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ORIGINAL ARTICLE

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The effect of kinesiotherapy supported by visual biofeedback on a stabilometric platform on health-related quality of life among patients with non-specific low back pain. A randomized, open-label study with a 6-month follow-up

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ABSTRACT

Introduction: Non-specific low back pain (NSLBP) influences health-related quality of life (HRQoL) in a significant number of people. This study aimed to evaluate the effect of two rehabilitation programs, kinesiotherapy combined with visual biofeedback on a stabilometric platform and kinesiotherapy alone, on HRQoL during a 6-month follow-up.

Material and methods: The study was performed using a randomized open-label design with a 6-month follow-up. Forty-nine patients with NSLBP were assigned to the study group (SG) and treated with kinesiotherapy supported by visual feedback on a stabilometric platform (TecnoBody ST 310 Plus), and 51 patients to the control group (CG) and treated with kinesiotherapy alone. HRQoL was evaluated using the SF-36v2 Health Survey Standard Polish Version 1.0 9/02 (SF-36).

Results: Compared to those in the CG, SG patients achieved greater improvement in physical HRQoL domain scores. This effect was lower in patients with initially greater NSLBP intensity (numeric rating scale [NRS] ≥ 7), and with a higher number of NSLBP recurrences (≥ 3) during the follow-up. The recurrence of NSLBP influenced not only the physical but also the mental health domains of the SF-36 Survey.

Conclusions: Compared to NSLBP patients who underwent kinesiotherapy alone, those who were treated with kinesiotherapy supported by visual feedback on a stabilometric platform achieved a greater improvement in HRQoL domain scores by the end of the 6-month follow-up. The level of HRQoL improvement was related to the initial severity of NSLBP and the number of NSLBP recurrences, which should be considered when assessing the effectiveness of NSLBP treatment.

Keywords: chronic non-specific low back pain, health-related quality of life, stabilometric platform, visual feedback, postural control, randomized control trial

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Introduction

Chronic non-specific low back pain (NSLBP) is an important socioeconomic and healthcare problem, as it is one of the leading causes of disability worldwide. It is defined as pain below the costal margin and above the inferior gluteal folds, lasting at least 8 weeks [1]. Numerous pharmacological (e.g., NSAIDs, opioids, paracetamol, anti-depressants, and muscle relaxants), non-pharmacological (e.g., exercise, patient education,

manual therapies, psychological therapies, multidisciplinary physiotherapeutic approaches, massage, acupuncture, mindfulness, and whole-body vibration) and invasive and non-invasive methods of treatment are available. However, the diversity of the outcomes measured, inadequate descriptions of methodology and the poor reporting of interventions, as well as a low number of high-quality randomized controlled trials on chronic NSLBP treatment, make it difficult to compare the effectiveness and safety of NSLBP therapeutic methods [2–10]. The following endpoints for evaluating the effectiveness of NSLBP therapy are commonly measured: severity of disability, pain, work productivity, and healthcare utilization [3, 11]. Changes in health-related quality of life (HRQoL) domain scores as indications of the effectiveness of treatment among NSLBP patients are rarely reported in the literature, despite HRQoL surveys, which estimate patients' suffering and physical and psychological functioning, being considered among the targets to be prioritized in NSLBP therapy [3, 12].

