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

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ABSTRACT

Study Design: Longitudinal, prospective, observational cohort.

Objective: Examine associations between McKenzie training, functional status (FS) at discharge, and number of physical therapy visits (utilization), for patients receiving physical therapy for low back pain **(**LBP).

Background: McKenzie method is commonly used in treating patients with LBP.

Methods: A McKenzie post-graduate educational program was initiated in a large outpatient physical therapy service. FS 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, D, & credential), FS score at discharge, and utilization, controlling for patient risk factors.

Results: Final dataset included 20882 patients (mean age (SD) = 51(16) years, 57% women), who completed FS surveys both at 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 - <.001), and fewer visits (0.6 to 0.9 P<0.001), compared with 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 (MCII), respectively. There were no significant differences in outcomes or utilization by level of McKenzie training.

Conclusions: There was a slightly greater improvement of 0.7-1.3 points in discharge FS in patients receiving physical therapy for LBP by physical therapists who underwent McKenzie training. This difference was clinically important for an additional 5% of patients who achieved the MCII if treated by therapists with some McKenzie training.

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Reduction in physical therapy utilization was 0.6-0.9 visits, with fewest visits utilized by patients of physical therapists at the McKenzie Part D and credentialed level. Together these findings suggest improved cost-effectiveness at advanced McKenzie training levels. Ways to improve ongoing education and patient outcomes were proposed.

Level of Evidence: Therapy, level 2b

Key Words: Continuing education, Cost-effectiveness, McKenzie Functional status, lumbar spine

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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 has 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]

The McKenzie post-graduate educational program consists of four 28 hour courses (Parts A-D) and a qualification credentials 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) or 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 major emphasis on problem solving case studies, clinical reasoning for patient classification, and practicing manual spinal mobilization techniques. McKenzie

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instructors recommend a 1 year interval between the 3 main training stages (A&B, C and D) to allow sufficient clinical experience. After all training levels are completed, a 1-day qualification credentials 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 for using McKenzie system for treating patients with LBP during every day 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 healthcare utilization,[47] or improved cost-effectiveness ratio,[48] no reports exist on associations between McKenzie training and physical therapy utilization. Therefore, our purposes were 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, D, & credential).

METHODS

Design

We conducted a prospective observational cohort study. Normal treatment was not altered therefore patient informed consent was not required. The Maccabi Healthcare

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Services (Maccabi) Institutional Review Boards for the Protection of Human Subjects approved the project.

Database

Data were collected within the Maccabi healthcare 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 Patient Inquiry® software developed by FOTO, Inc.[1] Patient Inquiry® is fully integrated into the Maccabi electronic medical record (EMR) system, providing a wealth of demographic and health patient characteristics collected during routine practice.[11, 59] FS was measured using FOTO's lumbar spine-specific computerized adaptive test (LCAT).[32, 37, 62]

McKenzie Educational Program

A McKenzie post-graduate educational program was initiated and included all 4 courses (Parts A, B, C, & D) and a qualification credentials examination. Physical therapists self-elected to participate in McKenzie training, with a 1 year time interval between the 3 main training stages (A&B, C, and D). Only Parts A & B training were allowed to be taken consecutively. Multiple courses for each training level were available over the data collection period as described in the **FIGURE**.

[1] Focus On Therapeutic Outcomes, Inc., P.O. Box 11444, Knoxville, TN, 37919, USA.

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Physical therapists

Physical therapists who participated in any McKenzie post-graduate course (N=237) and met the following inclusion criteria were included: had no formal McKenzie education prior to study initiation; had worked at Maccabi for at least 1 year; had at least 1 year of experience treating patients with LBP; had participated in at least Part A level; had an overall 40% completion rate defined as the percentage of patients with complete episodes (ie, FS measures both at admission and discharge) from those with only FS measures at admission to therapy;[11] and had at least 30 patients in the dataset 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 numbers of physical therapists who participated at each training level as well as their overall completion rates are presented in **TABLE 1**.

