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Martin Alfuth[1] · Dieter W. Welsink[2]

[1] Faculty of Health Care (Therapeutic Sciences), Niederrhein University of Applied Sciences, Krefeld, Germany

[2] medicoreha Welsink Rehabilitation GmbH, Ambulante Fachkliniken für Rehabilitation, Neuss, Germany

Pain and functional outcomes after outpatient physiotherapy in patients with low back pain

Introduction

About 85% of all humans suffer from low back pain (LBP) at least once in their lifetime [46]. Therefore, LBP is the most prevalent musculoskeletal complaint worldwide. LBP strongly affects lifestyle, quality of life and work and causes high costs for patients and health insurance providers. More than 50% of patients engage in primary health care; however, patients receive treatment from different health care practitioners who commonly advise patients to participate in rehabilitation programs [9].

Physiotherapeutic interventions within multimodal treatment programs are recommended in rehabilitation of subacute and chronic LBP [2, 20, 31, 43]. Thereby, the aims are to analyse strength, flexibility, coordination and endurance as well as to restore physical function and activity [2]. As there is a growing commitment for physiotherapists to demonstrate the effectiveness of their services, the analysis of treatments and treatment programs becomes increasingly important. Evidence-based practice means evaluating clinical performance by measuring outcomes [1, 36]. As programs of intensive physiotherapy with education for the treatment of LBP became available only in the past 10 years [31], the demand to analyse these treatment programs grows.

Therefore, the aim of this study was to describe pain, disability, trunk muscle strength and flexibility following a 6-month outpatient physiotherapy treatment program within the "Integrierte Versorgung Rücken" ("integrated health care for the back") in patients with LBP. It was hypothesized that pain, disability, trunk muscle strength and flexibility improve after the intervention. Furthermore, a relationship between pain, disability, trunk muscle strength and flexibility was expected to exist.

Methods

Patients

From August 2012 to May 2014, 98 patients suffering from LBP met the inclusion criteria and participated in this study. Following a per-protocol analysis, 85 patients (55 women and 30 men) were analysed. Their mean age was 52.3 years (standard deviation [SD] 12.3 years, range 23–77 years). Their average height was 172.0 cm (±0.1 cm), their mean body mass 77.6 kg (±14.8 kg) and their mean body mass index 26.0 kg/m^2 (±3.8 kg/m^2). Each of the patients had a history of LBP of at least 4 weeks and was referred to the outpatient treatment program by the corresponding practitioner. As acute LBP is considered less than 16 days [15], the group of patients included in the present study suffered from subacute (>4 weeks to <3 months) or chronic (>3 months) LBP [40]. To assess the severity of pain, the hierarchical classes by von Korff et al. [44] were used (**Table 1**). The classes are

- Grade I: low disability – low intensity,
- Grade II: low disability – high intensity,
- Grade III: high disability – moderately limiting,
- Grade IV: high disability – severely limiting.

Further inclusion criteria were pain or discomfort in the lower back region at rest or during activity (≥2 points on the numeric rating scale) with (Lasègue sign >30° [25]) or without moderate lower extremity symptoms or disability in activities of daily living (≥2 points on the Roland Morris Disability Questionnaire [RMDQ] score). Activities were defined as walking, stair climbing, sitting down on and standing up from a chair as well as bending down to the floor.

Main exclusion criterion was severe lasting pain with neurological symptoms (Lasègue sign <30° [25]; paresis [29]) that precluded an objective testing of strength and flexibility. Furthermore, patients demonstrating inflammatory symptoms, i. e. continuous severe pain with remarkable increased skin temperature after surgery that might have indicate florid inflammatory processes [25, 29], were excluded. Further exclusion criteria were cardiopulmonary, inflammatory rheumatologic and neurological diseases, spinal tumors as well as pregnancy. Patients with slight pain (<2 points on the numeric rating scale at rest and during activity) and disability (<2 points on the RMDQ score) were also excluded. Drug delivery was controlled by the attending physician. However, patients were instructed to announce relevant changes of drug intake to the attending therapist. All included patients did not report relevant changes of drug intake from the onset to the end

of intervention. Furthermore, patients in the age under 20 and over 80 years were excluded. Diagnostic and sociodemographic data of patients are presented in **Table 1**. All subjects gave written consent after being informed about the aims and procedures of the investigation by the corresponding physiotherapist at the first visit.

