



Innovative Therapeutic Exercise Development for Chronic Nonspecific Low Back Pain Improving Pain and Function

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Abstract

Study purpose. Low back pain (LBP) can occur in anyone with musculoskeletal health issues such as acute lumbosacral strain, lumbosacral ligament insufficiency, muscle weakness, osteoarthritis, spinal stenosis, and joint problems. This study aims to develop the an innovative exercise therapy program for the recovery of pain, flexibility, and functional ability in patients with chronic nonspecific LBP.

Materials and methods. This study employed the ADDIE (Analyze, Design, Development, Implementation, Evaluation) research and model development methodology. The participants in this study consisted of documents and seven experts. Data analysis utilized Aiken's formula. The second stage consists of Implementation and Evaluation. A small-scale pilot study was conducted with 7 participants suffering from chronic nonspecific LBP and 2 therapists. A large-scale pilot study involved 15 participants and 4 therapists. Data analysis was performed using the product-moment correlation. Pain was measured using the VAS (Visual Analogue Scale).

Results. The results of the study indicate that an innovative exercise therapy program for the rehabilitation of patients with chronic nonspecific LBP was developed using the ADDIE method, consisting of 20 movements. The exercise therapy innovation for the recovery of pain, flexibility, and functional ability in patients with chronic nonspecific LBP was deemed feasible using the Aiken index, with a lowest V-score of 0.821 and a highest V-score of 1.000 at a 5% significance level of 0.750. The small-scale test yielded a score of 95.16% (valid). The large-scale test yielded a score of 96.53% (valid).

Conclusions. This innovative exercise therapy program consists of 20 exercises that can be used to improve pain relief, flexibility, and functional ability in patients with nonspecific chronic lower back pain. This exercise therapy innovation can serve as an easy, affordable, and beneficial exercise therapy because it can be performed independently, whether at home or at exercise facilities or therapy centers.

Keywords: Exercise, Exercise Therapy, Chronic Nonspecific Low Back Pain

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Introduction

The world is undergoing rapid development, accompanied by cutting-edge technological advancements. Human needs are becoming increasingly complex, leading to significant changes in daily activities. To support daily living needs, humans cannot be separated from physical activity and functional abilities, which are an integration of the human body's systems. Complex human physical activities often lead to various complaints, which can cause fatigue and impair physical condition, thereby hindering a person's productivity (Hardinata et al., 2023; Suryadi et al., 2023). A decline in physical condition can result from an unhealthy lifestyle, excessive workloads, a hectic schedule, as well as insufficient and irregular sleep (Suryadi et al., 2024). A decline in physical condition leads to a decrease in bodily functions; if left unaddressed for too long, it can have fatal consequences, as it may cause various disorders or injuries to parts of the body (Arovah, 2021), and this can occur in all groups, including both athletes and the general public (Apriandi et al., 2023; Athaya et al., 2023; Balore et al., 2026; Da'i et al., 2024; Zulnadila et al., 2025).

LBP is a clinical syndrome that occurs in humans, with the primary symptom being pain or other discomfort in the lower back region. LBP can occur in anyone with musculoskeletal health issues such as acute lumbosacral strain, lumbosacral ligament insufficiency, muscle weakness, osteoarthritis, spinal stenosis, and problems with the (Simanjuntak et al., 2020). LBP patients experience pain in the spinal region (lower back), as well as in the surrounding muscles and nerves (Baron et al., 2016). Lower back pain is typically defined as pain, muscle tension, or stiffness localized below the costal margin and above the inferior gluteal fold, with or without leg pain or sciatica (Bernstein et al., 2017). Some types of LBP are related to the bones, muscles, or ligaments in that area. Chronic Nonspecific Lower Back Pain is a condition characterized by lower back pain that lasts for 12 weeks or longer, without any clear specific cause or pathology (Daneau et al., 2019; Ledford, 2017), or a condition that disrupts the function of joints, ligaments, muscles, nerves, tendons, and the spine (Ganesan et al., 2017). This pain can result from various daily human activities such as bending, pushing, squatting, lifting objects, jumping, running, standing or sitting for too long, and wearing socks and shoes. Some individuals may experience improper neuromuscular adaptations to maintain functions such as walking, running, or other activities (Bernstein et al., 2017; Thornton et al., 2021).