Patients

Primary dataset included episodes of care for patients that were: treated by a single physical therapist throughout the episode of care; were 18 years old or older; selected the lumbar area as their primary musculoskeletal impairment on admission to therapy; independently completed the LCAT at admission; had 2 or more visits during

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their episode of care; and were discharged from therapy. The final dataset included only episodes of care for patients that completed the LCAT both at admission and discharge from therapy. We analyzed each episode of care separately; therefore, we use the term "patient" when referring 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 EMR and electronic outcomes system described elsewhere.[11, 13] Demographic data for this study included: age; gender; 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 as 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; and pre-existing chronic medical conditions (co-morbidities),[13] and continuous use of medication prescribed for chronic use and recorded as having been purchased (**TABLE 2**).[13]

Treatment related process

Educational level of the treating physical therapist (no education, or level A, B, C,

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D, & credentialed) was determined on each patient's admission to therapy. Variables related to timing and access to physical therapy included: waiting days from date of referral to physical therapy to actual physical therapy admission known to be an important predictor of functional outcomes;[13, 21, 25] duration in days; and number of visits per episode of care were entered into the models predicting FS (**TABLE 2**).

Functional Status Outcomes

FS outcomes were quantified at discharge using the LCAT that quantifies FS specific to patients with lumbar spine syndromes.[32, 37, 62] FS scores range from 0 (low) to 100 (high functioning) on a linear metric.[32, 37] During the development of the FOTO CATs which was not part of the methodology of this research, items were co-calibrated into a conceptually and statistically unidimensional scale using Item Response Theory (IRT) methods.[60] The items are administered using a CAT application [61] described in detail elsewhere.[32] Using IRT and CAT 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 was supported for: adequate internal consistency reliability (α=0.92)[32] construct [32, 37] and predictive [34] validity; sensitivity to change;[33, 37] responsiveness;[33, 37] interpretability using levels of minimal detectable change (MDC), minimal clinically important improvement (MCII), and using a functional staging model;[62] and usability.[13, 63] We used the LCAT FS measures due to their interval nature based on a rating scale IRT model appropriate for regression techniques that assume linearity of continuous data.[65]

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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 Analyses

Descriptive analyses

Descriptive statistics were used to examine frequencies of categorical variables and average and amount of variation (standard deviation) for continuous measures. Because patients with intake data alone were not included in the final analysis, we assessed for possible patient selection bias due to missing data by comparing patients with FS at admission and discharge to those with FS at admission only. Comparisons were performed for all patient characteristics and treatment related variables described above. Chi-square tests were used for comparisons of categorical data, and student's t-tests or analyses of variance for comparisons of continuous data. α was set at 0.05. 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

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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 (OLS) regressions was performed allowing independent variables to enter and leave the model. Only variables with frequencies equal or greater than 2% of the sample were allowed to enter the model excluding low frequency co-morbidities (eg, CVA, 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 if the significance level of their t score was less than .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, we constructed several types of hierarchical linear mixed models, which employed all the significant variables identified in the earlier models, to account for both patient risk factors and possible non-random clustering of patients. Three different models were examined that accounted for non-random clustering of 1) patients nested within physical therapists only (ie, physical therapist being the random factor), 2) patients nested within clinics only (ie, clinic being the random factor), and 3) a multilevel model

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with patients nested within physical therapists that were nested within clinics. All 3 models were compared for model fit using the Schwarz's Bayesian Information Criterion (BIC). The model of patients nested within physical therapists only had the lowest BIC, indicating best model fit, 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 co-morbidities, and number of visits per treatment episode (FS model only), were allowed to enter the model as continuous measures. For categorical data, the category with the largest sample size was set as reference. All analyses were performed with SPSS statistical software, version 20.[2]

RESULTS

Physical therapists

Physical therapists' (N=195) mean age was 42 years (SD=9, range=28 to 65), with 67% women, average years of professional experience including clinical experience treating patients with LBP was 13 (SD=7, range=7 to 46), with 88% who earned a bachelor's degree in physical therapy and 11% who earned an advanced Master's degree. Only 1 physical therapist had obtained a Doctoral degree.