Intervention

The physiotherapeutic program within the "Integrierte Versorgung Rücken" is a standardized combination of treatment modalities including exercises, manual therapy, i. e. mobilisation and massage, and physical therapy, i. e. heat or electro therapy, as well as behavioural education of patients. The treatment modalities take place in individual sessions (20–30 min). Thereby, manual techniques aim at relieving tension of tight muscles and ligaments of the back and are usually applied during the early phase of treatment where problems are most likely severe. Then, low-load motor control exercises are added progressively, in order to train patients for activating deep stabilizing muscles of the trunk, especially during activities such as standing up and sitting down as well as walking, stair climbing and bending down to the floor. Supplementary heat or electrotherapeutic treatment last about 10 min per session.

In addition, exercise therapy with behavioural education is performed in group sessions (30 min) with the aim of strengthening local and global trunk and extremity muscles, to improve sensorimotor control and flexibility, as well as to educate patients about the musculoskeletal and neuroanatomical structure of the spine and potential pathologies that can affect movement, activities of daily living and participation. Education should help patients to reduce fear avoidance behaviour. Thereby, common exercises were performed on a mat in prone, supine, side-lying, sitting and standing positions without and with common devices (e. g. Swiss ball, bar or resistance band) and last 20 min. The intensity is selected such that participants are able to carry out three sets of at least 10 and at most 15 repetitions. The group sessions usually start with a 5 min warm-up and are finished with at most 5 min recreation.

Furthermore, physiotherapy-supported training based on an individually tailored training program including aerobic ergometer training, sensorimotor training, strengthening exercises with and without devices as well as functional exercises are performed under regular supervision of a physiotherapist (60 min). The training program usually starts with an aerobic cycling ergometer exercise (about 20 min) at about 80% of peak heart rate (peak heart rate = 220 – age). Then, balance exercises without and with devices (balance pad, posturomed etc.) are introduced (10 min), including double- and single-leg stance as well as all-fours position. Finally, core stability exercises in prone, supine and side-lying without or with devices (e. g. sling-trainer, mats, Swiss ball), as well as resistance exercises using training machines (e. g. lat pulldown machine, seated row machine, seated bench press, leg press) are performed progressively. As noted before, the intensity is selected such that patients are able to carry out three sets of at least 10 and at most 15 repetitions. However, individual physical conditions and different movement patterns [16] are considered by the therapist and patients are always allowed to discontinue exercises if they felt severe pain or discomfort. Treatment sessions take place 2–3 days per week. Usually, each patient obtains 44 sessions within 6 months. However, for different personal reasons of patients, the total number of completed sessions may sometimes differ.

Procedures and outcome measures

After practitioner's diagnosis the patients were referred to rehabilitation in consecutive order. The entire physiotherapeutic treatment took place at "medicoreha Welsink Rehabilitation GmbH, Ambulante Fachkliniken für Rehabilitation" (Neuss). Pain and disability were measured and documented by a physiotherapist at the first, second or third visit, after about 3 months (about 20 visits) and after about 6 months (about 40 visits)

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M. Alfuth · D. W. Welsink

Pain and functional outcomes after outpatient physiotherapy in patients with low back pain

Abstract

Background. Physiotherapy treatment programs are recommended in the rehabilitation of low back pain (LBP). Rehabilitation institutions are increasingly asked to demonstrate the outcomes of their intensive physiotherapy services.
Aim. To describe pain and functional outcome measures following a 6-month outpatient physiotherapy treatment program in patients with LBP.
Methods. A total of 85 patients were analysed after being treated with a combination of physiotherapeutic treatment modalities 2–3 days weekly. Pain and disability were measured before, 3 and 6 months after the onset of treatment. Isometric trunk muscle strength for flexion and extension and flexibility of dorsal trunk and thigh structures were measured before and 6 months after treatment.
Results. After 6 months, pain at rest decreased from a median of 4.0 to 0.0 ($p < 0.01$) and pain during activity from a median of 5.5 to 2.0 on the numeric rating scale ($p < 0.001$). The Roland–Morris Disability (RMDQ) score decreased from a median of 7.0 to 3.0 ($p < 0.001$). Mean trunk muscle flexion strength increased from 133.7 to 156.0 Nm and for extension from 235.5 to 278.3 Nm ($p < 0.001$). Flexibility was improved from a mean of −5.9 to −1.4 cm ($p < 0.001$). A moderate correlation between pain at rest and RMDQ score was found after 3 (r = 0.532, $p < 0.01$) and 6 months (r = 0.508, $p < 0.01$).
Conclusions. Patients with LBP who were treated with the physiotherapeutic treatment program showed a clinically relevant reduction of pain and disability with improved trunk muscle strength and flexibility. Reductions in pain and disability do not seem to correlate with increased trunk muscle strength and flexibility. No conclusions can be declared about long-term changes after the intervention.

