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Research Article

Changes in Pain and Disability After a Four-Week Exercise Program in Four Patients with Chronic Non-Specific Low Back Pain: An Uncontrolled Pilot Study

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Abstract

Non-specific low back pain is a leading cause of disability worldwide, and data on exercise programs delivered in resource-limited African settings remain scarce. This uncontrolled, single-arm, pre-post exploratory pilot study describes changes in pain and disability in patients with chronic non-specific low back pain who took part in a supervised exercise program at Gaston Berger University, Saint-Louis, Senegal, in 2022. Of nine adults who started the program, four (three women, one man; aged 24-48 years) completed 12 sessions over 4 weeks combining treadmill walking, elastic-band strengthening exercises of increasing volume, and stretching; five withdrew because of travel or relocation. Pain (numerical rating scale, 0-10), disability (Oswestry Disability Index) and the pain-related impact on daily life (Dallas Pain Questionnaire) were self-reported before and two days after the program. Analyses were descriptive, with exploratory paired t tests. In the four completers, mean pain decreased from 7.00 to 2.75 (mean change - 4.25 points; 95% CI - 6.64 to - 1.86) and mean disability from 43.75% to 19.00% (- 24.75 points; 95% CI - 43.99 to - 5.51); each participant improved by more than published minimal important change thresholds for both outcomes. Dallas scores decreased in all four domains, with a confidence interval including no change for social interest. No adverse event was observed, although adverse events were not a predefined outcome. Pain and disability scores decreased after the program in these four participants. The uncontrolled design, the very small completer-only sample, the absence of assessor blinding and of longer follow-up preclude conclusions about efficacy; the observations may inform the design of a larger controlled study.

Keywords

Low Back Pain, Exercise Therapy, Chronic Pain, Pilot Study, Disability Evaluation, Senegal

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1. Introduction

Musculoskeletal disorders represent a major public health concern in modern societies, affecting developed and developing countries alike [1]. Among these disorders, low back pain occupies a prominent place, often described as the "disease of the century." Low back pain is generally defined as pain located between the thoraco-lumbar junction and the inferior gluteal fold [2].

Low back pain has a lifetime prevalence of 84%, with eight out of ten people affected at least once during their lives [3]. In industrialized countries, its lifetime prevalence reaches 60-70%, and prevalence peaks between the ages of 35 and 55 years [4]. More worryingly, 6-8% of cases progress to chronicity, with substantial personal and socioeconomic consequences [5]. According to the most recent Global Burden of Disease Study, low back pain remains the leading musculoskeletal condition in terms of years lived with disability worldwide, affecting an estimated 619 million people in 2020, with this figure projected to reach 843 million by 2050 and the most pronounced increases expected in Asia and Africa [6]. A systematic review focusing specifically on the prevalence of low back pain in Africa found that lifetime, annual, and point prevalence in African countries exceeded globally reported estimates, underlining the particular relevance of this condition for the region [7].

Low back pain is classified into two broad categories: specific low back pain, which has an identifiable diagnosis and known origin, and non-specific low back pain, which has no clearly identifiable cause. Non-specific low back pain accounts for approximately 85% of all cases [8]. A temporal classification further distinguishes four forms: acute (4-6 weeks), subacute (6-12 weeks), chronic (beyond 3 months), and recurrent (at least two acute episodes within less than one year).

Management of chronic low back pain remains complex and typically requires a multidisciplinary approach. Although physical activity is widely recommended as a first-line intervention in European clinical guidelines [9] and in the 2023 World Health Organization guideline on chronic primary low back pain [10], no consensus currently exists regarding the relative efficacy of one type of exercise over another. A recent network meta-analysis found several exercise modalities to be effective for chronic low back pain without clear superiority of any single approach [11]. A 2025 meta-analysis of core training found that the most favourable modality differed depending on whether pain or function was considered, without significant differences between modalities [12], and existing programs continue to vary considerably in duration, intensity, exercise type, and number of sessions [13-15]. Evidence from African settings, where the burden of low back pain is high [7], remains limited.

