duration. *Arch Phys Med Rehabil*. 2006;87:749-756. http://dx.doi.org/10.1016/j.apmr.2006.02.033
3. Battie MC, Cherkin DC, Dunn R, Ciol MA, Wheeler KJ. Managing low back pain: attitudes and treatment preferences of physical therapists. *Phys Ther*. 1994;74:219-226.
4. Biering-Sørensen F. A prospective study of low back pain in a general population. I. Occurrence, recurrence and aetiology. *Scand J Rehabil Med*. 1983;15:71-79.
5. Brennan GP, Fritz JM, Hunter SJ. Impact of continuing education interventions on clinical outcomes of patients with neck pain who received physical therapy. *Phys Ther*. 2006;86:1251-1262. http://dx.doi.org/10.2522/ptj.20050382
6. Brennan GP, Fritz JM, Hunter SJ, Thackeray A, Delitto A, Erhard RE. Identifying subgroups of patients with acute/subacute "nonspecific" low back pain: results of a randomized clinical trial. *Spine (Phila Pa 1976)*. 2006;31:623-631. http://dx.doi.org/10.1097/01.brs.0000202807.72292.a8
7. Browder DA, Childs JD, Cleland JA, Fritz JM. Effectiveness of an extension-oriented treatment approach in a subgroup of subjects with low back pain: a randomized clinical trial. *Phys Ther*. 2007;87:1608-1618. http://dx.doi.org/10.2522/ptj.20060297
8. Cantillon P, Jones R. Does continuing medical education in general practice make a difference? *BMJ*. 1999;318:1276-1279.
9. Cleland JA, Fritz JM, Brennan GP, Magel J. Does continuing education improve physical therapists' effectiveness in treating neck pain? A randomized clinical trial. *Phys Ther*. 2009;89:38-47. http://dx.doi.org/10.2522/ptj.20080033
10. Cook KF, Choi SW, Crane PK, Deyo RA, Johnson KL, Amtmann D. Letting the CAT out of the bag: comparing computer adaptive tests and an 11-item short form of the Roland-Morris Disability Questionnaire. *Spine (Phila Pa 1976)*. 2008;33:1378-1383. http://dx.doi.org/10.1097/BRS.0b013e3181732acb
11. Deutscher D, Hart DL, Dickstein R, Horn SD, Gutvirtz M. Implementing an integrated electronic outcomes and electronic health record process to create a foundation for clinical practice improvement. *Phys Ther*. 2008;88:270-285. http://dx.doi.org/10.2522/ptj.20060280
12. Deutscher D, Hart DL, Stratford PW, Dickstein R. Construct validation of a knee-specific functional status measure: a comparative study between the United States and Israel. *Phys Ther*. 2011;91:1072-1084. http://dx.doi.org/10.2522/ptj.20100175
13. Deutscher D, Horn SD, Dickstein R, et al. Associations between treatment processes, patient characteristics, and outcomes in outpatient physical therapy practice. *Arch Phys Med Rehabil*. 2009;90:1349-1363. http://dx.doi.org/10.1016/j.apmr.2009.02.005
14. Deutscher D, Horn SD, Smout RJ, DeJong G, Putman K. Black-white disparities in motor function outcomes taking into account patient characteristics, nontherapy ancillaries, therapy activities, and therapy interventions. *Arch Phys Med Rehabil*. 2010;91:1722-1730. http://dx.doi.org/10.1016/j.apmr.2010.08.007
15. Druss BG, Marcus SC, Olfson M, Pincus HA. The most expensive medical conditions in America. *Health Aff (Millwood)*. 2002;21:105-111.
16. Escolar-Reina P, Medina-Mirapeix F, Gascón-Cánovas JJ, Montilla-Herrador J, Valera-Garrido JF, Collins SM. Self-management of chronic neck and low back pain and relevance of information provided during clinical encounters: an observational study. *Arch Phys Med Rehabil*. 2009;90:1734-1739. http://dx.doi.org/10.1016/j.apmr.2009.05.012