LBP can be triggered by various factors, such as anatomical abnormalities, poor posture, and a lack of physical activity and exercise (a sedentary lifestyle) (Gescheider et al., 2010; Hughes et al., 2020), standing or bending for too long, driving for extended periods, lifting or pulling heavy objects, or an unsuitable mattress (Golob & Wipf, 2014). The causes of LBP are broadly divided into two categories: specific and nonspecific lower back pain. Specific lower back pain is caused by specific diseases, injuries, structural disorders, and nerve root compression. Meanwhile, nonspecific lower back pain is generally caused by strain on muscles, ligaments, intervertebral discs, and joints (Chiarotto & Koes, 2022; S. K. Li et al., 2022; Zhang et al., 2015). The most common cause of lower back pain is located in the myofascial system. Myofascial pain is musculoskeletal pain caused by trigger points in muscles or tendons. Myofascial pain affects up to 95% of people and has also been found to be the primary cause of pain in 85% of patients with LBP (Malanga & Cruz Colon, 2010).

In Indonesia, LBP is a significant health issue. The exact number of people suffering from LBP in Indonesia is not yet known, but it is estimated that the prevalence ranges from 7.6% to 37% of the total population (Kemenkes RI, 2018). The incidence of LBP in several developing countries is approximately 15–20% of the total population, with the majority experiencing either acute or chronic back pain (Buchbinder et al., 2018). At any given time, more than 10% of the population suffers from chronic nonspecific LBP (Dorner et al., 2018), and global prevalence indicates that nearly 20% of people aged 20 to 59 experience LBP due to various causes (Meucci et al., 2015). Observations using the VAS showed high levels of

LBP; most participants experienced moderate to severe pain intensity prior to the intervention. Furthermore, unstructured interviews conducted with several patients suffering from low back pain (LBP) revealed that their LBP stemmed from improper movements, lifting heavy loads or objects such as buckets, large plant pots, or other heavy items, passive and non-ergonomic work postures, sitting for too long, pushing heavy objects beyond their capacity, and some patients were unaware of the initial cause of their LBP. A subsequent study conducted on a group of college students showed that 3.15% of students experienced LBP caused by sitting for too long while facing a computer or laptop (Yuniana et al., 2023).

Therefore, appropriate methods for LBP recovery are needed, including the use of exercise therapy. Exercise therapy is one of the most recommended treatment options for patients with LBP. Exercise can reduce disability and improve the functional status of patients with CLBP (Chronic Low Back Pain) by enhancing fitness levels and functional ability, and can help patients perform daily activities normally (Gasibat & Suwehli, 2017). Exercise therapy can be performed by patients during the chronic phase, where it can help improve or rehabilitate patients with injuries or health conditions (Quentin et al., 2021). Overall, exercise therapy involving systematic physical activities such as stretching helps prevent functional impairments, improve disability, prevent or reduce risk factors for health problems, and optimize health and fitness (Haidar et al., 2024, 2025; Liza et al., 2023; Simplicio et al., 2024). Parameters related to human body function include balance, cardiorespiratory fitness, coordination, flexibility, mobility, motor control, neuromuscular control, postural control, and stability (Arovah, 2016).

Based on the research findings outlined above, it can be concluded that exercise therapy is highly beneficial for the recovery from nonspecific LBP; however, it must be structured around movements that are simple, safe, comfortable, and can be integrated into daily activities. Innovative exercise therapy offers a targeted solution for muscle and joint flexibility exercises, muscle strengthening exercises, and muscle endurance exercises. This exercise therapy program is designed to be simple that is, easy and comfortable to perform, and requiring minimal time, space, and cost. The exercises are expected to provide a solution for lower back pain recovery by improving functional ability, increasing flexibility, and reducing pain intensity. Based on this, there is a need to develop an innovative exercise therapy that is validated for accuracy and tested for feasibility and efficacy in reducing pain and improving flexibility and functional ability in patients with chronic nonspecific LBP. Therefore, this study aims to develop an innovative form of exercise therapy for the recovery of pain, flexibility, and functional ability in patients with chronic nonspecific LBP.

Although there is a growing body of evidence supporting exercise therapy, several important research gaps remain. Previous studies have evaluated the effectiveness of individual exercise modalities such as stretching, core stabilization, motor control exercises, Pilates, yoga, or strength training programs with a focus on clinical outcomes including pain reduction and improvements in disability (Alonso-Sal et al., 2024; Comachio et al., 2025; Jia et al., 2022; Viderman et al., 2025). However, these interventions are often delivered as isolated therapeutic approaches, require supervision by a healthcare professional, or involve complex movement protocols that may reduce patient adherence in community or home settings. Furthermore, relatively few studies have focused on developing and validating a comprehensive exercise therapy model that simultaneously integrates flexibility, muscle strengthening, and muscular endurance exercises into a simple, practical, and evidence-based program suitable for self-administered implementation while evaluating its effects on pain, flexibility, and functional performance collectively. Consequently, there remains a shortage of validated therapeutic exercise models that combine scientific evidence with practical feasibility for routine clinical and home-based rehabilitation.