This exploratory pilot study therefore aimed to describe changes in pain, functional disability and the pain-related impact on daily life in patients with chronic non-specific low back pain who took part in a supervised four-week program combining walking, elastic-band strengthening and stretching, and to report the local implementation experience. Feasibility outcomes (recruitment, retention and adherence rates) were not defined prospectively, and the study was not designed to test efficacy.

2. Materials and Methods

2.1. Design, Setting, and Participants

This was an uncontrolled, single-arm, pre-post exploratory pilot study conducted at the Biomechanics and Physiology Laboratory of Gaston Berger University, Saint-Louis, Senegal. The exercise program ran from 15 August to 9 September 2022. Participants were recruited among patients followed for non-specific low back pain in the Neurology Department of the Saint-Louis Regional Hospital. The study was not registered in a trial registry.

Sampling was by convenience. Patients were referred by the attending physician and selected on the basis of their educational level, the proximity of their home to the laboratory, and the clinician's judgement, made before enrolment, that they would be able to attend the full program. Inclusion criteria were: (1) chronic non-specific low back pain lasting more than 3 months, diagnosed in the Neurology Department, with or without leg-referred pain, without radiculopathy or neurological deficit; (2) absence of any contraindication to exercise, confirmed by review of the medical records with the attending neurosurgeon; and (3) signed informed consent. Patients with specific low back pain were not included, namely lumbar spinal stenosis, spondylolisthesis, scoliosis, ankylosing spondylitis, vertebral fracture or bone tumour.

The numbers of patients screened, eligible and declining participation were not recorded by the referring department and are therefore not available. Nine patients started the program; five withdrew because of travel or relocation, and four completed all 12 sessions. Only completers were analysed: completion of the program was a criterion applied after enrolment, not an eligibility criterion assessed beforehand. Analgesics prescribed by the treating physician were taken on demand in case of intense pain; their consumption was not quantified. Participants were asked not to undertake any other treatment during the program and reported none. No a priori sample-size calculation was performed.

2.2. Equipment

The equipment comprised an h/p/cosmos motorized treadmill (speed and incline control); resistance elastic bands rated

at 5 kg (ankle mini-bands) and 15 kg (long bands), whose resistance was kept constant throughout the program; and a fitness mat for floor exercises and stretching.

2.3. Intervention

The program comprised 12 supervised sessions (3 per week for 4 weeks), each lasting 45- 60 minutes including rest periods. All sessions were delivered by a Master's student in Science and Techniques of Physical and Sports Activities (Education and Motricity), under the supervision of a coach. Each session comprised: (1) 10 minutes of treadmill walking at 0% incline, starting at 4 km/h and progressing to 6 km/h by the end of the program; (2) elastic-band strengthening exercises targeting the trunk extensor, abdominal, gluteal and pelvic-girdle muscles; and (3) 10 stretching exercises performed at every session. Strengthening volume progressed through the number of exercises (4 in week 1, 6 in week 2, 8 in week 3 and 10 in week 4) and of repetitions (10-14 in weeks 1-2 and 16-20 in weeks 3-4), while band resistance remained constant. One set of each exercise was performed in weeks 1, 3 and 4. Two sets were prescribed in week 2; because participants had difficulty performing the exercises correctly during the second set, the protocol was modified and a single set was used from week 3 onwards. Movements were performed at a slow, controlled tempo, and repetitions were progressed according to individual tolerance. Micro-rest periods between exercises lasted 1 minute in week 1 and 1.5 minutes in weeks 2-4, with a 3-minute rest between the two sets in week 2 (Table 1).

Exercise 1 (standing hip extension): standing behind a chair and holding the backrest, with a 5 kg mini-band around the ankles and the knees slightly bent, the participant leaned forward with a straight back and extended one leg backwards until it was in line with the trunk, without arching the lower back, held the position for 4 s and returned slowly. Exercise 8 (wide-grip prone row): with a 15 kg band attached to a fixed bar and the participant lying prone far enough away for the band to be slightly tensed with the arms extended forward, the participant pulled the band towards the chest, keeping the arms parallel and lifting the chest slightly off the floor, held for 4 s and returned slowly. Exercise 10 (prone straight-leg raise): lying prone with the forehead resting on crossed arms and a 5 kg mini-band around the ankles, the participant raised one leg until the band resistance was felt, held for 2-4 s and returned. Of the 10 stretching exercises, four were held for three breathing cycles, four were held for 15-20 s, and two were performed as 8 repetitions.