Patient Sample

[2] SPSS, Inc., 233 S. Wacker Drive, Chicago, IL 60606.

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Our primary dataset included 36348 patients who had completed the LCAT at admission, of which 11208 (31%) dropped out of treatment before discharge. Of the remaining patients, 20882 completed the LCAT at discharge and were included in the final analysis, representing a 57% overall completion rate.[11] There were 4258 (12%) patients who completed treatment but did not complete the LCAT at discharge. A comparison of patients with complete (selected for final analysis) or incomplete (not selected for 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 with physical therapists with lesser training. Unadjusted number of visits per episode of care was lower for patients treated by physical therapists with any McKenzie education compared with those with no training, with 11-13% fewer visits for level C or above.

Risk adjusted FS outcomes

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The stepwise R^2 selection procedure for ordinary least squares regressions predicting either FS at discharge or number of physical therapy visits explained 36% and 6% of the dependents' variable variance, respectively. Results from the hierarchical linear mixed models predicting either FS at discharge or 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 higher age; female gender; having an office oriented daily activity compared with a combined activity involving both office and physical work, selecting 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 orthopedic 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 physical exercises performed at least 1 or twice a week; using medications related to the lumbar impairment; having a cardiovascular condition or obesity (body mass index > 30 kg/m^2); 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. Finally, 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

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with no McKenzie education, with no significant differences between educational levels. The random factor (physical therapist) was significant but 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: higher age; female gender; 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 co-morbidities, and more than 30 waiting days from referral to physical therapy admission were associated with less visits per episode of care. After controlling for these risk factors, all McKenzie educational levels were significantly associated with less (0.6 to 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

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We examined associations between 6 different levels of McKenzie post-graduate training (no education, Part A, Part B, Part C, Part 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 post-graduate McKenzie education had better FS outcomes as compared with 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 for physical therapists to complete the full McKenzie educational program or achieve credentialed status regarding FS outcomes.

However, a significant decrease of 11-13% in number of visits occurred for level C or above, as well as a significant 7-9% decrease occurring after reaching basic McKenzie educational levels A and B (**TABLE 3**). Also, lower number of visits during the episode of care was associated with better FS outcomes (**TABLE 4**), after adjusting for significant patient risk factors. These results replicate our previous finding for patients with spinal impairments,[13] and are consistent with data from Fritz et al[22] for patient receiving physical therapy due to LBP, with better clinical outcomes associated with fewer physical therapy visits.[22] 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 for medical care in general [53] and supported by pay-for-performance simulations in outpatient therapy.[30] Lower

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physical therapy visit utilization after controlling for patient and treatment related risk factors, suggests lower direct physical therapy costs would be achieved for patients treated for LBP by physical therapists attending the McKenzie post-graduate program (Parts A-D), with fewest visits utilized by patients of physical therapists at the McKenzie Part D and credentialed level. 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 caseload [13] or approximately 30000 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 orthopedic 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 caseload at Maccabi,[13] we believe that further study of the impact of McKenzie education on patient's with cervical impairments is warranted.

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The primary purposes of continuing education programs such as the McKenzie post-graduate training examined in our study, are to impact physical therapists' knowledge and practice behaviors to improve patient outcomes in an efficient manner.[8] Recent clinical practice guidelines and systematic reviews suggest that individually

328 tailored and supervised exercise programs while promoting long-term patient adherence
329 to self-exercise are the most effective strategies to improve patient functional
330 outcomes.[16, 38] Although these exercise strategies are basic tenets underlying the
331 McKenzie approach, it was interesting that FS outcomes improved only slightly during
332 the full post graduate McKenzie educational program. The magnitude of this
333 improvement compared with no McKenzie education was approximately 1-2 unadjusted
334 FS points corresponding to only 20-40% of the 5 FS points representing the MCII at the
335 individual level, and 12.5-25% of the 8 point MDC reported previously for the LCAT. [62]
336 However, there were small, statistically significant differences ($P<0.001$ – data not shown
337 in **TABLES**) in the proportion of patients who had achieved the MCII and MDC during
338 treatment. For patients treated by therapists with no versus some McKenzie education,
339 55% versus 60% achieved at least the MDC, respectively, and 65% versus 70% achieved
340 at least the MCII, respectively.