The urgency of this research is underscored by the high global prevalence and recurrent nature of chronic nonspecific low back pain, which continues to impose a substantial physical, psychosocial, and economic burden while limiting individuals' functional independence and quality of life. Although exercise therapy is strongly recommended in current clinical guidelines (Ganesan et al., 2017; H. Li et al., 2019; Ng et al., 2021; Schulz et al., 2019), there remains a need for interventions that are scientifically validated, easy to implement, cost-effective, and adaptable to various clinical and community settings. Developing an evidence-based therapeutic exercise model with proven validity, feasibility, and effectiveness can improve patient adherence, support self-management strategies, and provide healthcare professionals with a standardized rehabilitation approach. Therefore, this study aims to develop and validate an innovative therapeutic exercise model and test its effectiveness in reducing pain intensity while improving flexibility and functional performance in patients with chronic nonspecific low back pain.

Materials and methods

Participants

The initial phase of this study involved a comprehensive review of international literature on exercise therapy and rehabilitation for chronic nonspecific low back pain (CNSLBP) to establish the conceptual framework for developing the intervention. Subsequently, an exploratory needs assessment was conducted using purposive sampling to recruit seven female participants aged 18–50 years who had experienced CNSLBP. These participants took part in unstructured interviews to identify common symptoms, activity limitations, perceived causes of pain, and expectations regarding exercise-based rehabilitation. The findings from this phase informed the design of the therapeutic exercise model.

The inclusion criteria for participants with CNSLBP were: (1) female adults aged 18–50 years; (2) diagnosis of chronic nonspecific low back pain persisting for ≥ 12 weeks; (3) pain intensity of 3–7 on the 10-cm Visual Analog Scale (VAS), indicating mild-to-moderate pain that allowed safe participation in exercise; (4) ability to walk independently without assistive devices; (5) no participation in structured physiotherapy or therapeutic exercise programs within the previous four weeks; and (6) willingness to participate voluntarily by providing written informed consent. The exclusion criteria were: (1) specific causes of low back pain, including spinal fracture, spinal tumor, inflammatory spinal disease, spinal infection, or radiculopathy with progressive neurological deficits; (2) history of spinal surgery within the previous 12 months; (3) pregnancy; (4) severe osteoporosis or other musculoskeletal disorders that contraindicated exercise; (5) uncontrolled cardiovascular, respiratory, or neurological diseases limiting physical activity; (6) cognitive impairment preventing participants from understanding study procedures; and (7) severe pain (VAS > 7) requiring immediate medical intervention or preventing safe exercise participation.

The expert validation phase involved seven experts with experience in physiotherapy, sports rehabilitation, therapeutic exercise, and musculoskeletal rehabilitation. Experts were selected based on their academic qualifications, professional experience, and expertise in exercise therapy for chronic nonspecific low back pain. Their role was to evaluate the content validity, practicality, and feasibility of the developed therapeutic exercise model. The subjects for the pre-experimental single-treatment design (one-shot case study) consisted of 7 participants for the small-scale test and 15 participants for the large-scale test.

Study organization

This study employed a research and development (R&D) methodology. The development model utilized was the ADDIE model, developed by Dick and Carry (1996). The ADDIE model consists of five development stages.

Table 1. ADDIE Procedure

ADDIE Stages	Description
Analysis Stage	A phase of information gathering that can be used as material
Design Phase	The design phase is the stage of conceptualizing the product to be developed, based on field research and literature review.
Development Stage,	Development is the process of developing the designed product by having it validated by experts and practitioners
Implementation Phase	Implementation is the testing of a product's feasibility for field application through small-scale and large-scale trials.
Evaluation Phase	The process of testing the product's effectiveness according to established or expected criteria.