Keywords

Evidence-based practice · Physiotherapeutic treatment program · Disability · Trunk muscle strength · Treatment outcome

Schmerz und funktionelle Ergebnisse nach ambulanter Physiotherapie bei Patienten mit Kreuzschmerzen

Zusammenfassung

Hintergrund. Physiotherapeutische Behandlungsprogramme werden in der Rehabilitation von Kreuzschmerzen empfohlen. Von Rehabilitationseinrichtungen wird zunehmend erwartet, die Ergebnisse ihrer intensiven physiotherapeutischen Leistungen darzulegen.
Ziel. Darstellung von Schmerz und Funktion nach Ablauf eines 6-monatigen ambulanten physiotherapeutischen Behandlungsprogramms bei Patienten mit Kreuzschmerzen.
Methodik. Es wurden 85 Patienten analysiert, die an einem aus mehreren Behandlungsmodalitäten bestehenden physiotherapeutischen Behandlungsprogramm teilgenommen hatten (2–3 Tage pro Woche). Schmerz und schmerzbedingte Behinderung wurden vor sowie 3 und 6 Monate nach Beginn der Intervention gemessen. Die isometrische Muskelkraft der Rumpfmuskulatur für die Flexion und Extension sowie die Beweglichkeit der dorsalen Strukturen des Rumpfs und des Oberschenkels wurden vor der Therapie und 6 Monate danach gemessen.
Ergebnisse. Nach 6 Monaten reduzierte sich der Ruheschmerz von einem Median von 4,0 auf 0,0 ($p < 0,01$) und der Schmerz während körperlicher Aktivität von einem Median von 5,5 auf 2,0 auf der numerischen Rating-Skala ($p < 0,001$). Der Roland-Morris-Disability-Questionnaire(RMDQ)-Score verringerte sich von einem Median von 7,0 auf 3,0 ($p < 0,001$). Die durchschnittliche Muskelkraft des Rumpfs für die Flexion steigerte sich von 133,7 auf 156,0 Nm, bezüglich der Extension nahm sie von 235,5 auf 278,3 Nm zu ($p < 0,001$). Die Beweglichkeit verbesserte sich von einem Mittelwert von −5,9 auf −1,4 cm ($p < 0,001$). Eine moderate Korrelation bestand zwischen dem Ruheschmerz und dem RMDQ-Score nach 3 Monaten (r = 0,532, $p < 0,01$) und nach 6 Monaten (r = 0,508, $p < 0,01$).
Schlussfolgerung. Patienten mit Kreuzschmerzen, die mit dem physiotherapeutischen Programm behandelt wurden, zeigten nach 6 Monaten eine klinisch relevante Reduzierung des Schmerzes und der schmerzbedingten Behinderung bei verbesserter Muskelkraft der Rumpfmuskulatur und besserer Beweglichkeit. Die Reduzierungen des Schmerzes und der schmerzbedingten Behinderung scheinen nicht mit den Steigerungen der Muskelkraft der Rumpfmuskulatur und der Beweglichkeit in Zusammenhang zu stehen. Die Ergebnisse geben keinen Aufschluss über die Nachhaltigkeit der Veränderungen.