341

342 We propose the following discussion points to help understand our results. First,
343 we did not study if and at which educational levels the McKenzie continuing education
344 impacted clinician practice behaviors. It has been reported that the least effective and
345 most commonly used educational methods in general practice, are lecture format teaching
346 and unsolicited printed materials.[8] Prior research suggests that traditional continuing
347 education emphasizing short-term intensive courses with no follow-up or individualized
348 outreach, and passive education in general, is ineffective and unlikely to result in
349 behavior change.[27] However, a longitudinal education approach including interactive
350 learning in small groups (audit circles) [42] and ongoing follow-up training sessions,

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resulted in better patient care and outcomes compared with traditional short-term intensive courses only.[5, 9] McKenzie courses try to minimize lecture format, emphasize interactive learning and in vivo case presentations by McKenzie instructors, and include some follow up by design, ie, consecutive courses over time. Yet, no specific format for long term post-course 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 can enhance changes in clinician behaviors and patients' outcomes.

Second, our regression model, 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 to us. There is increasing evidence that therapist-patient therapeutic relationship has a major contribution in improving patient outcomes.[17, 24, 49] In a recent systematic review, the authors reported a positive influence of a 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 best treatment outcomes were achieved by physical therapists demonstrating attributes characterized by use of reflection, collaborative clinical reasoning, and promotion of patient empowerment. Future research is recommended to determine the explanatory power of a therapist-patient working alliance when predicting functional outcomes and examining whether McKenzie post graduate program positively influences this alliance.

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Lastly, we assessed change of risk adjusted FS outcomes for patients treated by physical therapists who completed different levels of McKenzie educational program. However, we did not evaluate whether or not 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 if and how specific physical therapists change their behavior following continuing education. Such knowledge may help design clinician-specific post graduate 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, with the possibility of introducing patient selection bias. We examined this limitation by investigating the completion rate which was 57% overall (**TABLE 1**). This completion rate includes the 31% drop-out 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 thus had the potential for 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, therefore expected to have lower outcomes than patients not selected for final analysis.[13, 55, 56] On the other

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hand, selected patients had a slightly lower rate of chronicity which would favor them in 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 be differential by level of McKenzie education.

The observational design in this study also precludes conclusions about the causal factors related to better patient functional outcomes or fewer visits. It may be that physical therapists who seek out post-graduate 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 the specific type of training they chose 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 two years of data were collected prior to the ethics application and approval.

Finally, additional known or unknown potential risk factors may have contributed to potential confounding. For example, we did not collect information on educational, socioeconomic levels, or psychosocial factors, known to be associated with FS outcomes.[1, 35] Also, although we are not aware of any formal continuing professional education relevant to LBP available to staff during the study period, non-formal education occurring commonly during every day clinical practice might have occurred

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without our knowledge possibly contaminating our 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 just 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 controls partially for a possible time confounder. However, some confounding related to time might have influenced out 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 post-graduate education as 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 0.6-0.9 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 1.5-3% improved efficiency of the overall Maccabi physical therapy health service. Enhancement of active ongoing education and promotion of future studies

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to understand which physical therapists' characteristics are associated with improved patient outcomes were proposed to improve efficacy of continuing education programs.

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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.

Acknowledgements:

We thank the hundreds of physical therapists and their managers from Maccabi Healthcare Services who are engaged in ongoing data collection. Their daily efforts enabled us to improve our knowledge on ways to continue and improve functional outcomes, for the benefit of our patients.