Table 1 a preliminary study with a qualitative descriptive design was conducted to analyze needs and review the literature to identify the causes and issues related to chronic nonspecific low back pain, examine existing recovery techniques, explore concepts for exercise therapy for chronic nonspecific low back pain, and develop a hypothetical exercise therapy protocol for the recovery from chronic nonspecific low back pain. A development study with an evaluation design. The evaluation design involved assessing the hypothetical exercise therapy among experts using the Delphi technique (Hsu & Sandford, 2007). Subsequently, a pre-experiment with a single-treatment design (one-shot case study) was conducted to test the implementation of the developed hypothetical exercise therapy. This design was used in both small-scale and large-scale trials. It is the simplest design: a group of subjects is given treatment X, followed by assessment O. Table 2 below lists the exercise therapy innovations that have been developed.

Table 2. Innovative Exercise Therapy

No	Description	Research to be conducted
1	Type of Exercise	Various Types of Stretching, Flexibility, and Strengthening Exercises
2	How to Perform the Exercise	Performed 5–7 times a week
3	Exercise Volume	Light-intensity exercise falls into the moderate category, with 5–12 repetitions per set, 2–3 sets, for 20 minutes
4	Number of Repetitions/ Exercises	Using about 20 movements

The pain scale assessment instrument uses the VAS (Visual Analogue Scale). The VAS has a validity coefficient of $r = 0.941$ and a reliability coefficient of 0.97 (Alghadir et al., 2018). The instrument for measuring flexibility uses the Fingertips to Floor (FTF) test. The instrument used to measure the lumbar functional disability index is the Modified Oswestry Disability Index (M-ODI).

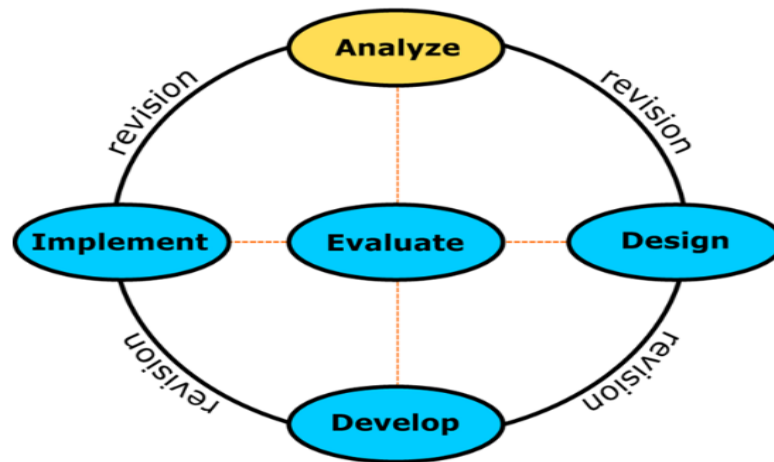


Figure 1. Stages of the ADDIE Model

Data Analysis

Data analysis techniques in this study were conducted through three main stages tailored to the objectives of each research phase. In the initial stage, data were analyzed using a qualitative thematic analysis approach as described. The analysis process began with preparing and grouping data obtained from observations, interviews, and documentation. Next, the researcher identified items relevant to the research focus, then organized the data based on common topics or specific themes. Data with similar characteristics were subsequently examined to form representative thematic categories. Subsequently, content validity analysis is conducted using Aiken's V validity coefficient, developed by Lewis R. Aiken (1985). This technique is used to measure the level of agreement among experts regarding the relevance, clarity, and appropriateness of the research instrument.

During the product testing phase, the study employed a pre-experimental design in the form of a one-shot case study using a quantitative analysis approach. Data analysis was conducted to determine the effectiveness of the product or treatment administered to the research subjects following implementation. The quantitative data obtained were analyzed descriptively through the calculation of mean values, percentages, and the interpretation of result categories to describe the success rate of the developed product's implementation. This approach was used to provide an empirical overview of the responses and outcomes of product use within the research context. The analysis was conducted using SPSS 26.

Results

Chronic nonspecific LBP is one of the most common musculoskeletal disorders experienced by people. Approximately 80% of the world's population has experienced LBP at least once in their lifetime. This makes LBP a critical issue that requires attention, particularly regarding the development of treatment therapies for LBP. The exercise therapy developed in this study includes 20 types of exercises. These exercises are Knee to Chest, Double Knee to Chest, Lower Back Twist, Bridge Pose, Back Extension, Seated Trunk Twist, Butterfly Stretch, Child's Pose, Side Child's Pose Stretch, Head to Knee, Cat-Cow Pose, Downward Dog, Standing Side Bend, Triangle Pose, Deep Lunges, Partial Curl-Ups, Superman Lift, Boat Pose, Side Plank, and Leg-Hand Balance. This exercise therapy innovation model focuses on specific muscles, namely the lower back/lumbar muscles (*latissimus dorsi*, lumbar triangle, iliac crest, *iliocostalis lumborum*, *serratus posterior*) and the gluteal muscles (*gluteus muscles*). For a more complete and clear overview, the initial draft of the exercise therapy program developed includes 20 types of exercises along with their implementation procedures as follows:

