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Review

Rehabilitation Outcome Measures in Patients with Spinal Stenosis: A Literary Review

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Abstract: Background: Lumbar spinal stenosis causes considerable disability in everyday life; its incidence is increasing due to aging in the world population. First-line treatment is generally conservative, but rehabilitation outcome is still unclear; the aim of this systematic review was to define which domains need to be evaluated for the lumbar stenosis physiotherapy approach, further specifying if the literature suggests patient-centred or objective measures. Methods: A systematic review of the literature according to the PRISMA statement was carried out; the PICO model was used to draw research questions. RCTs about the rehabilitation of lumbar spinal stenosis conducted in the last five years were considered includible, with no difference in terms of stenosis location. The following databases were screened through specific search strings: PubMed, EBSCO, PEDro, Cochrane Database, Scopus, and Google Scholar; two independent researchers assessed results and a third opinion was requested to solve conflicts. Critical appraisal of the included studies was conducted through Pedro Jadad scores. The following data were extracted: author and year, country, sample, intervention, outcome domains, and tools. Results: From 10,069 records, three RCTs were included in the final review stage; they all showed high methodological quality. It is recommended for physiotherapists dealing with lumbar spinal stenosis to assess five main domains: disability, pain, clinical tests, mental wellbeing and kynesiophobia, and quality of life. Domains were mainly assessed through self-reported questionnaires/scales, while objective tests evaluate general lower limb movements, the active range of motion, or the muscles' endurance. Conclusion: This five-domain evaluation model is reliable and can be practised in each rehabilitation setting (home, outpatient, and hospital); sustainability is guaranteed by the prevalent employment of self-reported tools. Future studies should evaluate the best questionnaire/scale for each domain, especially the definition of a gold standard for pain assessment in patients with lumbar stenosis as this is a challenge for the future.

Keywords: lumbar spinal stenosis; rehabilitation; outcome measures; disability; quality of life; clinical tests

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1. Introduction

Lumbar Spinal Stenosis (LSS) is the narrowing of the spinal canal or intervertebral foramina by surrounding bone and soft tissue, compressing neural and vascular structures [1]. Lumbar spinal stenosis affects more than 200,000 people in the United States, causing substantial pain and disability [2].

Current aetiology models support two LSS types:

- Congenital LSS, due to postnatal disorders which cause pathological stricture of the central spinal canal. This form is quite rare (only 4–5% of all LSS) [3].
- Acquired LSS due to aging and subsequent degenerative changes of spinal structures, particularly facet joints, intervertebral discs (with associated bulging), and the ligamentum flavum.

- Combined LSS deriving from both of the precedent conditions [4].

LSS could create a canal compression in different directions: central, lateral recess, and in the neurologica foramen [5,6].

A typical symptom of lumbar spinal stenosis is pain at the gluteus level and/or lower extremities, which may or may not be associated with the lower back [7]. Neurogena claudication is a hallmark symptom of LSS and is characterised by pain in the lower limbs and the presence of neurological symptoms exacerbated by walking [8]. In addition, these symptoms are exacerbated by standing and lumbar extension. Anterior flexion of the trunk and maintaining a sitting and supine position alleviate symptoms [9].

LSS symptoms significantly impact the patient's everyday life, affecting mobility, functional independence, and physical activity. Most people with symptomatic LSS have limited walking ability to the extent that they resort to the use of aids or, in extreme cases, of a wheelchair [10–13]. This limitation affects the patient's general health and physical performance, even leading to sedentary behaviour [14].

Traditionally, a cycle of conservative treatments is prescribed for most patients with lumbar spinal stenosis before considering surgery [15]. Conservative treatment may include drugs, physiotherapy, acupuncture, injections, postural education, and cognitive-behavioural treatments [16]. Physiotherapists recommend flexibility exercises, stabilisation exercises, strengthening exercises, heat or ice, acupuncture, and joint mobilisation [17]. In case of failure of conservative treatment and persistence of symptoms, surgery is considered [18,19].

Many attempts to reach an overall judgment about the best conservative practice on LSS patients have been conducted in past years [20,21]: a 2016 Cochrane systematic review (aimed at comparing surgical and conservative LSS management) stated that conservative approaches are often not well-described based on multimodal treatment, with an overall low quality of available articles [22]. A most recent document states that a comprehensive multimodal conservative approach can be considered moderately safe and effective on LSS patients with neurogena claudication [17].

In light of this, a clear guideline for LSS physiotherapy and treatment of LSS symptoms has not yet been established; another criticality is represented by the wide spectrum of clinical features of LSS, which affect quality of life, movement ability, self-efficacy, and caregiver dependence [23].

In fact, studies focus on a wide range of rehabilitative outcome measures, not stating a shared and significant evaluation for these patients; individual aspects of treatment are often reported such as pain, functionality, alleviation of symptoms, and recourse to surgery [24,25]. This can lead physiotherapists to overlook the complexity of LSS [26], quantifying a rehabilitative approach only through partial evaluations that do not accurately reflect all possible mental/physical improvements.

With this perspective, the first aim of this review was to establish which outcome domains and related measures were indicated in the scientific literature regarding rehabilitation treatment in patients with LSS. The second objective was to then find out whether the literature recognises predominantly patient-centred outcome measures, and also whether objective variables are described.