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TABLE 1. Therapists and patients by education level and data collection period

McKenzie education level (study period)	№ of therapists	№ of patients with a FS measure at admission	№ of Patients with FS measures at admission & discharge	Completion rate*
None (Apr 2006-Jan 2011)	195	13574	7373	54%
Part A (May 2007-Dec 2012)	192**	6570	3745	57%
Part B (Mar 2008-Dec 2012)	172	7001	4166	60%
Part C (Mar 2009-Dec 2012)	105	4852	3016	62%
Part D (May 2010-Dec 2012)	63	2209	1332	60%
CRD (June 2010-Dec 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 & discharge from those with a FS measure at admission

**** Three participating therapists did not provide data to part A due to participating in Parts A & B consecutively with not enough time between courses to see new patients who met the inclusion criteria.**

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650
651 **TABLE 2. Comparison of patient characteristics and treatment related variables for**
652 **patients with complete (selected) and incomplete (not selected) FS data**
653

Patient characteristics	Complete N=20882 (57%)	Incomplete N=15466 (43%)	*P-value*
Demographic characteristics			
*Age (mean(SD)) years	51.3(16.4)	49.7(15.9)	**<.001**
Age groups (%)			**<.001**
18-44	37.2	40.6	
45-64	40.3	40.7	
65-74	14.7	12.1	
75 or more	7.8	6.6	
Women (%)	56.9	58.9	**<.001**
Type of work/activities 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	
Orthopedic surgeon	64.1	63.7	
Other	21.8	22.4	
General health characteristics			
* FS at admission (mean(SD))	46.8(12.7)	46.0(12.7)	**<.001**
Acuity as days from lumbar impairment onset (%)			**<.001**
Acute (0-21 days)	17.1	15.9	
Sub-acute (22-90 days)	32.1	29.4	
Chronic (91 days 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	

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Seldom or never	52.4	56.6	
Medication use related to the lumbar impairment (%)	44.2	45.0	.130
Comorbidities (%)			
*№ of comorbidities (mean(SD))	1.4(1.5)	1.3(1.5)	**<.001**
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: BMI >= 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
Chronic use of medications (%)			
Hypercholesterolemia/Hyperlipidemia (%)	32.1	29.2	**<.001**
Cardiovascular disease (%)	32.0	28.8	**<.001**
Anti-thrombotic (%)	21.0	18.9	**<.001**
Anti-depressants (%)	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
Anti-diabetic (%)	8.2	8.5	.413
Hormone replacement therapy (%)	**6.7**	**6.2**	**.043**
Prostate conditions (%)	6.6	5.5	**<.001**
Anti-convulsants/muscle relaxants (%)	5.5	6.0	.054
Treatment related variables			
*Waiting days from referral to physical therapy admission	32.6(34.3)	32.7(38.5)	.827
Waiting days groups (%)			**<.001**
0-7 days	16.1	16.2	
8-14 days	12.5	11.9	
15-30 days	25.0	24.5	
Over 30 days	40.2	39.0	
Missing data	6.2	8.4	
*Duration (days) per episode of care	50.3(43.6)	34.4(45.1)	**<.001**
*№ of visits per episode of care	6.6(3.8)	4.7(3.6)	**<.001**
McKenzie educational levels (%)			**<.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	

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Part D	6.4	5.7
Credentialed	6.0	5.8

Abbreviations: BMI, body mass index; FS, functional status; HMO, healthcare medical organization

Patient characteristics at admission to physical therapy and treatment related variables allowed to enter the regression model for those with FS at admission & discharge (selected) versus those with FS at admission only (not selected)

P-values are a result of chi square tests unless mark with * for t-tests

Significant P-values at α=0.05 are marked in **bold**

† Underweight: BMI=<19 for age 18-64; BMI=<22 for age 65-74; BMI=<23 for age 75+
Overweight: BMI=25-<30 for age 18-64, BMI=27-<30 for age 65+