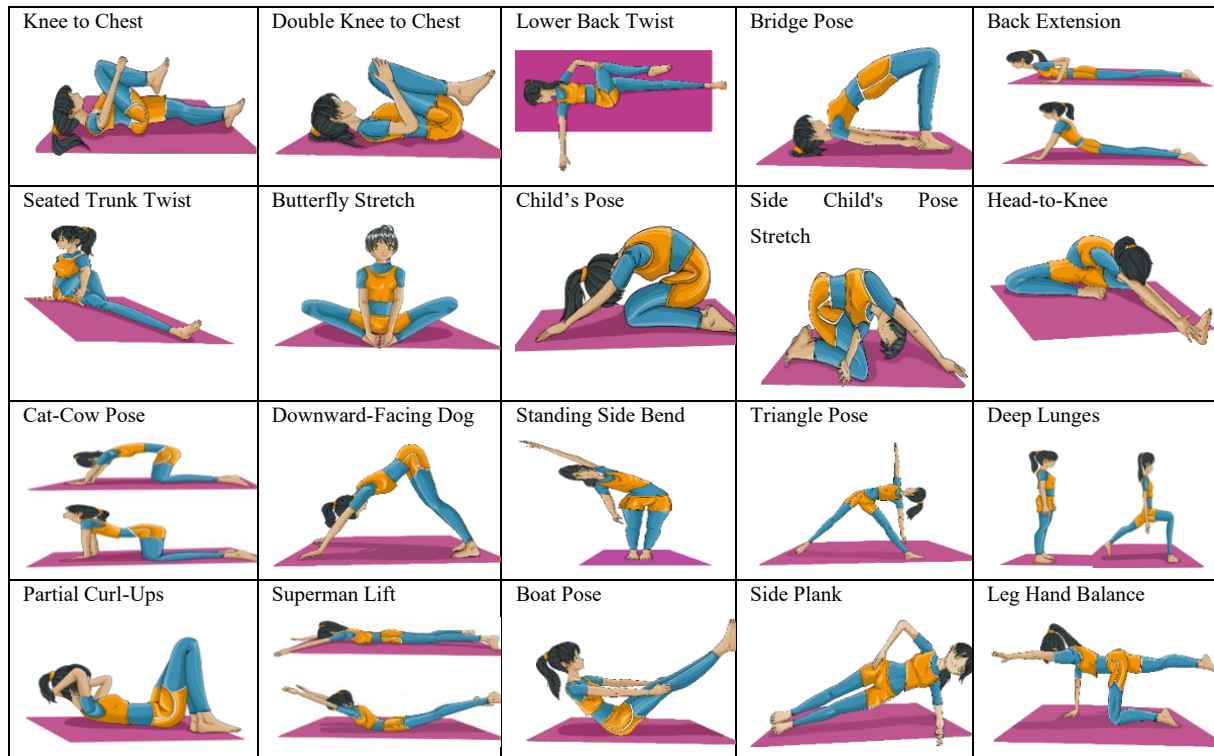


Figure 2. Exercise Therapy Innovation Model for LBP

Validity testing was conducted by several expert validators. Validity was calculated using the Aiken's V Index formula. Content validity using the Aiken's V Index quantifies the validators' judgments in assessing an item, thereby determining the content validity index of that item. The results of the validity testing using the Aiken's V Index for the validation of the initial draft of this study are as follows. Table 3 shows the results of the validity calculations using Aiken's V Index for the 10 statement items, with the lowest V score being 0.821 and the highest V score being 1.000. The conclusion regarding validity using Aiken's V Index is drawn by comparing Aiken's V Index with the V table value. The table V value for items evaluated by 7 validators with a 5-point Likert scale at a 5% significance level is 0.50. Based on the calculation results, it can be concluded that all 10 items have an Aiken's V Index value greater than the table V value (>0.50), meaning that all items are deemed valid. Based on the results of the validity test, it is concluded that the developed exercise therapy is valid based on the assessment by expert validators, including the clarity of the exercise therapy content and the clarity of the exercise therapy procedures. Statistical calculations of the validity test using Aiken's V Index indicate that the statement items are valid.