All four completers attended the 12 sessions. Symptom exacerbation and stopping criteria (appearance of red-flag signs) were monitored at each session using the pain scale and questioning. No symptom exacerbation, incident or adverse event was observed during the program. However, adverse events were not recorded with a predefined procedure, and no conclusion about safety is drawn from this study.

Table 1. *Content and progression of the 4-week exercise program.*

Week	Sessions (sets × repetitions)	Strengthening exercises (elastic bands)	Stretching exercises	Rest
Week 1	S1: 1×10; S2: 1×12; S3: 1×14	1. Standing hip extension; 2. Seated horizontal row; 3. Trunk curl-up; 4. Donkey kick	Exercises 11-20	Micro-rest 1 min
Week 2	S4: 2×10; S5: 2×12; S6: 2×14	Exercises 1-4 + 5. Deadlift variant; 6. Glute bridge with band	Exercises 11-20	Micro-rest 1 min 30 s; 3 min between sets
Week 3	S7: 1×16; S8: 1×18; S9: 1×20	Exercises 1-6 + 7. Band squat; 8. Wide-grip prone row	Exercises 11-20	Micro-rest 1 min 30 s
Week 4	S10: 1×16; S11: 1×18; S12: 1×20	Exercises 1-8 + 9. Band deadlift; 10. Prone straight-leg raise	Exercises 11-20	Micro-rest 1 min 30 s

S, session. Each session began with 10 min of treadmill walking at 0% incline, from 4 km/h (start of program) to 6 km/h (end of program). Band resistance was constant (5 kg ankle mini-bands; 15 kg long bands). Tempo slow and controlled. Two sets were used in week 2 only (see Section 2.3). Stretching exercises performed at every session: 11. pelvic anteversion/retroversion; 12. piriformis stretch; 13. trunk twist with bent legs; 14. lateral trunk flexion; 15. seated lumbar rotation; 16. lumbar flexion; 17. cat-camel; 18. lumbar extension; 19. child's pose; 20. hamstring stretch.

2.4. Outcome Measures

All outcomes were self-reported in French on paper, after explanation by the provider, at baseline (in the days following review of the medical records, the week before the program started) and two days after the 12th session. The provider who delivered the program also administered the questionnaires; outcome assessment was therefore not blinded.

Pain intensity was measured with an 11 point numerical rating scale (NRS) presented as a horizontal line graduated from 0 (no pain) to 10 (extreme pain). Participants circled or wrote the number corresponding to their pain over the previous 7 days.

Functional disability was measured with the Oswestry Disability Index (ODI) [16], in its validated French version [17]. Its 10 sections are each scored from 0 to 5; the score is the total divided by the maximum possible score for the sections completed (5 × number of sections), multiplied by 100. One missing or non-applicable section was tolerated. At baseline, Patient 1 left one section blank, giving 15/45 = 33.3% (reported as 33%). Scores were categorised as minimal (0-20%), moderate (21-40%) or severe (41-60%) disability, crippling back pain (61-80%) and bed-bound or symptom exaggeration (81-100%) [16]; these categories are descriptive only.

The pain-related impact on daily life was measured with the Dallas Pain Questionnaire (DPQ) [18], in its French version validated by the Groupe d'Étude des Lombalgies [19]. Its 16 items cover four domains: daily activities (items 1-7), work and leisure activities (items 8-10), anxiety/depression (items 11-13) and social interest (items 14-16). In the French version each item is answered by ticking one of six graded boxes; when a participant ticked the line between two boxes, the higher value was counted, as recommended. Each domain score is the sum of its item scores multiplied by a coefficient (×3 for daily activities; ×5 for the other three domains) and is expressed as a percentage, higher scores indicating greater impact. DPQ scores are interpreted as the pain-related impact in these domains rather than as global quality of life.