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659
660 **TABLE 3. Unadjusted outcomes measures**
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McKenzie educational levels	***Overall N= 20,882*** *(100%)*	**No N= 7,373** (11.3%)	**A N= 3,745** (13.2%)	**B N= 4,166** (18.6%)	**C N= 3,016** (23.3%)	**D N= 1,332** (6.7%)	**CRD N=1,250** (27.1%)	**P-value**
Unadjusted functional status								
FS at admission mean(SD)	*46.8(12.7)*	47.6(12.1)	47.2(13.0)	46.6(12.7)	46.5(13.2)	44.6(13.6)	45.3(13.3)	**<.001**
95% CI	*46.7-47.0*	47.3-47.8	46.8-47.6	46.2-47.0	46.1-47.0	43.9-45.4	44.5-46.0	
FS change mean(SD)	*11.9(13.3)*	10.9(12.9)	12.0(13.5)	12.0(13.0)	12.7(13.7)	13.0(13.4)	13.2(14.2)	**<.001**
95% CI	*11.7-12.0*	10.6-11.2	11.5-12.4	11.6-12.4	12.3-13.2	12.2-13.7	12.4-14.0	
FS at discharge mean(SD)	*58.7(14.6)*	58.5(14.2)	59.2(14.5)	58.6(14.7)	59.3(15.1)	57.6(15.3)	58.5(15.6)	**.003**
95% CI	*58.5-58.9*	58.2-58.8	58.7-59.6	58.2-59.1	58.7-59.8	56.8-58.4	57.6-59.4	
Unadjusted utilization								
№ of visits mean(SD)	*6.6(3.8)*	7.0(4.0)	6.4(3.7)	6.5(3.8)	6.2(3.4)	6.1(3.3)	6.2(3.7)	**<.001**
95% CI	*6.5-6.6*	6.9-7.1	6.3-6.5	6.3-6.6	6.1-6.4	5.9-6.3	5.9-6.4	

Unadjusted (crude) outcomes measures for patients with complete episodes.
Higher FS sores represent higher level of functioning.
P-values are a result of ANOVA for comparisons by educational levels
Significant P-values at α=0.05 are marked in **bold**
Abbreviations: CI, confidence intervals; CRD, credentialed; FS, functional status

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665 **TABLE 4. Hierarchical linear mixed model with patients nested within therapists:**
666 **associations between level of McKenzie education and FS at discharge, controlling**
667 **for patient characteristics at admission and treatment related processes**

№ of patients = 20,882
Random factor: Treating therapists (N=195, Sig=P<.001, Variance explained=2.2%)

Significant predictors of FS at discharge (reference)	B*	T†	P	95% CI
Intercept	20.7	20.4	<.001	18.7 to 22.6
Demographic characteristics				
Age (continuous)	-0.03	-4.6	<.001	-0.04 to -0.02
Women (reference=Men)	-1.2	-6.4	<.001	-1.5 to -0.8
Type of work/activities during the day (reference=Combined)				
Office	0.5	2.9	.004	0.2 to 0.9
Physical	0.5	1.7	.087	-0.1 to 1.0
Language used to answer the FS survey (reference=Hebrew)				
Russian	1.4	6.6	<.001	1.0 to 1.8
English	1.8	3.7	<.001	0.9 to 2.8
Arabic & Spanish	-0.2	-0.3	.735	-1.3 to 0.9
Payer (reference=Maccabi)				
Motor vehicle accident	-4.1	-15.4	<.001	-4.6 to -3.6
Work accident	-4.7	-10.5	<.001	-5.5 to -3.8
Other	-0.8	-0.3	.728	-5.4 to 3.8
Specialty of referring doctor (reference=Orthopedic)				
GP	1.1	4.4	<.001	0.6 to 1.5
Other	0.5	2.4	.018	0.1 to 0.9
General health characteristics				
Functional Status at admission (continuous)	0.6	79.0	<.001	0.6 to 0.6
Acuity as days from lumbar impairment onset (reference=Chronic-Over 3 months)				
Acute (0-21 days)	6.0	23.2	<.001	5.5 to 6.5
Sub-acute (22-90 days)	3.3	17.6	<.001	3.0 to 3.7
No surgical history (reference=1 or more)	3.2	9.5	<.001	2.5 to 3.8
Exercise history prior to the lumbar impairment (reference=Seldom or never)				
At least 3 times a week	1.9	9.7	<.001	1.5 to 2.3
Once or twice a week	1.4	6.1	<.001	0.9 to 1.8
No related medication use at intake	1.0	5.5	<.001	0.6 to 1.3