General HRQoL is measured in patients with NSLBP mainly by using a 12- or 36-item Short Form Health Survey version 2 (SF-12; SF-36) questionnaire. HRQoL domain scores have been found to improve after the following: 5 weeks of massage therapy, therapeutic exercise, and a therapeutic education program [13]; therapeutic ultrasound in addition to exercise [2]; minimally invasive treatment [6]; invasive laser acupuncture [14]; negative pulsed-pressure myofascial vacuum therapy [15]; photobiomodulation therapy using low-intensity Light Amplification by Stimulated Emission of Radiation (LASER) and light-emitting diodes [16]; continuous, low-level heat therapy [17]; Medi-Taping [18]; low-energy pulsed electromagnetic signals therapy [19]; pulsed electromagnetic field therapy [20]; exercises on a Pilates mat and home exercise programs [21]; traditional Thai self-massage combined with home stretching exercises [22]; whole-body vibration [23]; and mountain hiking combined with Mg-Ca-SO_4 spa therapy [24]. Moreover, core stability exercises (CSE) combined with self-compassion training were more effective for patients with non-specific chronic low back pain compared to CSE alone [25]. Similarly, the following showed greater improvement in HRQoL for patients with NSLBP when compared to a control/comparison group: unsupervised home intervention (McKenzie exercises and electroanalgesia) supported by an individualized video exercise program (*via* an e-Health program) compared to the same program with printed instructions [26]; Fu's subcutaneous needling compared to massage therapy [27]; core stability exercises compared to rest or no/minimal intervention as well as in combination with other types of exercise [28]; Feldenkrais method intervention (2 sessions per week for 5 weeks) compared to an educational program and home-based core stability exercises for 5 weeks [29]; and stretching or strengthening exercise therapy compared to those in a 'Sham' group (receiving only gentle palpation of the skin) [30]. In a study by Michalsen et al. [31], when compared to the 'gold standard' of conventional physiotherapeutic exercises, eurythmy and yoga therapies led to comparable HRQoL improvement in patients with chronic NSLBP, although the results of this study were limited due to the small sample size of the three therapeutic arms. In contrast, in a study by Almeida Silva et al. [32], dry cupping therapy was not found to be superior to sham cupping for improving HRQoL, pain, physical function, mobility, psychological symptoms or medication use in patients with NSLBP, and in another study, Matarán-Peñarrocha et al. [33] found that supervised and non-supervised exercise showed similar improvement in HRQoL in both the short- and long-term follow-up of patients with NSLBP. Similar observations were made by Kanas et al. [34], who reported that weekly supervision did not have a significant influence on the final improvement in HRQoL compared to a single supervised exercise session with the continuation of a rehabilitation program at home. Some new trials evaluating HRQoL are planned in patients with NSLBP [35, 36].

In the randomized, open-label study with a 6-month follow-up, the authors co mpare the effect on HRQoL of kinesiotherapy supported by visual biofeedback on a stabilometric platform with standard kinesiotherapy alone among patients with chronic NSLBP. To the best of their knowledge, this study is the first to assess this new physiotherapeutic technique for NSLBP treatment, which relies on the addition of postural balance exercises to standard kinesiotherapy, over kinesiotherapy alone.

Material and methods

Patients

One hundred consecutive patients referred to the Rehabilitation Clinic at the study University Hospital due to NSLBP lasting for at least 12 weeks were enrolled on the study. The following exclusion criteria were used: (a) age below 30 and above 50 years; (b) diseases of the nervous system affecting balance (e.g., stroke, cerebellar stroke, cerebellar ataxia or labyrinth disorders); (c) history of leg amputation; and (d) chronic use of opioids. Patients were recruited for the study between January 1, 2017 and June 30, 2018.

Methodology

A randomized open-label trial with a 6-month follow-up was designed. After the patients' enrolment, they were randomly assigned to one of two study groups

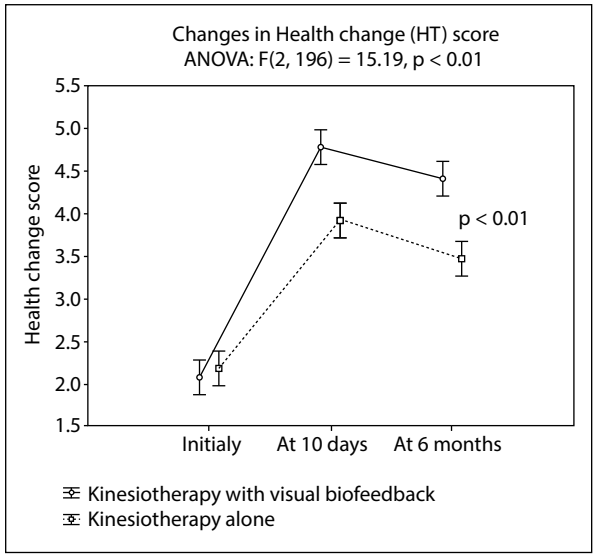

Figure 1. Statistically significant stronger effect of kinesiotherapy supported by visual feedback on a stabilometric platform on Health transition (HT) score compared to kinesiotherapy alone

by permuted block randomization (5:5). Patients in the study group were referred for kinesiotherapy supported by visual feedback on a stabilometric platform (TecnoBody ST 310 Plus), and patients in the control group were treated with kinesiotherapy alone (described below). The following were performed for all patients recruited to the study: medical history, physical examination, and analysis of up-to-date imaging undertaken to ensure that the patient had no structural abnormalities of the spine (the main criterion for NSLBP diagnosis). The following scores were also obtained: low back pain intensity [estimated using a numeric rating scale (NRS)] and the standard Oswestry Disability Index (ODI), which measures a patient's functional disability [37]. A flowchart (based on a CONSORT diagram) showing the participants at each stage of the project is presented in Figure 1.