Table 3. Results of the Aiken's V Index Validity Test

No	Statement	Rating							Aiken's V Index
		1	2	3	4	5	6	7	
1	The exercise therapy model is tailored to the goal of reducing pain.	5	5	4	5	5	5	4	0.929
2	The exercise therapy model is tailored to the goals of recovery and improving flexibility.	5	5	5	4	5	5	4	0.929

3	The exercise therapy model is tailored to the goal of restoring functional ability.	5	5	5	5	5	5	5	1,000
4	The movements developed in the exercise model are easy to perform.	5	5	4	4	5	5	4	0.893
5	The movements developed in the training model are consistent with training principles.	5	4	4	4	4	5	5	0.857
6	The movements developed in the training model are interesting.	5	4	5	4	5	5	4	0.893
7	The exercise therapy model developed is safe for patients with chronic nonspecific LBP.	5	5	4	4	4	5	5	0.893
8	The exercise therapy model developed is suitable for patients with chronic nonspecific LBP aged 18–50 years.	4	5	4	5	3	5	5	0.857
9	The images and text in the practice model are clear and easy to understand.	5	3	5	4	4	5	4	0.821
10	The exercise therapy model is tailored to the needs of patients with chronic nonspecific LBP.	5	5	4	4	5	5	4	0.893

(The complete validity calculation can be found in the appendix)

Table 4. Input and suggestions from expert validators regarding the initial draft

Name	Comments
Prof. Dr. Ali Satia Graha, M.P.H., AIFO	Exercise therapy has met the objectives outlined in the title as intended by the researchers, covering exercise, exercise programs, safety, comfort, and enjoyment of movement. The recommendation provided is that movements be sequenced according to the initial position (lying down, sitting, standing, either supine or prone).
Prof. Dr. dr. Rachmah Laksmi Ambardini, M.P.H.	The exercise therapy model developed is appropriate for the needs of patients with chronic nonspecific LBP.
Prof. dr. Novita Intan Arovah, M.P.H., Ph.D.	The criteria for chronic nonspecific LBP targeted in this therapy are defined, such as chronic nonspecific LBP in the acute, subacute, or chronic phases, along with their justifications.
Arif Indriyanto, S.Or	The exercise therapy program developed features excellent exercises that are easy to perform independently. The recommended exercises are comprehensive and can be performed sequentially while lying down, sitting, or standing. Patients can easily perform them. The illustrations and instructions are clear and easy to understand.
Danang Dwi Purwanto, M.Or	The exercise therapy developed is excellent in terms of its movements and is easy to perform independently. The recommended exercises are complex and can be performed sequentially while lying down, sitting, or standing. Patients

Neni Wijayanti, S.Or	can easily perform them. The illustrations and instructions are clear and easy to understand. The exercises in the training program are appropriate for managing chronic nonspecific LBP. The recommendations provided should specify the frequency of the training sessions—for example, whether they should be done daily, 3–5 times a week, or only when pain occurs. Based on our clients' experiences, once the chronic nonspecific LBP subsides, clients often stop performing the exercises we recommend. Consequently, when the client is engaged in high levels of activity, the pain may resurface.
Eko Budianto, S.Or	A trial of the exercise program is required before data collection, and expert or practitioner supervision is necessary during the research implementation.

There were seven experts who served as validators in this study, namely: (1) Dr. Ali Satia Graha, M.Kes., AIFO, a lecturer at Yogyakarta State University, as a subject matter expert; (2) Dr. dr. Rachmah Laksmi Ambardini, M.Kes, serving as a Lecturer at Yogyakarta State University, as a subject matter expert; (3) Prof. dr. Novita Intan Arovah, M.P.H., Ph.D, serving as a Lecturer at Yogyakarta State University, as a subject matter expert; (4) Arif Indriyanto, S.Or, serving as a practitioner expert, (5) Danang Dwi Purwanto, M.Or, serving as a practitioner expert, (6) Neni Wijayanti, S.Or, serving as a practitioner expert, (7) Eko Budianto, S.Or, serving as a practitioner expert. The initial draft of the exercise therapy is suitable for pilot testing with revisions based on input and suggestions from the validators. Input and suggestions from the expert validators regarding the initial draft of the exercise therapy can be seen in [Table 5](#).