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(reference=1 or more)				
Comorbidities				
Cardiovascular	-0.9	-3.3	.001	-1.4 to -0.4
Obesity: BMI >= 30	-0.5	-2.7	.006	-0.9 to -0.2
Chronic use of medications				
Anti-convulsants / muscle relaxants	-1.8	-4.9	<.001	-2.5 to -1.1
Anti-depressants	-1.5	-6.3	<.001	-2.0 to -1.1
Anti-diabetic	-0.9	-2.8	.005	-1.5 to -0.3
Osteoporosis treatment	-1.7	-5.3	<.001	-2.4 to -1.1
Prostate conditions	-0.9	-2.6	.011	-1.6 to -0.2
Treatment related variables				
Waiting days from referral to physical therapy admission (reference=Over 30 days)				
0-7 days	1.6	6.0	<.001	1.1 to 2.2
8-14 days	0.2	0.7	.485	-0.3 to 0.7
15-30 days	0.1	0.7	.507	-0.3 to 0.6
Missing data	0.4	0.8	.422	-0.5 to 1.2
№ of visits per episode of care (continuous)	-0.2	-9.5	<.001	-0.3 to -0.2
McKenzie educational level				
McKenzie educational levels (reference=No education)				
Part A	0.7	2.9	.004	0.2 to 1.2
Part B	1.0	4.0	<.001	0.5 to 1.5
Part C	1.3	4.4	<.001	0.7 to 1.8
Part D	0.8	2.0	.043	0.02 to 1.6
Credentialed	1.2	2.8	.005	0.4 to 2.0

* B = 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.
† T = T values indicate the importance of each independent variable on predicting discharge FS (dependent variable).
Higher FS sores represent higher level of functioning.

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TABLE 5. Hierarchical linear mixed model with patients nested within therapists: associations between level of McKenzie education and utilization (number of visits), controlling for patient characteristics at admission and treatment related processes

№ of patients = 20,882 Random factor: Treating therapists (N=195, Sig=P<0.001, Variance explained=8.7%)				
Significant predictors of number of visits (reference)	**B***	**T†**	**P**	**95% CI**
Intercept	8.5	40.8	<.001	8.1 to 8.9
Demographic characteristics				
Age (continuous)	0.02	10.1	<.001	0.02 to 0.02
Women (reference=Men)	0.4	8.1	<.001	0.3 to 0.5
Language used to answer the FS survey (reference=Hebrew)				
Russian	-0.2	-2.6	.009	-0.3 to 0.0
English	0.0	-0.1	.938	-0.3 to 0.3
Arabic & Spanish	0.0	0.1	.934	-0.3 to 0.3
Payer (reference=Maccabi)				
MVA	1.1	14.1	<.001	0.9 to 1.3
Work accident	0.5	4.0	<.001	0.3 to 0.8
Other	-0.8	-1.2	.247	-2.2 to 0.6
General health characteristics				
FS at admission (continuous)	-0.03	-12.4	<.001	-0.03 to -0.03
No surgical history (reference=1 or more)	-0.2	-2.4	.018	-0.43 to -0.04
Exercise history prior to the lumbar impairment (reference=Seldom or never)				
At least 3 times a week	0.1	2.3	.022	0.02 to 0.25
Once or twice a week	0.2	2.4	.019	0.03 to 0.29
No related medication use at intake	-0.2	-3.3	.001	-0.3 to -0.1
Comorbidities				
№ of co-morbidities (continuous)	-0.1	-3.4	.001	-0.11 to -0.03
Treatment related variables				
Waiting days from referral to **physical therapy** admission (reference=Over 30 days)				
0-7 days	0.3	3.5	<.001	0.1 to 0.4
8-14 days	0.2	2.9	.004	0.1 to 0.4
15-30 days	0.2	2.5	.014	0.0 to 0.3