Intervention

Kinesiotherapy was conducted daily (Monday-Friday) for both study groups by the same physiotherapist for 2 weeks (amounting to 10 sessions, each lasting 60 minutes). Each session consisted of a warm-up (10 minutes), general exercises (20 minutes), balance exercises on a stabilometric platform (TecnoBody ST 310 Plus) for the study group or on a rehabilitation mat for the control group (20 minutes), and relaxation (10 minutes). In addition to their kinesiotherapy, patients in the study group also performed exercises that included visual feedback on the TecnoBody stabilometric platform.

HRQoL measurement

Each subject was asked to complete the SF-36v2 Health Survey Standard Polish Version 1.0 9/02 for standard recall (license number: QM037864). This questionnaire is the most frequently used survey for evaluating general HRQoL, including research concerning NSLBP [2–36]. The subjects' original responses to the questions in the SF-36 questionnaire were re-coded using scoring algorithms to values between 0 and 100 and then, following the instructions, these values were averaged to form the eight scales: physical functioning (PF), role limitation due to physical health (RP), bodily pain (BP), general health perception (GH), vitality (VT), social functioning (SF), role limitation due to emotional problems (RE), and mental health (MH)/emotional well-being. Three summarized measures were calculated: first, the total average SF-36 Survey score, which was the sum of all the health-related scores; second, the physical component summary (PCS), which was the sum of physical functioning (PF), role limitation due to physical health (RP), bodily pain (BP), health transition (HT), and general health perception (GH) scale scores; and third, the mental component summary (MCS), which was the sum of the energy/fatigue (vitality; VT), social functioning (SF), role limitation due to emotional problems (RE) and mental health (MH) scale scores.

Measured outcomes

Three control visits were performed: at the beginning of the study; at the end of 2 weeks of physiotherapy; and during a 6-month follow-up visit after the rehabilitation procedures were completed. The following parameters were measured during each visit: low back pain intensity (NRS), ODI score, and SF-36 Survey score. In addition, the number of low back pain recurrences since the end of the rehabilitation sessions was noted at the 6-month follow-up visit.

Bioethics

The study was performed after receiving permission from the Bioethics Committee of Nicolaus Copernicus University in Ludwik Rydygier Collegium Medicum in Bydgoszcz (no. KB 706/2016 given on November 22, 2016). The study and data analysis were performed in accordance with the revised version of the Helsinki Declaration. Each patient signed a written informed consent form.

Statistical analysis

The results were presented as the mean ± standard deviation; median; interquartile range (IQR); or as a frequency (n, %) of the categorical variables (absolute and

Table 1. Clinical characteristics of the patients studied

Parameter	Kinesiotherapy with visual biofeedback (n = 49)	Classic kinesiotherapy alone (n = 51)	P-value
Female gender [n, %]	36 (73.5)	40 (78.4)	0.566
Age [years]	39.57 ± 5.44	36.65 ± 5.21	0.007
Body weight [kg]	72.82 ± 16.57	69.55 ± 11.85	0.258
Height [m]	1.72 ± 0.09	1.68 ± 0.07	0.038
BMI [kg/m^2]	24.50 ± 4.02	24.37 ± 2.89	0.853
NRS before beginning the training program (score)	6.84 ± 0.87	6.61 ± 0.85	0.188
ODI sum of scores before beginning the training program (score)	12.37 ± 3.35	11.90 ± 4.46	0.558
Number of NSLBP recurrences during the 6-month follow-up	2.41 ± 1.50	4.59 ± 2.35	< 0.001
NRS at 6-month visit (score)	2.20 ± 0.87	3.74 ± 1.48	< 0.001
ODI sum of scores at 6-month visit (score)	1.49 ± 2.12	4.96 ± 5.05	< 0.001

BMI — body mass index; NRS — numeric rating scale; NSLBP — non-specific low back pain; ODI — Oswestry Disability Index

relative values). The statistical significance level was set at a p-value of < 0.05. The normal distribution of the study variables was analysed using the Kolmogorov-Smirnov test. The statistical significance of differences between groups was verified using the Student's t-test and the Mann-Whitney U-test for the quantitative variables (for the parametric and non-parametric tests, respectively) and the Chi-square test for the qualitative variables. ANOVA with the Bonferroni post-hoc test was used to determine the statistical significance of changes in HRQoL scores between the respective visits during the follow-up period.