Schlüsselwörter

Evidenzbasierte Praxis · Physiotherapeutisches Behandlungsprogramm · Behinderung · Kraft der Rumpfmuskulatur · Therapieergebnis

(**Table 1**). Pain at rest as well as during physical activity were measured using the Numeric Rating Scale (NRS, 0 = no pain, 10 = the worst possible pain). Reliability for the NRS was reported to be r = 0.96 [13] , sensitivity = 0.26, specificity = 1.00, positive predictive value = 1 and negative predictive value = 0.28 [24].

Disability was measured using the German version of the Roland Morris Disability Questionnaire [45]. The questionnaire consists of a 24-item scale with scores ranging from 0–24 points. The higher the score the stronger the disability as a result of LBP [19]. The Roland Morris Disability Questionnaire is a well-established and recommended instrument for measuring disability with high reliability, validity and responsiveness [33].

Maximal voluntary isometric trunk muscle strength for flexion and extension was tested using the software-based testing and training devices by tergumed® (proxomed® Medizintechnik GmbH, Alzenau, Germany) at the first and the

Table 1 Diagnostic, sociodemographic, and measurement related data of patients ($n = 85$). For example, measurement 1 was made on average at the first visit, at the earliest at the first visit, and at the latest at the third visit, etc.

	Patients, *n*	%	Lower extremity symptoms[c]	%/85
Classification of low back pain (LBP)				
Subacute LBP[a]	58	68.2	14	16.5
Chronic LBP[b]	12	14.1	6	7.1
Chronic LBP[b] with degenerative disorder	15	17.7	2	2.4
Classes of pain severity (Von Korff)				
Grade I	40	47.1	–	–
Grade II	37	43.5	–	–
Grade III	8	9.4	–	–
Grade IV	–	–	–	–
Previous episodes of LBP				
None	84	98.8	–	–
At least one episode	1	1.2	–	–
Employment characteristics				
Employed	63	74.1	–	–
Housewife/-husband	3	3.5	–	–
Pensioner	17	20.0	–	–
Not reported	2	2.4	–	–
Activity characteristics				
Sport participation	57	67.1	–	–
No sport participation	21	24.7	–	–
Not reported	7	8.2	–	–
Measurement	Visit (average)	Visit (at the earliest)	Visit (at the latest)	–
Measurement 1	1	1	3	–
Measurement 2	19	14	26	–
Measurement 3	43	35	45	–

[a]Symptom duration <12 weeks
[b]Symptom duration >12 weeks
[c]Pain and/or paresthesia

last visit after about 6 months. The approach of the devices was standardised for all patients. It was ensured that patients sat in an upright position, with the lumbar spine in contact with the lordosis cushion of the testing device. The feet stood on an adjustable platform in a hip-wide position. The knees were flexed (30°). The hip flexion angle was 90°. The axis of rotation of the testing device was about 3 cm beneath the iliac crest in the centre of the body. The cushion where the patients pushed into flexion was placed at the level of the sternum. For pushing in extension the upper edge of the cushion was placed at the level of the spine of scapula. Patients were instructed to fold the arms across their chest and to not use them for generating force. After a warm-up three trials were performed. The best trial was taken for further analysis. Strength was expressed in the units of torque (Newton–metre [Nm]) by multiplying force [N] with the individual length of the lever (metre [m]) that was positioned at the testing device. For each patient the test condition was exactly the same between pretest and posttest.

Flexibility was measured with a modified sit-and-reach test. The patient sat on the treatment bench with legs extended and feet in a neutral position. Feet (medial edge of the calcanei) were placed 30 cm apart. A tape was placed at the end of the plantar heels. A tape measure was positioned perpendicular to the tape in the middle of the distance between feet with the score of 30 cm representing the zero point on the scale. With one hand on top of the other, the patient slowly slid the hands along the tape measure as far as possible and held the farthest position for 2 s. The best of three trials was recorded. The difference between maximum reach and the zero point on the scale (30 cm) was calculated and used for further analysis. A negative value represents that patient did not reach the zero point on the scale and may demonstrate deficient flexibility of dorsal trunk and thigh structures. A positive value indicates that patient exceeded the zero point on the scale and may demonstrate sufficient flexibility of the structures. The sit-and-reach test was used in patients with LBP [10, 30] and reliability was reported to be excellent with r = 0.98 [30].