2.5. Statistical Analysis

Data were processed using Excel and STATISTICA. Given the sample of four completers, individual trajectories and descriptive changes are the primary results. For each outcome we report the mean ± standard deviation (SD) at baseline and after the program, the mean paired change (final-baseline) and its 95% confidence interval (CI) based on the t distribution with 3 degrees of freedom, and the relative change calculated from unrounded means. Pre-post comparisons were analysed in STATISTICA with repeated-measures analysis of variance (ANOVA); with two time points this is equivalent to a paired t test ($F(1, 3) = t^2$), and results are reported as such. These tests and CIs assume approximately normally distributed change scores, which cannot be verified with four observations; they are exploratory and are reported without labels of significance strength. As an illustration of this fragility, a Wilcoxon signed-rank test cannot yield $p < 0.125$ with four pairs.

Statistical significance was distinguished from clinical importance. Individual changes in pain and disability were compared with the minimal important change thresholds proposed by an international consensus: 2 points or 30% for the 0-10 pain scale and 10 points or 30% for the ODI [20]. No such threshold was applied to the DPQ.

2.6. Ethical Considerations

This study was conducted in 2022 as part of a Master's research project. The protocol was not submitted to an ethics committee before the study began; no institutional determination of exemption was obtained, and no other regulatory authorization was sought. The study was not registered in a trial registry.

All participants were adults. They were informed of the aims of the study and of the experimental protocol, volunteered, and gave written, signed informed consent before enrolment. Each patient's medical records were reviewed with the attending neurosurgeon to confirm fitness to participate. The authors acknowledge that written consent and medical clearance do not substitute for independent ethical review.

3. Results

3.1. Sample Characteristics

Nine patients started the program, five withdrew (travel or relocation) and four completed all 12 sessions and were analysed: three women and one man, mean age 35.0 ± 12.9 years (range 24-48 years). All four had non-specific low back pain for more than 3 months and were followed in the Neurology Department. Individual baseline and final scores are shown in Table 5.

3.2. Pain

Mean pain decreased from 7.00 ± 0.82 at baseline to 2.75 ± 1.71 after the program (mean paired change −4.25 points; 95% CI - 6.64 to -1.86; exploratory paired t test, $t(3) = 5.67$, $p = 0.011$; Table 2), a relative decrease of 60.7%. Pain decreased in all four participants, by 3 to 6 points (Table 5), each change exceeding the minimal important change of 2 points and 30% [20].

Table 2. *Pain intensity (NRS, 0-10) before and after the program.*

Variable	Baseline	Final	Mean change (95% CI); p
Pain (NRS, 0-10)	7.00 ± 0.82	2.75 ± 1.71	−4.25 (−6.64 to −1.86); 0.011

Values are mean ± SD (n = 4 completers). Change = final − baseline; 95% CI from the t distribution (3 df), assuming approximately normal change scores, which cannot be verified with n = 4. Exploratory paired t test (equivalent to the repeated-measures ANOVA, F (1, 3) = t^2): t (3) = 5.67.

3.3. Functional Disability

Mean ODI scores decreased from 43.75 ±7.93% to 19.00 ± 10.52% (mean paired change -24.75 points; 95% CI -43.99 to -5.51; t (3) = 4.09, p = 0.026; Table 3), a relative decrease of 56.6%. Individual decreases ranged from 14 to 42 points, all exceeding the 10-point minimal important change [20]. At baseline, one participant was in the moderate and three in the severe disability category; after the program, two were in the minimal and two in the moderate category.

Table 3. Functional disability (ODI,%) before and after the program.

Variable	Baseline	Final	Mean change (95% CI); p
ODI (%)	43.75 ± 7.93	19.00 ± 10.52	−24.75 (−43.99 to −5.51); 0.026

Values are mean ± SD (n = 4 completers). Change = final − baseline; 95% CI from the t distribution (3 df), assuming approximately normal change scores, which cannot be verified with n = 4. Exploratory paired t test (equivalent to the repeated-measures ANOVA, F (1, 3) = t^2): t (3) = 4.09.