The sample size was calculated with the following assumptions: use of two-factorial ANOVA with three repetitions; 25% reduction in the severity of NSLBP between measurements in both therapeutic groups; 90% power (1-β); and $\alpha < 0.005$. The calculated sample size was 35 for a single study group and 65 for interactions. On this basis, 100 participants were chosen ($\approx$50 for each group) in case of patient dropout. Statistical analysis was conducted using the licensed version of the statistical analysis software STATISTICA version 13.1 (TIBCO Software, Inc., 2017).

Results

Clinical characteristics

Patients with chronic NSLBP who were randomly assigned to kinesiotherapy supported by visual feedback on a stabilometric platform were significantly older and taller than the patients treated with kinesiotherapy alone (Tab. 1). The other potential confounding factors differed between the groups but not significantly so. NSLBP patients who underwent the combined treatment had a significantly lower number of low back pain recurrences during the 6-month follow-up than patients treated with kinesiotherapy alone (Tab. 1).

Comparison of the outcomes for the two treatment methods

Compared to the patients treated with kinesiotherapy alone, patients treated with kinesiotherapy supported by visual feedback on a stabilometric platform achieved higher scores in 6 of the 11 domains of the SF-36 Survey at their 6-month visit after finishing the rehabilitation program (Tab. 2). However, for changes in HRQoL scores between the respective visits during the follow-up period, the type of kinesiotherapy treatment was only significant for the health change (HT) domain and physical component summary (PCS) (Fig. 1 and 2, respectively).

Patients with a greater intensity of NSLBP (NRS $\geq$ 7) at the beginning of the study reported greater impairment on the physical component summary (PCS) and in 5 of the 11 SF-36 domains, both initially and directly after finishing the assigned rehabilitation program, compared to patients with a lower NSLBP intensity. However, at the 6-month follow-up, the majority of these differences were no longer apparent; only bodily pain (BP) and the physical component summary (PCS) showed significant differences (Tab. 3). Patients who had a lower number of back pain recurrences (< 3) during the 6-month follow-up compared to those for whom this symptom recurred at least three times had a significantly higher score in 10 of the 11 domains of the SF-36 Survey at

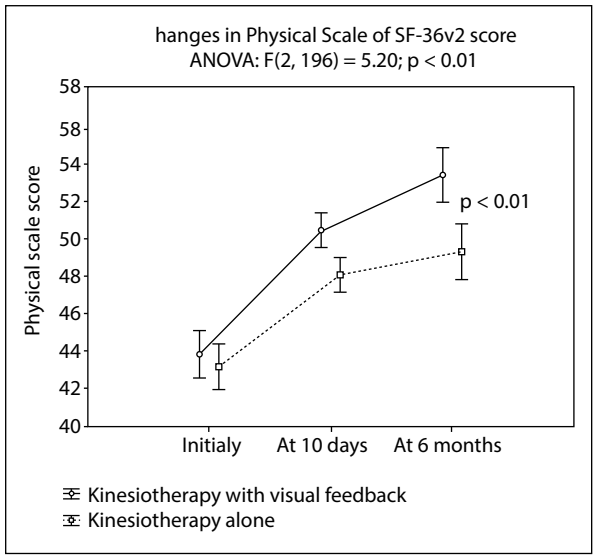

Figure 2. Statistically significant stronger effect of kinesiotherapy supported by visual feedback on a stabilometric platform on physical scale score compared to kinesiotherapy alone

the 6-month visit across both the physical and mental domains (Tab. 4).

In the whole study group, the HRQoL scores 6 months after finishing the rehabilitation program correlated both with initial NSLBP severity [e.g., with bodily pain, BP ($r = –0.25$; $p = 0.14$); with the physical component summary, PCS ($r = –0.24$; $p = 0.17$)]; the initial sum of the ODI scores [with BP ($r = –0.20$, $p = 0.047$)]; and the number of pain recurrences [e.g., with initial BP ($r = –0.63$; $p < 0.01$); initial PCS ($r = –0.54$; $p < 0.01$)]. Further, a higher number of recurrence incidents explained 29–40% of HRQoL variance 6 months after finishing a rehabilitation program. The stabilometric platform parameters obtained, such as the ellipse area measured with eyes open and eyes closed (mm^2), stability index [limits of stability (LoS)], and Romberg index obtained at the beginning of the study did not correlate with the HRQoL domain scores at the 6-month follow-up visit (data not presented in detail).