Table 5. Subjects' Assessment Results Regarding Exercise Therapy in the Small-Scale Trial

No	Statement	Total	%
1	Developing an innovative exercise therapy model for the recovery of pain, flexibility, and functional ability in patients with chronic nonspecific LBP is a very interesting endeavor	34	97.14
2	The movement steps in the innovative exercise therapy for pain relief, flexibility, and functional ability in patients with chronic nonspecific LBP are easy to understand	31	88.57
3	The exercises used in physical therapy to improve pain relief, flexibility, and functional ability in patients with chronic nonspecific LBP are not monotonous	34	97.14
4	The exercise therapy innovations developed for pain relief, flexibility, and functional ability in patients with chronic nonspecific LBP are easy to perform	33	94.29
5	The developed exercise therapy innovation can increase the motivation of patients with chronic nonspecific LBP to perform exercises	34	97.14
6	The movements in the exercise therapy innovation for pain relief, flexibility, and functional ability are safe for patients with chronic nonspecific LBP.	35	100
7	Exercise therapy innovations for pain recovery, flexibility, and functional ability—the movements are not too strenuous for patients with chronic nonspecific LBP	33	94.29

8	The movements in the developed exercise therapy do not cause or exacerbate injuries	33	94.29
9	Innovative exercise therapy for pain relief, flexibility, and functional ability in patients with chronic nonspecific LBP can be performed anywhere and at any time	34	97.14
10	The developed exercise therapy innovation is appropriate and beneficial for the recovery of pain, flexibility, and functional ability in patients with chronic nonspecific LBP	32	91.43
Total		333	95.14

The rating scale for the pilot survey used a Likert scale with ratings from 1 to 5, consisting of 10 questions. Based on the table above, the pilot study responses showed a total score of 333 with a percentage of 95.16%. Overall, the subjects in the small-scale pilot study agreed that exercise therapy is appropriate, safe, and beneficial for the recovery of pain, flexibility, and functional ability in patients with chronic nonspecific LBP. The results can be seen in [Table 6](#).

Table 6. Subjects' Assessment of Exercise Therapy in the Large-Scale Trial

No	Statement	Total	%
1	Developing an innovative exercise therapy model for the recovery of pain, flexibility, and functional ability in patients with chronic nonspecific LBP is a very promising endeavor	74	98.67
2	The movement steps in the innovative exercise therapy for pain relief, flexibility, and functional ability in patients with chronic nonspecific LBP are easy to understand	71	94.67
3	The movements in exercise therapy for pain relief, flexibility, and functional ability in patients with chronic nonspecific LBP are not boring	73	97.33
4	The exercise therapy innovations developed for pain relief, flexibility, and functional ability in patients with chronic nonspecific LBP are easy to perform	70	93.33
5	The developed exercise therapy innovation can increase the motivation of patients with chronic nonspecific LBP to perform exercises	72	96
6	Exercise therapy interventions for pain relief, flexibility, and functional ability are safe for patients with chronic nonspecific LBP.	75	100
7	Exercise therapy innovations for pain recovery, flexibility, and functional ability involve movements that are not too strenuous for patients with chronic nonspecific LBP.	70	93.33
8	The movements in the developed exercise therapy do not cause or exacerbate injuries	73	97.33
9	Exercise therapy innovations for the recovery of pain, flexibility, and functional ability in patients with chronic nonspecific LBP can be performed anywhere and anytime	72	96
10	The developed exercise therapy innovation is appropriate and beneficial for the recovery of pain, flexibility, and functional ability in patients with chronic nonspecific LBP	74	98.67
Total		724	96.53

Based on the table above, the assessment results from the large-scale study on exercise therapy show progressively better outcomes. These positive results indicate that the exercise therapy developed is increasingly effective in providing benefits for pain recovery and improving flexibility and functional ability in patients with chronic nonspecific LBP. The assessment score from the large-scale study increased to 96.53%.