17. Ferreira PH, Ferreira ML, Maher CG, Refshauge KM, Latimer J, Adams RD. The therapeutic alliance between clinicians and patients predicts outcome in chronic low back pain. *Phys Ther*. 2013;93:470-478. http://dx.doi.org/10.2522/ptj.20120137
18. Feuerstein M, Marcus SC, Huang GD. National trends in nonoperative care for nonspecific back pain. *Spine J*. 2004;4:56-63.
19. Foster NE, Thompson KA, Baxter GD, Allen JM. Management of nonspecific low back pain by physiotherapists in Britain and Ireland. A descriptive questionnaire of current clinical practice. *Spine (Phila Pa 1976)*. 1999;24:1332-1342.
20. Freburger JK, Holmes GM, Agans RP, et al. The rising prevalence of chronic low back pain. *Arch Intern Med*. 2009;169:251-258. http://dx.doi.org/10.1001/archinternmed.2008.543
21. Fritz JM, Childs JD, Wainner RS, Flynn TW. Primary care referral of patients with low back pain to physical therapy: impact on future health care utilization and costs. *Spine (Phila Pa 1976)*. 2012;37:2114-2121. http://dx.doi.org/10.1097/BRS.0b013e31825d32f5
22. Fritz JM, Cleland JA, Speckman M, Brennan GP, Hunter SJ. Physical therapy for acute low back pain: associations with subsequent healthcare costs. *Spine (Phila Pa 1976)*. 2008;33:1800-1805. http://dx.doi.org/10.1097/BRS.0b013e31817bd853
23. Fritz JM, Delitto A, Erhard RE. Comparison of classification-based physical therapy with therapy based on clinical practice guidelines for patients with acute low back pain: a randomized clinical trial. *Spine (Phila Pa 1976)*. 2003;28:1363-1371; discussion 1372. http://dx.doi.org/10.1097/01.BRS.0000067115.61673.FF
24. Fuentes J, Armijo-Olivo S, Funabashi M, et al. Enhanced therapeutic alliance modulates pain intensity and muscle pain sensitivity in patients with chronic low back pain: an experimental controlled study. *Phys Ther*. 2014;94:477-489. http://dx.doi.org/10.2522/ptj.20130118
25. Gellhorn AC, Chan L, Martin B, Friedly J. Management patterns in acute low back pain: the role of physical therapy. *Spine (Phila Pa 1976)*. 2012;37:775-782. http://dx.doi.org/10.1097/BRS.0b013e3181d79a09
26. Gracey JH, McDonough SM, Baxter GD. Physiotherapy management of low back pain: a survey of current practice in northern Ireland. *Spine (Phila Pa 1976)*. 2002;27:406-411.
27. Grimshaw JM, Shirran L, Thomas R, et al. Changing provider behavior: an overview of systematic reviews of interventions. *Med Care*. 2001;39:II-2-II-45.
28. Haley SM, Coster WJ, Andres PL, et al. Activity outcome measurement for postacute care. *Med Care*. 2004;42:I-49-I-61. http://dx.doi.org/10.1097/01.mlr.0000103520.43902.6c
29. Hall AM, Ferreira PH, Maher CG, Latimer J, Ferreira ML. The influence of the therapist-patient relationship on treatment outcome in physical rehabilitation: a systematic review. *Phys Ther*. 2010;90:1099-1110. http://dx.doi.org/10.2522/ptj.20090245
30. Hart DL, Connolly JB. Pay-for-Performance for Physical Therapy and Occupational Therapy: Medicare Part B Services. Knoxville, TN: Focus On Therapeutic Outcomes, Inc; June 1, 2006.
31. Hart DL, Deutscher D, Werneke MW, Holder J, Wang YC. Implementing computerized adaptive tests in routine clinical practice: experience implementing CATs. *J Appl Meas*. 2010;11:288-303.
32. Hart DL, Mioduski JE, Werneke MW, Stratford PW. Simulated computerized adaptive test for patients with lumbar spine impairments was