3.4. Pain-Related Impact on Daily Life (Dallas Pain Questionnaire)

DPQ scores decreased in all four domains in every participant (Tables 4 and 5). Mean paired changes were -39.75 points for daily activities (95% CI -71.74 to -7.76; p = 0.029), -32.50 for work/leisure (95% CI -61.91 to -3.09; p = 0.039), - 35.00 for anxiety/depression (95% CI -65.47 to -4.53; p = 0.035) and -26.25 for social interest (95% CI −61.46 to 8.96; p = 0.098). Two participants scored 0% for anxiety/depression after the program. The wide intervals reflect the very small sample, and no minimal important change threshold was applied to the DPQ.

Values are mean ± SD (n = 4 completers). Change = final − baseline; 95% CI from the t distribution (3 df), assuming approximately normal change scores, which cannot be verified with n = 4. Exploratory paired t test (equivalent to the repeated-measures ANOVA, F (1, 3) = t^2): t (3) = 3.95 (daily activities), 3.52 (work/leisure), 3.66 (anxiety/depression) and 2.37 (social interest).

Table 4. Dallas Pain Questionnaire scores (pain-related impact,%) before and after the program.

Dimension	Baseline (%)	Final (%)	Mean change (95% CI); p
Daily activities	69.75 ± 6.18	30.00 ± 14.07	−39.75 (−71.74 to −7.76); 0.029
Work / leisure	51.25 ± 14.93	18.75 ± 4.79	−32.50 (−61.91 to −3.09); 0.039
Anxiety / depression	42.50 ± 9.57	7.50 ± 9.57	−35.00 (−65.47 to −4.53); 0.035
Social interest	36.25 ± 20.16	10.00 ± 4.08	−26.25 (−61.46 to 8.96); 0.098

Table 5. Individual pre- and post-program scores (baseline → final).

Outcome	Patient 1	Patient 2	Patient 3	Patient 4
Pain (NRS, 0-10)	7 → 2	8 → 5	6 → 3	7 → 1
ODI (%)	33 → 10	46 → 26	44 → 30	52 → 10
DPQ - daily activities (%)	75 → 15	66 → 42	63 → 42	75 → 21
DPQ - work/leisure (%)	55 → 15	35 → 20	45 → 25	70 → 15

Outcome	Patient 1	Patient 2	Patient 3	Patient 4
DPQ - anxiety/depression (%)	50 → 0	40 → 10	30 → 20	50 → 0
DPQ - social interest (%)	45 → 5	15 → 10	25 → 15	60 → 10

Higher scores indicate greater pain, disability or impact. NRS, numerical rating scale; ODI, Oswestry Disability Index; DPQ, Dallas Pain Questionnaire. Patient 1 baseline ODI: one section not completed (15/45).

4. Discussion

4.1. Statement of Principal Findings

In this uncontrolled pilot study, the four participants who completed a 4-week, thrice-weekly supervised program combining treadmill walking, elastic-band strengthening and stretching reported lower pain (mean change −4.25 points on the 0-10 scale) and lower disability (mean change −24.75 ODI points) two days after the program, and each participant improved beyond published minimal important change thresholds for both outcomes. DPQ scores decreased in all four domains, although the confidence interval for social interest included no change. Because there was no control group, these changes cannot be attributed to the program.