Discussion

This study aims to develop an innovative form of exercise therapy for pain relief, flexibility, and functional ability in patients with chronic nonspecific low back pain. The main focus here is on the effectiveness of exercise therapy for pain relief, improving flexibility, and enhancing functional ability in patients with chronic nonspecific low back pain. Exercise therapy was administered to patients through regular exercise sessions, and the acute effects of the therapy were assessed. The study results show high recovery scores for patients with CNLBP through innovative exercise therapy. Innovative exercise therapy offers targeted solutions for muscle and joint flexibility exercises, muscle strengthening exercises, and muscle endurance exercises. This exercise therapy program is designed to be simple, consisting of 20 easy and comfortable movements, and requires minimal time, space, and cost. Exercise therapy, such as core stability exercises, can effectively reduce pain and thus alleviate discomfort in patients with chronic nonspecific lower back pain (S. K. Li et al., 2022). In fact, other methods such as acupuncture and massage also have a positive effect on pain reduction in LBP (Chou et al., 2014; Comachio et al., 2020; S. K. Li et al., 2022; Mu et al., 2020; Parfenov et al., 2019; Kumar. et al., 2017; Zotti et al., 2013). This is due to the strengthening of the lumbar muscles, as evidenced by increased electromyographic signals in the multifidus muscles and improved lumbar function in patients with chronic nonspecific LBP (Tuninetti et al., 2025; van Middelkoop et al., 2010). Additionally, the effects of physical exercise can reduce pain in patients with chronic nonspecific LBP and increase serum cortisol levels in individuals with LBP (Barros dos Santos et al., 2021).

Treating chronic nonspecific LBP with appropriate exercise is more effective than no treatment or standard care such as electrotherapy or education alone (Hayden et al., 2021). In exercise therapy, such as the Pilates exercise model, Pilates can provide benefits for increasing strength and restoring the function of muscles that are interconnected or involved in lumbopelvic stabilization, namely the transversus abdominis, multifidus, diaphragm, and pelvic floor muscles (Eliks et al., 2019). Lower back exercise programs provide positive benefits for increasing abdominal muscle strength and can effectively reduce pain or discomfort caused by LBP (Hayden et al., 2021; Hong & Lee, 2020; Lindberg & Leggit, 2022). Active exercise can serve as a therapeutic intervention or treatment to reduce pain in patients with LBP, improving their health and fitness levels compared to passive relaxation alone (Peng et al., 2022). During exercise, specific principles of this program must be followed and implemented with the goal of restoring or maintaining motor control of the lumbar spine and proper body posture.

Flexibility is essential for human movement. For individuals with LBP, flexibility plays a significant role in enabling movement, as those experiencing LBP often face movement limitations such as walking, bending, sitting for extended periods, or other physical activities (Lim et al., 2018; Thornton et al., 2021). To maintain and preserve good flexibility in individuals with LBP, they must perform exercise therapy regularly and consistently, in accordance with appropriate exercise intensity and exercise principles (Thornton et al., 2021). Based on all flexibility measurement data, such as flexion, extension, and left and right FTF, it can be concluded that exercise therapy effectively improves flexibility in patients with chronic nonspecific LBP. Exercise therapy effectively improves the flexibility of muscles, ligaments, and tendons in the back, helping to expand the range of motion, which is beneficial for patient

recovery (Suh et al., 2019; Thornton et al., 2021). Exercise therapy, such as stretching exercises, can improve joint range of motion (ROM) and enhance muscle function (Reiner et al., 2021).

The functional ability of patients with LBP must be improved so that they can perform daily activities smoothly without any interference or pain that might disrupt their daily routines. Well-structured exercise therapy can improve the functional ability of patients with chronic nonspecific LBP. Based on research findings regarding exercise therapy for the recovery of patients with chronic nonspecific LBP, there is a reduction in disability scores, leading to an increase in the functional ability of these patients. This occurs because exercise stimulates and increases blood flow and nutrient delivery to the soft tissues in the back, enhancing the recovery process and reducing muscle tension, which in turn alleviates back pain. Consequently, this improves the functional ability of patients with chronic nonspecific LBP to resume normal daily activities (Schulz et al., 2019; Shipton, 2018).

Conclusions

Based on the research findings, this study successfully developed an ADDIE-based exercise therapy model consisting of 20 movements for patients with lower back pain. This program has been validated by experts and is suitable for use as an exercise therapy for patients with chronic nonspecific lower back pain. This innovative exercise therapy is effective in reducing pain, improving flexibility, and enhancing functional ability in patients with nonspecific chronic lower back pain. For patients with lower back pain, this innovative exercise therapy can serve as an easy, affordable, and beneficial exercise program because it can be performed independently, either at home or at a gym or therapy center. A limitation of this exercise therapy is that it is designed only for chronic nonspecific low back pain (CNLBP) with mild to moderate pain intensity. Further research is recommended to apply this innovative exercise therapy to patients with chronic nonspecific low back pain and to compare it with other methods.

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Conflict of interest

The author declares that there is no conflict of interest in the preparation, implementation of the research, data analysis, writing, or publication of this article. The author also declares that this research was conducted independently without any personal, commercial, or financial interests that could influence the results or interpretation of the research.

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