Data analysis

Data were tested for scales of measurement and normal distribution using the Kolmogorov–Smirnov test. For the outcome parameters pain and disability, significance of differences within group was analysed using Friedman tests ($p < 0.05$) and Wilcoxon signed rank tests ($p < 0.05$) with post hoc Bonferroni correction for pairwise comparisons. To evaluate strength and flexibility changes, paired t-tests ($p < 0.05$) were conducted. Effect sizes were determined using Cohen's approach [8] where effect size is classified into small ($d < 0.2$), medium ($d < 0.8$) and large ($d > 0.8$). Relative changes within group were calculated using the mean of individual differences for all outcome measures. Spearman's rho was used to determine correlations between outcome measures pain, disability, strength and flexibility. Statistical analysis was conducted with commercial software (IBM SPSS Statistics 21.0).

Results

Treatment sessions

On average, patients' obtained 42.6 ± 2.3 treatment sessions with a minimum of 35 and a maximum of 45 sessions.

Table 2 Interquartiles of pain at rest and during activity before, after 3 months and after 6 months of treatment measured with the Numeric Rating Scale (*NRS*; $n = 85$)

Interquartiles	Pain at rest [NRS]			Pain during activity [NRS]		
	Pre	3 months	6 months	Pre	3 months	6 months
Minimum	0.0	0.0	0.0	1.0	0.0	0.0
25th percentile	2.0	0.0	0.0	4.0	2.0	0.0
Median	4.0	1.0	0.0	5.5	3.0	2.0
75th percentile	5.0	3.0	2.5	7.0	4.5	3.5
Maximum	9.5	8.5	8.0	10.0	8.0	8.0

Table 3 Interquartiles of disability before, after 3 months and after 6 months of treatment measured with the Roland Morris Disability Questionnaire, *RMDQ* ($n = 85$)

Interquartiles	RMDQ score		
	Pre	3 months	6 months
Minimum	0.0	0.0	0.0
25th percentile	5.0	2.0	0.0
Median	7.0	4.0	3.0
75th percentile	9.0	7.0	6.0
Maximum	18.0	17.0	17.0

Pain

Before treatment, pain at rest was rated at a median of 4.0; at the second measurement at 1.0 and after treatment at 0.0 ($p < 0.01$) (**Fig. 1**; **Table 2**). The effect size was $d = 1.0$. Pain during physical activity before treatment was rated at a median of 5.5, at the second measurement at 3.0 and after treatment at 2.0 ($p < 0.001$) (**Fig. 1**; **Table 2**). Interquartiles are presented in **Table 2**. The effect size was $d = 1.4$. Relative change (mean of individual differences) for pain at rest between baseline measurement and the 6-month control was 59.9% and for pain during activity 55.9%, respectively.

Disability

RMDQ scores decreased significantly from a median of 7.0 at baseline to 4.0 after 3 months ($p < 0.001$) (**Fig. 2**; **Table 3**). At the 6-month control a further decrease to a median of 3.0 was found ($p < 0.001$) (**Fig. 2**; **Table 3**). Interquartiles are presented in **Table 3**. The effect size was $d = 1.0$. Relative change for RMDQ scores between baseline measurement and 6-month control was 48.7%.

Maximal voluntary isometric trunk muscle strength

Flexion measurements revealed a significant increase of maximal isometric trunk muscle strength from a median of 133.7 Nm (±66.4 Nm) at baseline to 156.0 Nm (±68.7 Nm) after 6 months ($p < 0.001$) (**Fig. 3**). For extension a significant increase from 235.5 Nm (±120.2 Nm) to 278.3 Nm (±116.0 Nm) was found ($p < 0.001$) (**Fig. 3**). For flexion the effect size was $d = 0.3$ and for extension $d = 0.4$. Relative change for trunk muscle flexion strength between baseline and the 6-month control was 24.1% and for trunk muscle extension strength 33.3%.

Flexibility

The sit-and-reach test demonstrated a significant decrease of range of motion restriction from a median of −5.9 cm (±10.1 cm) at baseline measurement to −1.4 cm (±8.7 cm) at measurement after 6 months ($p < 0.001$). The effect size was $d = 0.4$. Relative change for the sit-and-reach test between baseline measurement and the 6-month control was 83.1%.