4.2. Strengths and Weaknesses of the Study

The strengths of this report are a detailed description of a supervised protocol with session-by-session progression, the use of validated French-language instruments, and the presentation of individual data. Its limitations are substantial. First, the uncontrolled design means that the observed changes may reflect natural history, regression to the mean (patients are often referred when symptoms are high), concomitant on-demand analgesic use, and the expectation and attention effects of supervised sessions. Second, the sample was very small, selected by convenience on educational level, proximity and anticipated capacity to complete the program, and only completers were analysed (five of nine participants withdrew); the numbers screened are unknown. These factors introduce selection and attrition bias and limit generalizability. Recruitment was mainly hindered by distance, as most referred patients lived outside the commune of Saint-Louis. Third, the provider also administered the outcome questionnaires, without blinding, which may have encouraged favourable responses. Fourth, the final assessment took place two days after the last session, with no longer follow-up. Fifth, inferential statistics with four participants are exploratory and rest on assumptions that cannot be checked. Sixth, feasibility outcomes, adverse events, kinesiophobia and medication use were not measured prospectively, and no mechanistic outcomes (strength, range of motion) were collected. Finally, the study was not reviewed by an ethics committee or registered before it began.

4.3. Strengths and Weaknesses in Relation to Other Studies

Previous controlled trials have examined single-modality programs such as McKenzie exercises [21], lumbar stabilization exercise [22], walking [23] or global postural re-education stretching [24]. Our program combined several components, but its design cannot show whether the combination adds benefit. Regarding walking, the WalkBack randomized trial found that an individualised, progressive walking and education program reduced the recurrence of low back pain in adults who had recently recovered from an episode [25]; this is a prevention population, which differs from patients treated for ongoing chronic pain such as ours. Ozsoy et al. reported improvements with core stabilization exercise combined with myofascial release in older adults with non-specific low back pain [26]. Cochrane systematic reviews of Pilates [27] and of motor control exercise [28], and of exercise therapy more broadly [13], have reported improvements in pain and function compared with minimal intervention, with no clear superiority of one exercise type over another [11, 15]; Calatayud et al. evaluated group-based progressive strength training in primary care in a randomized trial [29]. Unlike these controlled studies and reviews, our design does not allow the magnitude of change to be compared with theirs.

4.4. Discussion of Important Differences in Results

Mean decreases were observed in all DPQ domains, but the confidence interval for social interest was the widest and included no change, reflecting the large baseline variability in this domain (15% to 60%). With four participants, apparent differences between domains cannot be interpreted, and we refrain from mechanistic explanations. Kim and Yim reported improvements in physical function and activity after core stability and hip exercises in a randomized trial [30]; our study did not measure strength, mobility or other mechanistic variables that would allow such links to be examined.

4.5. Meaning of the Study

These observations describe the local implementation of a

supervised program using modest equipment (a treadmill, elastic bands and a mat) in a university laboratory in Senegal, a region where the burden of low back pain has been reported to exceed global estimates [7] and where exercise is recommended by international guidance [9, 10]. No conclusion can be drawn about affordability, scalability, medication use or safety, as costs, analgesic consumption and adverse events were not measured. The implementation experience, difficulty recruiting patients living far from the laboratory, five withdrawals out of nine, and the need to reduce exercise volume after week 2, is relevant to the planning of a larger study.

4.6. Unanswered Questions and Future Research

A larger, prospectively registered randomized controlled trial approved by an ethics committee, with an a priori sample-size calculation, is needed to determine whether such a program is effective. It should define feasibility outcomes in advance (screening, eligibility, recruitment, retention and adherence), use blinded outcome assessment, record adverse events, analgesic use and co-interventions systematically, and include follow-up of 3 to 12 months. Kinesiophobia, which is associated with pain intensity and disability in chronic non-specific low back pain [31] and may decrease with exercise [32], should be measured rather than assumed. Home-based or telerehabilitation formats [33] could be explored to reach patients living far from supervised facilities. Dismantling designs could identify the contribution of each component (walking, strengthening, stretching).

5. Conclusions

Pain and disability scores decreased after the program in these four participants. The uncontrolled design and very small sample preclude conclusions about efficacy; the observations may inform the design of a larger controlled study.

Abbreviations

ANOVA	Analysis of Variance
CI	Confidence Interval
DPQ	Dallas Pain Questionnaire
NRS	Numerical Rating Scale
ODI	Oswestry Disability Index
S	Session
SD	Standard Deviation

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Author Contributions

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Arona Koulibaly: Methodology, Supervision

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Data Availability Statement

The data supporting the outcome of this research work has been reported in this manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

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