Discussion

To the best of the authors' knowledge, this work is the first worldwide to compare the improvement in HRQoL measured using the SF-36 questionnaire between patients undergoing kinesiotherapy supported by visual feedback on a stabilometric platform and kinesiotherapy alone during a 6-month follow-up. It was found that, compared to standard kinesiotherapy, the combined NSLBP therapy was associated not only with significantly lower NRS and ODI scores at the 6-month visit and a lower number of NSLBP recurrences during the 6-month follow-up (Tab. 1) but also with greater improvement in HRQoL physical component summary (PCS) scores (Tab. 2, Fig. 2). These effects were affected by initial NSLBP intensity (Tab. 3) and the number of NSLBP recurrences (Tab. 4), which explained 29–40% of the patients' HRQoL variance 6 months after finishing a kinesiotherapy program.

In the introduction section, the authors referred to literature that examined the effect of various methods of rehabilitation on HRQoL [2–25]. These investigations revealed different outcomes after a rehabilitation program for NSLBP, both favourable and unfavourable (i.e., those reporting a lack of improvement in HRQoL). At the time of writing, the authors cannot find articles examining changes in HRQoL after kinesiotherapy supported by visual feedback on a stabilometric platform.

In the present study, the HRQoL scores at a 6-month follow-up visit were affected by initial pain severity (only concerning the physical scale, Tab. 3) and the number of NSLBP recurrences (in relation both to the physical and mental scales, Tab. 4). A similar effect was observed in Fors et al. [38], who found that initial intensity of NSLBP, illness perception, a more negative attitude to the possibility of improvement, a negative emotional response to symptom intensity, and patient expectations regarding prognosis and treatment effect were associated with worse scores in outcomes measured at 3 and 12 months after physiotherapy. This was similar to the findings of a study by Mohamed Mohamed et al. [39], who examined the associations between NSLBP patients' expectations and low back pain intensity in the short and long term. In contrast to the results of the present study (Tab. 4), Zackova et al. [6] found that even patients who were in a worse physical condition were more likely to experience improved HRQoL after treatment if they had a more positive emotional outlook to NSLBP than patients in better physical condition but with a more negative emotional outlook. Moreover, these authors found an inverse correlation between mental component summary (MCS) and physical component scale summary (PCS) scores obtained from the SF-36, whereas, in the present study, these domains correlated non-significantly but positively. In Cruz et al. [40], poor HRQoL-related outcomes of chronic NSLBP treatment were not only significantly influenced by initial pain severity but also by maladaptive psychosocial factors and unemployment. In other studies, in addition to initial pain intensity, the number of pain recurrences and patients' expectations, HRQoL-related outcomes of NSLBP treatment were associated with the following: the number of previous episodes of NSLBP, body mass index, age, symptom duration, distress, maladaptive pain behaviours, greater depressive symptoms, functional disability, general health status, and job satisfaction [41–50].

Table 2. Changes in SF-36 domain scores in the two study groups during the 6-month followup