Correlation between outcome measures

A moderate correlation between pain at rest and RMDQ score was found after 3 months ($r = 0.532$, $p < 0.01$) and 6 months ($r = 0.508$, $p < 0.01$). No further significant correlations between outcome parameters existed.

Discussion

The main finding of this observational study with repeated measures was that pain and disability significantly decreased after the physiotherapeutic treatment program. Furthermore, trunk muscle strength and flexibility significantly improved. Similarly, the effects of functional restoration and physiotherapy programs for LBP on the outcomes for pain, strength, disability and others are comprehensively reported in the literature [4, 11, 22, 23, 26, 34]. Especially exercise therapy is considered to be effective [7]. Hansen et al. [18] reported a superior effectiveness of intensive dynamic back-muscle exercise and conventional physiotherapy compared with placebo treatment.

Patients in the present study had a pain level of 4.0 at rest and of 5.5 during activity at the beginning of the treatment. This is similar to previously reported pain levels [21, 31]. Some studies reported higher pain levels at baseline with a range from 5.6–6.5 on the Visual Analogue Scale or Numeric Rating Scale [28, 35, 37]. The differences between these and the results in the present study may be explained by the definition of exclusion criteria. In the present study, patients who could not perform strength testing procedures at baseline caused by severe acute pain with neurological symptoms were excluded. The cited studies included questionnaires and balance testing without strength measurements using maximal voluntary contraction. Furthermore, in the present study pain at rest and during activity was differentiated compared with the other studies where no differentiation was reported. Pain intensity was reduced by 4 points in the NRS score from baseline to 6-month follow-up and is therefore

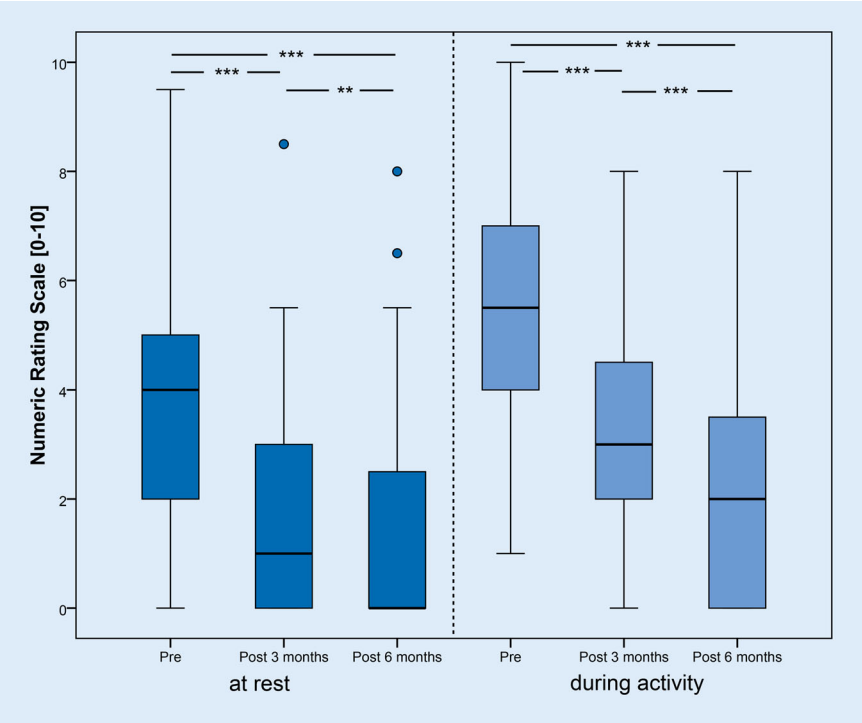

Fig. 1 ▲ Boxplots showing significant differences between measurements of pain at rest (*dark blue*) and during physical activity (*light blue*) (Numeric Rating Scale). $^{**}p < 0.01$; $^{***}p < 0.001$

a clinically meaningful change [12, 31, 38].