efficient and produced valid measures of function. *J Clin Epidemiol*. 2006;59:947-956. http://dx.doi.org/10.1016/j.jclinepi.2005.10.017

33. Hart DL, Stratford PW, Werneke MW, Deutscher D, Wang YC. Lumbar computerized adaptive test and Modified Oswestry Low Back Pain Disability Questionnaire: relative validity and important change. *J Orthop Sports Phys Ther*. 2012;42:541-551. http://dx.doi.org/10.2519/jospt.2012.3942

34. Hart DL, Werneke MW, Deutscher D, George SZ, Stratford PW. Effect of fear-avoidance beliefs of physical activities on a model that predicts risk-adjusted functional status outcomes in patients treated for a lumbar spine dysfunction. *J Orthop Sports Phys Ther*. 2011;41:336-345. http://dx.doi.org/10.2519/jospt.2011.3534

35. Hart DL, Werneke MW, Deutscher D, George SZ, Stratford PW, Mioduski JE. Using intake and change in multiple psychosocial measures to predict functional status outcomes in people with lumbar spine syndromes: a preliminary analysis. *Phys Ther*. 2011;91:1812-1825. http://dx.doi.org/10.2522/ptj.20100377

36. Hart DL, Werneke MW, George SZ, Deutscher D. Single-item screens identified patients with elevated levels of depressive and somatization symptoms in outpatient physical therapy. *Qual Life Res*. 2012;21:257-268. http://dx.doi.org/10.1007/s11136-011-9948-x

37. Hart DL, Werneke MW, Wang YC, Stratford PW, Mioduski JE. Computerized adaptive test for patients with lumbar spine impairments produced valid and responsive measures of function. *Spine (Phila Pa 1976)*. 2010;35:2157-2164. http://dx.doi.org/10.1097/BRS.0b013e3181cbc17f

38. Hayden JA, van Tulder MW, Tomlinson G. Systematic review: strategies for using exercise therapy to improve outcomes in chronic low back pain. *Ann Intern Med*. 2005;142:776-785.

39. Horn SD, DeJong G, Smout RJ, Gassaway J, James R, Conroy B. Stroke rehabilitation patients, practice, and outcomes: is earlier and more aggressive therapy better? *Arch Phys Med Rehabil*. 2005;86:S101-S114. http://dx.doi.org/10.1016/j.apmr.2005.09.016

40. Horvath AO, Greenberg LS. Development and validation of the Working Alliance Inventory. *J Counsel Psychol*. 1989;36:223-233.

41. Jette AM, Haley SM, Tao W, et al. Prospective evaluation of the AM-PAC-CAT in outpatient rehabilitation settings. *Phys Ther*. 2007;87:385-398. http://dx.doi.org/10.2522/ptj.20060121

42. Kaltwasser JP, Wollenhaupt J, Dick W, Raven U, Herholz H. [Continuing education as an instrument of medical quality management]. *Z Rheumatol*. 1998;57:437-441.

43. Lewin-Epstein N, Sagiv-Schifter T, Shabtai EL, Shmueli A. Validation of the 36-item short-form Health Survey (Hebrew version) in the adult population of Israel. *Med Care*. 1998;36:1361-1370.

44. Liddle SD, Baxter GD, Gracey JH. Physiotherapists' use of advice and exercise for the management of chronic low back pain: a national survey. *Man Ther*. 2009;14:189-196. http://dx.doi.org/10.1016/j.math.2008.01.012

45. Long A, Donelson R, Fung T. Does it matter which exercise? A randomized control trial of exercise for low back pain. *Spine (Phila Pa 1976)*. 2004;29:2593-2602.

46. Luo X, Pietrobon R, Sun SX, Liu GG, Hey L. Estimates and patterns of direct health care expenditures among individuals with back pain in the United States. *Spine (Phila Pa 1976)*. 2004;29:79-86. http://dx.doi.org/10.1097/01.BRS.0000105527.13866.0F

47. Machado LA, Maher CG, Herbert RD, Clare H, McAuley JH. The effectiveness of the McKenzie method in addition to first-line care for acute low back pain: a randomized controlled trial. *BMC Med*. 2010;8:10. http://dx.doi.org/10.1186/1741-7015-8-10

48. Manca A, Dumville JC, Torgerson DJ, et al. Randomized trial of two physiotherapy interventions for primary care back and neck pain patients: cost effectiveness analysis. *Rheumatology (Oxford)*. 2007;46:1495-1501. http://dx.doi.org/10.1093/rheumatology/kem183

49. Martin DJ, Garske JP, Davis MK. Relation of the therapeutic alliance with outcome and other variables: a meta-analytic review. *J Consult Clin Psychol*. 2000;68:438-450.