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Missing data	0.0	0.0	.977	-0.3 to 0.3
FS at discharge (continuous)	-0.02	-10.1	<.001	-0.02 to -0.02
McKenzie educational level				
McKenzie educational levels (reference=No education)				
Part A	-0.56	-7.4	<.001	-0.71 to -0.41
Part B	-0.70	-9.2	<.001	-0.85 to -0.55
Part C	-0.81	-9.1	<.001	-0.99 to -0.64
Part D	-0.90	-7.4	<.001	-1.14 to -0.66
Credentialed	-0.94	-7.1	<.001	-1.20 to -0.68

* B = 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.
† T = T values indicate the importance of each independent variable on predicting discharge FS (dependent variable).
Higher FS sores represent higher level of functioning.

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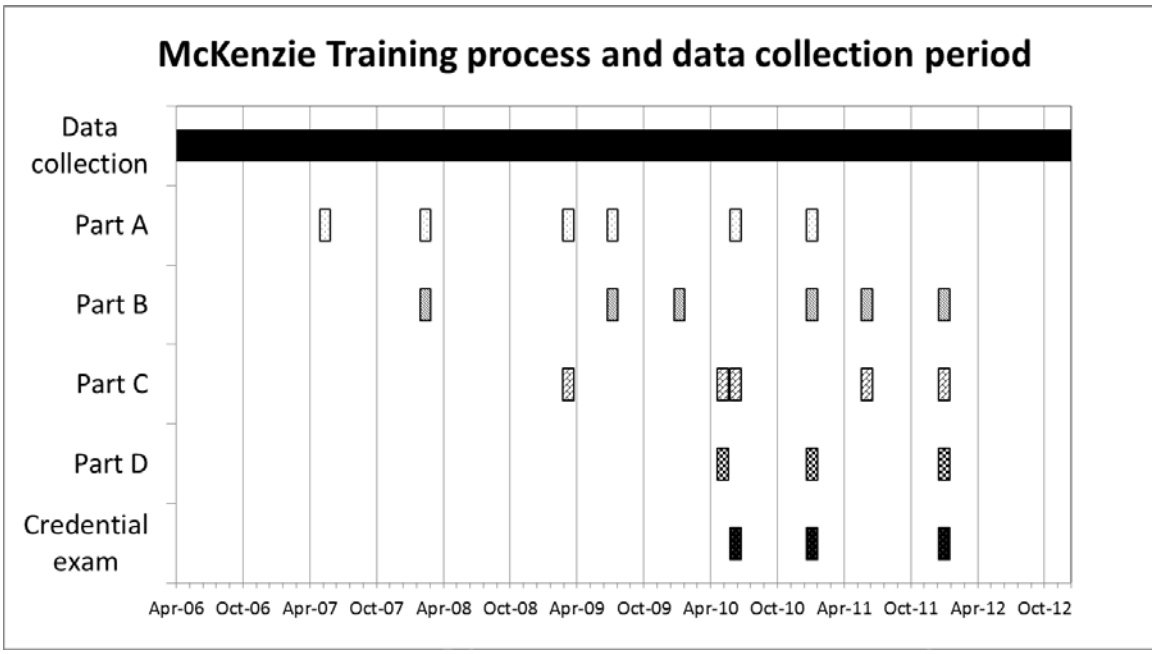
FIGURE. McKenzie educational process



Each box represents a McKenzie post graduate course.
Data collection refers to the data collection period for the study, starting April 2006 and ending December 2012.

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