	SF-36 Survey domain (score)	Kinesiotherapy with visual biofeedback (n = 49)	Classic kinesiotherapy alone (n = 51)	P-value
Before physiotherapy	Physical functioning (PF)	80.92 ± 7.27	81.37 ± 9.80	0.793
	Role limitation due to physical health (RP)	54.59 ± 16.08	53.19 ± 16.41	0.666
	Bodily pain (BP)	39.35 ± 9.09	39.67 ± 9.32	0.863
	General health perception (GH)	59.08 ± 12.18	57.39 ± 14.18	0.525
	Vitality (VT)	51.02 ± 9.23	52.57 ± 12.57	0.484
	Social functioning (SF)	58.93 ± 15.52	60.54 ± 14.66	0.595
	Role limitation due to emotional problems (RE)	82.48 ± 16.86	87.09 ± 16.53	0.171
	Mental health (MH)/Emotional well-being	61.12 ± 10.96	61.76 ± 12.84	0.789
	Health change (HT)	2.06 ± 0.75	2.18 ± 0.79	0.457
	Physical component summary (PCS)	43.81 ± 4.41	43.12 ± 4.38	0.434
	Mental component summary (MCS)	45.60 ± 5.55	46.97 ± 6.56	0.263
Directly after finishing a 10-day rehabilitation program	Physical functioning (PF)	80.92 ± 7.27	81.37 ± 9.80	0.793
	Role limitation due to physical health (RP)	54.59 ± 16.08	53.19 ± 16.41	0.666
	Bodily pain (BP)	39.35 ± 9.09	39.67 ± 9.32	0.863
	General health perception (GH)	59.08 ± 12.18	57.39 ± 14.18	0.525
	Vitality (VT)	51.02 ± 9.23	52.57 ± 12.57	0.484
	Social functioning (SF)	58.93 ± 15.52	60.54 ± 14.66	0.595
	Role limitation due to emotional problems (RE)	82.48 ± 16.86	87.09 ± 16.53	0.171
	Mental health (MH)/Emotional well-being	61.12 ± 10.96	61.76 ± 12.84	0.789
	Health change (HT)	2.06 ± 0.75	2.18 ± 0.79	0.457
	Physical component summary (PCS)	43.81 ± 4.41	43.12 ± 4.38	0.434
	Mental component summary (MCS)	45.60 ± 5.55	46.97 ± 6.56	0.263
6 months	Physical functioning (PF)	93.47 ± 6.71	91.27 ± 7.99	0.141
	Role limitation due to physical health (RP)	78.44 ± 16.98	71.45 ± 16.50	0.039
	Bodily pain (BP)	69.92 ± 15.39	55.69 ± 18.94	< 0.001
	General health perception (GH)	77.61 ± 14.91	70.51 ± 17.45	0.031
	Vitality (VT)	69.26 ± 13.55	66.91 ± 13.71	0.391
	Social functioning (SF)	82.40 ± 12.22	77.21 ± 12.43	0.038
	Role limitation due to emotional problems (RE)	85.71 ± 15.87	89.54 ± 14.42	0.209
	Mental health (MH)/Emotional well-being	73.98 ± 13.27	72.94 ± 12.93	0.693
	Health change (HT)	4.41 ± 0.64	3.47 ± 0.92	< 0.001
	Physical component summary (PCS)	53.40 ± 4.78	49.29 ± 5.63	< 0.001
	Mental component summary (MCS)	50.53 ± 6.58	51.25 ± 5.91	0.564

SF-36 — version 2 of the SF-36 questionnaire for evaluating general health-related quality of life

Strengths and limitations of the study

The innovative contribution of the present study lies in the use of a stabilometric platform as a tool for supporting kinesiotherapy in a homogeneous group of NSLBP patients aged 30–50. Moreover, this study used NSLBP intensity as well as improvement in general HRQoL scores as outcomes measured in respect of the other than NSLBP intensity rehabilitation program efficacy, which, as stated in the introduction, is an approach that is rarely applied. In this study, which, to the best of the authors' knowledge, is the first of its kind, the associations were evaluated between HRQoL and values of parameters of posture stability and adaptation obtained

Table 3. Changes in SF-36 domain scores in the whole study group in relation to the initial intensity of non-specific low back pain expressed as an NRS score during the 6-month follow-up