In the present study, patients' maximal voluntary isometric trunk muscle strength ranged from 133.7 to 156.0 Nm for flexion and from 235.5 to 278.3 Nm for extension before and after treatment. Gruther et al. [17] found a mean peak flexion torque of 84.38 Nm and a mean peak extension torque of 178.92 Nm at 100° of hip flexion. Under the same conditions controls showed a mean peak extension torque of 260.92 Nm and a mean peak flexion torque of 116.64 Nm. The differences between results of these studies may be attributed to the different hip flexion angles in the testing procedure. However, results of the cross-sectional study from Gruther et al. [17] enable a comparison with healthy people and other patients with chronic low back pain (CLBP) at a current stage, but not changes after a treatment.

Harts et al. [19] found a reduction in disability with a mean difference of 4.5 after low-intensity strength training and 2.5 after high-intensity strength training measured with RMDQ. These results are comparable with the results of the present study. As 2–3 points represent the minimal clinically important difference of RMDQ scores for patients with current RMDQ scores <9 [14, 41] a difference of 4 points in the present study fulfilled this assumption. The main changes in pain and disability were observed between baseline and the 3-month control. The same observation was reported in literature [37] and might be explained by a short-term adaptation of tissue and function followed by a habituation and an implementation of a new level of function in everyday life.

Flexibility scores measured by different approaches of sit-and-reach test in young healthy women ranged from a mean of −8.3 to 6.9 cm [3]. As the means in the present study were in this range, standard deviation was high, effect size was small and no correlations between sit-and-reach test and pain, disability and strength were found it appears that flexibility measured by sit-and-reach test might not have clinical relevance in patients suffering from LBP.

Limitations of the study

The main limitation was the lack of a control group. Therefore, no causal relationship between intervention and outcomes can be declared. Consequently, the improvements might have been a result of a spontaneous progress. However, the main purpose of the present study was to describe pain, disability, strength and flexibility in patients with LBP undergoing a 6-month physiotherapeutic treatment program. Moreover, the treatment techniques and exercises may have differed individually. A reason might have been that therapists adapted selection of exercises and intensity to patients' different physical conditions and different movement patterns [16]. It was shown that the effects of low-load motor control exercises, high-load sling exercises and general exercises lead to pain reduction in the long term but did not differ between each other [42]. In the treatment program of the present study all kinds of exercises were used. As reported by Moseley [31], for the present study it was impossible to differentiate the contribution of single treatment methods to the overall treatment effect as well.

The main complaint of all included patients was LBP. However, the group was heterogeneous with respect to their individual diagnosis. Patients suffering from LBP are considered to be treated more successfully if they are classified to more homogeneous subgroups on the basis of valid criteria [5, 6, 27, 39]. Additionally, patients in the present study had primarily moderate subacute LBP with fair disability and it remains unclear, how patients with high levels of chronicity and pain would react to the treatment program. Therefore, future work should try to classify patients in more homogeneous groups on the basis of diagnosis, age and chronicity of LBP. As reductions in pain and disability were not associated to increased trunk muscle strength and flexibility and psychosocial factors have a central meaning in subacute and chronic LBP [20], psychosocial assessments should be implemented in the physiotherapy treatment program that was presented in the present study. Furthermore, data for a long-term fol-