50. McKenzie R, May S. *The Cervical and Thoracic Spine: Mechanical Diagnosis and Therapy*. 2nd ed. Waikanae, New Zealand: Spinal Publications; 2006.

51. McKenzie R, May S. *The Lumbar Spine: Mechanical Diagnosis and Therapy*. 2nd ed. Waikanae, New Zealand: Spinal Publications; 2003.

52. Munder T, Wilmers F, Leonhart R, Linster HW, Barth J. Working Alliance Inventory-Short Revised (WAI-SR): psychometric properties in outpatients and inpatients. *Clin Psychol Psychother*. 2010;17:231-239. http://dx.doi.org/10.1002/cpp.658

53. Porter ME, Teisberg EO. *Redefining Health Care: Creating Value-Based Competition on Results*. Boston, MA: Harvard Business School Press; 2006.

54. Resnik L, Gozalo P, Hart DL. Weighted index explained more variance in physical function than an additively scored functional comorbidity scale. *J Clin Epidemiol*. 2011;64:320-330. http://dx.doi.org/10.1016/j.jclinepi.2010.02.019

55. Resnik L, Hart DL. Using clinical outcomes to identify expert physical therapists. *Phys Ther*. 2003;83:990-1002.

56. Resnik L, Liu D, Mor V, Hart DL. Predictors of physical therapy clinic performance in the treatment of patients with low back pain syndromes. *Phys Ther*. 2008;88:989-1004. http://dx.doi.org/10.2522/ptj.20070110

57. Rosedale R, Rastogi R, May S, et al. Efficacy of exercise intervention as determined by the McKenzie System of Mechanical Diagnosis and Therapy for knee osteoarthritis: a randomized controlled trial. *J Orthop Sports Phys Ther*. 2014;44:173-181. http://dx.doi.org/10.2519/jospt.2014.4791

58. Schwarz G. Estimating the dimension of a model. *Ann Statist*. 1978;6:461-464. http://dx.doi.org/10.1214/aos/1176344136

59. Swinkels IC, van den Ende CH, de Bakker D, et al. Clinical databases in physical therapy. *Physiother Theory Pract*. 2007;23:153-167. http://dx.doi.org/10.1080/09593980701209097

60. van der Linden WJ, Hambleton RK. *Handbook of Modern Item Response Theory*. New York, NY: Springer; 1996.

61. Wainer H, Dorans NJ, Eignor D, et al. *Computerized Adaptive Testing: A Primer*. 2nd ed. Mahwah, NJ: Lawrence Erlbaum Associates; 2000.

62. Wang YC, Hart DL, Werneke M, Stratford PW, Mioduski JE. Clinical interpretation of outcome measures generated from a lumbar computerized adaptive test. *Phys Ther*. 2010;90:1323-1335. http://dx.doi.org/10.2522/ptj.20090371

63. Werneke MW, Hart DL, Cutrone G, et al. Association between directional preference and centralization in patients with low back pain. *J Orthop Sports Phys Ther*. 2011;41:22-31. http://dx.doi.org/10.2519/jospt.2011.3415

64. Werneke MW, Hart DL, George SZ, Deutscher D, Stratford PW. Change in psychosocial distress associated with pain and functional status outcomes in patients with lumbar impairments referred to physical therapy services. *J Orthop Sports Phys Ther*. 2011;41:969-980. http://dx.doi.org/10.2519/jospt.2011.3814

65. Wright BD, Linacre JM. Observations are always ordinal; measurements, however, must be interval. *Arch Phys Med Rehabil*. 1989;70:857-860.

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