	SF-36 Survey domain (score)	NRS ≥ 7 (n = 64)	NRS < 7 (n = 36)	P-value
Before physiotherapy	Physical functioning (PF)	89.53 ± 4.15	92.22 ± 4.99	0.005
	Role limitation due to physical health (RP)	66.89 ± 11.77	73.96 ± 14.21	0.009
	Bodily pain (BP)	59.42 ± 10.72	66.17 ± 12.50	0.005
	General health perception (GH)	69.16 ± 14.26	71.08 ± 15.01	0.526
	Vitality (VT)	58.20 ± 8.83	63.02 ± 10.60	0.017
	Social functioning (SF)	77.34 ± 11.33	78.13 ± 14.45	0.765
	Role limitation due to emotional problems (RE)	92.06 ± 11.25	96.30 ± 5.79	0.038
	Mental health (MH)/Emotional well-being	72.50 ± 10.12	74.17 ± 10.39	0.435
	Health change (HT)	4.41 ± 0.79	4.22 ± 0.93	0.297
	Physical component summary (PCS)	48.49 ± 3.27	50.44 ± 4.31	0.012
	Mental component summary (MCS)	50.85 ± 4.63	51.84 ± 4.56	0.306
Directly after finishing a 10-day rehabilitation program	Physical functioning (PF)	89.53 ± 4.15	92.22 ± 4.99	0.005
	Role limitation due to physical health (RP)	66.89 ± 11.77	73.96 ± 14.21	0.009
	Bodily pain (BP)	59.42 ± 10.72	66.17 ± 12.50	0.005
	General health perception (GH)	69.16 ± 14.26	71.08 ± 15.01	0.526
	Vitality (VT)	58.20 ± 8.83	63.02 ± 10.60	0.017
	Social functioning (SF)	77.34 ± 11.33	78.13 ± 14.45	0.765
	Role limitation due to emotional problems (RE)	92.06 ± 11.25	96.30 ± 5.79	0.038
	Mental health (MH)/Emotional well-being	72.50 ± 10.12	74.17 ± 10.39	0.435
	Health change (HT)	4.41 ± 0.79	4.22 ± 0.93	0.297
	Physical component summary (PCS)	48.49 ± 3.27	50.44 ± 4.31	0.012
	Mental component summary (MCS)	50.85 ± 4.63	51.84 ± 4.56	0.306
6 months after finishing a rehabilitation program	Physical functioning (PF)	91.56 ± 7.23	93.75 ± 7.69	0.159
	Role limitation due to physical health (RP)	72.46 ± 16.80	79.17 ± 16.77	0.058
	Bodily pain (BP)	59.67 ± 16.47	67.97 ± 21.18	0.032
	General health perception (GH)	71.89 ± 15.77	77.72 ± 17.48	0.091
	Vitality (VT)	68.75 ± 12.84	66.84 ± 15.00	0.504
	Social functioning (SF)	78.32 ± 11.19	82.29 ± 14.45	0.129
	Role limitation due to emotional problems (RE)	85.94 ± 16.32	90.74 ± 12.56	0.130
	Mental health (MH)/Emotional well-being	73.05 ± 12.43	74.17 ± 14.22	0.682
	Health change (HT)	3.91 ± 0.95	3.97 ± 0.88	0.734
	Physical component summary (PCS)	50.44 ± 5.01	52.85 ± 6.30	0.039
	Mental component summary (MCS)	50.71 ± 5.81	51.22 ± 6.98	0.695

NRS — numeric rating scale; NSLBP — non-specific low back pain; SF-36 — version 2 of the SF-36 questionnaire for evaluating general health-related quality of life

on a stabilometric platform, which were assumed to be potentially helpful for determining factors (e.g., balance impairment) that influence HRQoL in NSLBP patients undergoing kinesiotherapy; however, this hypothesis was not confirmed.

As with the majority of other investigations, this study also has limitations that should be taken into consideration. A significant limitation of the study is the sample size, however, similar to, for example, in work by Michalsen et al [31]. The following study limitation,

Table 4. Changes in SF-36 domain scores in the whole study group in relation to the number of low back pain recurrences during the 6-month follow-up