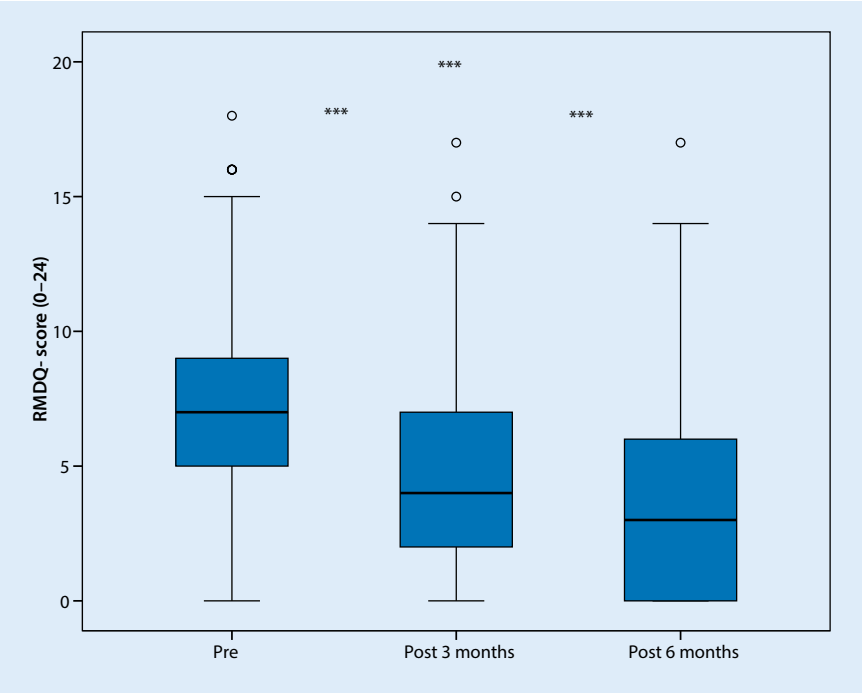

Fig. 2 ▲ Boxplots showing significant differences between measurements of disability (Roland Morris Disability questionnaire *RMDQ score*). $^{***}p < 0.001$

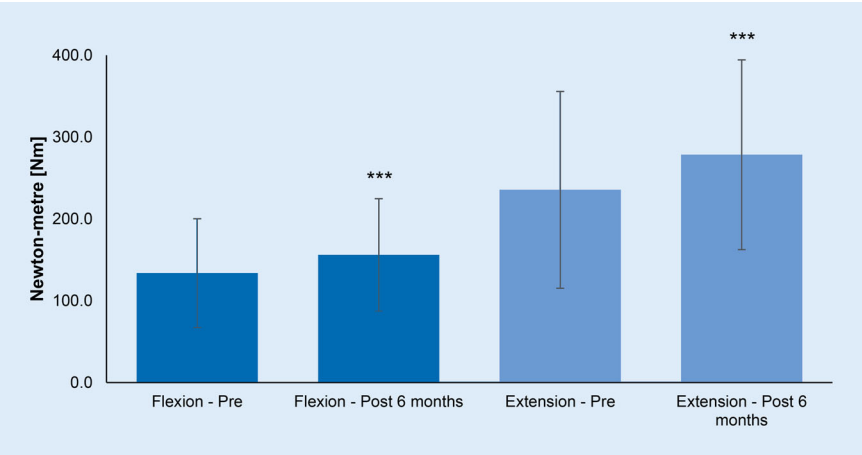

Fig. 3 ▲ Significance of differences between the means of maximal voluntary isometric trunk muscle strength for flexion and extension (tergumed®, proxomed). $^{***}p < 0.001$. The error bars represent the corresponding standard deviations

low-up were not measured because of patients' availability. Consequently, no conclusions can be declared about long-term changes after the intervention. It was reported in literature that improvements in pain, disability, strength and range of motion appear to persist until 18 months after a similar intervention [32]. However, as the cited study did not include a control group as well, persistent functional improvements could only be speculated.

Conclusions

Based on the results of the present study, patients suffering from low back pain who were treated with the physiotherapeutic treatment program within the "Integrierte Versorgung Rücken" showed clinically relevant decreases in pain at rest and during activity as well as in disability. Furthermore, they demonstrated increased trunk muscle strength. Therefore, the predefined working hypothesis can be accepted. However, increases in trunk muscle strength and flexibility did not correlate with reductions in pain and disability. Furthermore, no conclusions can be made about long-term changes after the intervention. The effectiveness of the program on LBP should be evaluated and compared with similar treatment approaches using a controlled study design.

Corresponding address

M. Alfuth
Faculty of Health Care (Therapeutic Sciences), Niederrhein University of Applied Sciences
Reinarzstr. 49, 47805 Krefeld, Germany
martin.alfuth@hs-niederrhein.de

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Compliance with ethical guidelines

Conflict of interest. D.W. Welsink is executive manager of medicoreha Welsink Rehabilitation GmbH. M. Alfuth declares that he has no competing interests.

The study was completed in accordance with national law and the Helsinki Declaration of 1975 (in its current, revised form). It was reviewed by the "Ethik-Kommission des Deutschen Verbands für Physiotherapie an der Physio-Akademie gGmbH, Wremen". It was approved that this investigation evaluates rehabilitation practice with the aim of enhancing patients' medical care and that no ethical approval is required. All patients included in the study gave written informed consent.

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