	SF-36 Survey domain (score)	Number of NSLBP recurrences ≥ 3 (n = 57)	Number of NSLBP recurrences < 3 (n = 43)	P-value
Before physiotherapy	Physical functioning (PF)	81.84 ± 9.62	80.23 ± 7.07	0.356
	Role limitation due to physical health (RP)	53.40 ± 15.58	54.51 ± 17.11	0.737
	Bodily pain (BP)	38.47 ± 9.74	40.88 ± 8.24	0.194
	General health perception (GH)	57.96 ± 14.15	58.56 ± 11.98	0.825
	Vitality (VT)	51.43 ± 11.87	52.33 ± 9.93	0.688
	Social functioning (SF)	59.65 ± 15.49	59.88 ± 14.58	0.939
	Role limitation due to emotional problems (RE)	85.23 ± 16.59	84.30 ± 17.18	0.785
	Mental health (MH)/Emotional well-being	60.44 ± 11.93	62.79 ± 11.87	0.330
	Health change (HT)	2.07 ± 0.75	2.19 ± 0.79	0.459
	Physical component summary (PCS)	43.43 ± 4.55	43.50 ± 4.22	0.935
	Mental component summary (MCS)	46.06 ± 6.36	46.61 ± 5.78	0.658
Directly after finishing a 10-day rehabilitation program	Physical functioning (PF)	90.35 ± 5.50	90.70 ± 3.20	0.712
	Role limitation due to physical health (RP)	67.98 ± 13.10	71.37 ± 12.96	0.202
	Bodily pain (BP)	59.40 ± 11.02	65.09 ± 12.11	0.016
	General health perception (GH)	68.21 ± 14.86	72.02 ± 13.86	0.194
	Vitality (VT)	60.09 ± 10.55	59.74 ± 8.66	0.860
	Social functioning (SF)	77.19 ± 12.97	78.20 ± 11.92	0.692
	Role limitation due to emotional problems (RE)	92.84 ± 11.18	94.57 ± 7.69	0.384
	Mental health (MH)/Emotional well-being	71.58 ± 9.96	75.12 ± 10.26	0.086
	Health change (HT)	4.21 ± 0.84	4.51 ± 0.83	0.077
	Physical component summary (PCS)	48.71 ± 4.03	49.82 ± 3.36	0.147
	Mental component summary (MCS)	50.84 ± 4.88	51.69 ± 4.22	0.363
6 months after finishing a rehabilitation program	Physical functioning (PF)	90.61 ± 8.08	94.65 ± 5.81	0.007
	Role limitation due to physical health (RP)	70.61 ± 15.67	80.52 ± 17.26	0.003
	Bodily pain (BP)	54.46 ± 16.14	73.53 ± 16.09	< 0.001
	General health perception (GH)	69.81 ± 16.95	79.53 ± 14.43	0.003
	Vitality (VT)	65.79 ± 14.66	71.08 ± 11.57	0.054
	Social functioning (SF)	75.88 ± 11.78	84.88 ± 11.75	< 0.001
	Role limitation due to emotional problems (RE)	85.23 ± 16.67	90.89 ± 12.44	0.065
	Mental health (MH)/Emotional well-being	70.61 ± 13.83	77.21 ± 10.98	0.012
	Health change (HT)	3.68 ± 0.93	4.26 ± 0.82	0.002
	Physical component summary (PCS)	49.45 ± 5.31	53.78 ± 5.04	< 0.001
	Mental component summary (MCS)	49.75 ± 6.50	52.40 ± 5.56	0.034

NSLBP — non-specific low back pain; SF-36 — version 2 of the SF-36 questionnaire for evaluating general health-related quality of life

which should be taken into account is the potential influence of confounding factors, such as cognitive function [51], patients' expectations concerning treatment outcome [38, 39], spinopelvic parameters [52], and leg length discrepancy [53], which can potentially affect HRQoL in patients undergoing a rehabilitation program due to NSLBP but which were not evaluated in this study. It is also known that the course of NSLBP can fluctuate and, therefore, 6 months may be too short a follow-up period to estimate the effect of different treatment methods on HRQoL in patients with NSLBP [38].

Conclusions

Compared to NSLBP patients who underwent kinesiotherapy alone, those who undertook kinesiotherapy supported by visual feedback on a stabilometric platform achieved not only a greater reduction in NSLBP intensity, ODI score, and risk of low back pain recurrence but also a higher level of improvement in HRQoL domain scores after a 6-month follow-up. The degree of HRQoL improvement was related to the initial severity of NSLBP and the number of NSLBP recurrences, which should be considered as a secondary outcome in assessing the effectiveness of NSLBP treatment.

Article information

Ethics statement: *The study was performed after receiving permission from the Bioethics Committee of Nicolaus Copernicus University in Ludwik Rydygier Collegium Medicum in Bydgoszcz (no. KB 706/2016 given on November 22, 2016). The study and data analysis were performed in accordance with the revised version of the Helsinki Declaration. Each patient signed a written informed consent form.*

Author contributions: *A.K., K.K.: data acquisition, data interpretation, literature search, writing the article, revising the manuscript critically for important intellectual content, final approval of the version to be submitted. M.P.: data acquisition, data interpretation, revising the manuscript critically for important intellectual content, and final approval of the version to be submitted. A.S.: data interpretation, literature search, writing the article, revising the manuscript critically for important intellectual content, and final approval of the version to be submitted. M.H.-D.: data collection, data interpretation, revising the manuscript critically for important intellectual content, and final approval of the version to be submitted. J.B.: study conception, study design, study supervision, statistical analysis, data interpretation, literature search, writing the article, revising the manuscript critically for important intellectual content, and final approval of the version to be submitted.*

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