2. Methods

A literary review was conducted in accordance with the Prisma Statement [27]. This research was aimed at describing existing evidence about rehabilitation treatment evaluation for LSS patients; particularly, we wanted to better compare positively influenced areas of rehabilitation by studying all of the dimensions that could be improved, not only referring to symptoms but also to the patient's general wellbeing and quality of life.

With this perspective, we identified two research queries (RQ):

1. RQ1: Which are the main outcome domains to be evaluated in the rehabilitation of the patient with lumbar stenosis?
2. RQ2: Does the literature only suggest self-reported outcome measures (questionnaires) or does the literature include objective scores?

These RQs were further declined according to the PICO (population, intervention, comparison, outcome) model [28,29]:

- P: Patients with a diagnosis of lumbar spinal stenosis, with an indication to undergo an intensive physiotherapy treatment period. No difference was defined depending on stenosis location (central canal, lateral recess, foramen).
- I: Physiotherapy modalities (therapeutic exercises, manual therapy, strength exercises, stretching protocols, aerobic exercises), even in multidisciplinary rehabilitation plans.
- C: Inactive control groups or usual care prosecution.
- O: Physiotherapy-related tools, both patient-centred (questionnaires) and objective ones (evaluation scales performed by physiotherapists, clinical/instrumental tests). Patient satisfaction was not considered. The main hypothesised domains of outcome: functionality, quality of life, pain, symptom control, and fear of movement.

Exclusion criteria: patients who underwent low back surgery; patients with cervical disc degeneration or cervical stenosis; patients treated with physical therapy, hydrokinesiotherapy, and epidural injections; manipulative approach; previous history of neurological disease (both acute and neurodegenerative ones); psychiatric disease.

Our theoretical inclusion profile was drawn in order to achieve a faithful description of an LSS patient who undergoes rehabilitation intervention alone, with no other similar comorbidities and no previous history of other treatment approaches (even conservative ones). This strategy also prevented possible selection/intervention bias.

We searched for randomised controlled trials published in the last five years, in English or Italian.

The electronic search was performed by two independent researchers; in case of doubt, a third team member's opinion was required to solve conflicts. Search results were screened firstly by title and abstract, then by full-text retrieval and reading; data extraction was performed on the final included articles. For each study, first author, year, country, sample, intervention, outcome tools, and timing of administration were elaborated in tabular form and described in a narrative results paragraph.

Includible RCTs were evaluated using PEDro Scale [30] and Jadad [31] scores in order to assess the methodological quality of includible studies.

Search Strategy

The databases screened were PubMed, Medline, EBSCO, PEDro, the Cochrane Database for Systematic Reviews, Scopus, and Google Scholar. The search strings used for each database are described in Table 1. Databases were last accessed on 22 September 2022.

Table 1. Search string for each included database.

Database	Search String
Pubmed	[[lumbarised OR lumbarization OR lumbars OR lumbosacral region OR lumbosacral region [mesh]]] AND [[spinal stenosis [mesh] OR spinal stenosis]] AND [[physical therapy modalities [mesh] OR rehabilitation [mesh] OR strenght exercise OR manual therapy OR stretching exercise OR multidisciplinary treatment]] AND [outcome assessment]; filters: from 2017 to 2022
Cochrane	[["lumbarised" OR "lumbarization" OR "lumbars" OR "lumbosacral region" OR ["lumbosacral" AND "region"] OR "lumbosacral region"]] AND [["spinal stenosis" OR ["spinal" AND "stenosis"] OR "spinal stenosis"]] AND [["physical therapy modalities" OR "rehabilitation"]] AND ["outcome assessment"] in All Text; filters: from 2017 to 2022
Scholar	[[lumbarized OR lumbarization OR lumbar OR lumbosacral region]] AND [[spinal stenosis]] AND [[physical therapy modalities OR rehabilitation OR strength exercise OR manual therapy OR stretching exercise OR multidisciplinary treatment]] AND [outcome assessment]; filters: from 2017 to 2022
Scopus	[lumbar OR lumbosacral AND region OR lumbarization] AND [spinal AND stenosis] [physiotherapy OR rehabilitation OR manual AND therapy OR strength AND exercise OR stretching OR multidisciplinary AND rehabilitation] in All fields; filters: from 2017 to 2022
Pedro	Simple search: lumbar spinal stenosis physiotherapy
EBSCO	[[lumbarised OR lumbarization OR lumbars OR lumbosacral region]] AND [[spinal stenosis]] AND [[physical therapy modalities OR rehabilitation OR strength exercise OR manual therapy OR stretching exercise OR multidisciplinary treatment]] AND [outcome]; filters: from 2017 to 2022

3. Results

The selection strategy among all database results was conducted as described in Figure 1 (Prisma statement flowchart for databases and registers). The search yielded a total of 10,069 results. Duplicates (n = 2352) and articles unsuitable for automation tools (n = 54) were initially removed. From the remaining 7663 articles, a further 7179 were excluded by reading the title and abstract. The remaining 484 results were searched for full-text screening, and 257 were discarded because the full text could not be found. The full text of 227 articles was screened and, of these, 93 were eliminated as they did not meet the study design, a further 49 studies were eliminated as they considered drug-related outcomes, and a further 81 studies were eliminated as they described a surgical approach to spinal stenosis. Finally, one article was eliminated because it described a 12-month follow-up of a previously included study. Finally, three RCTs were included in the present review.

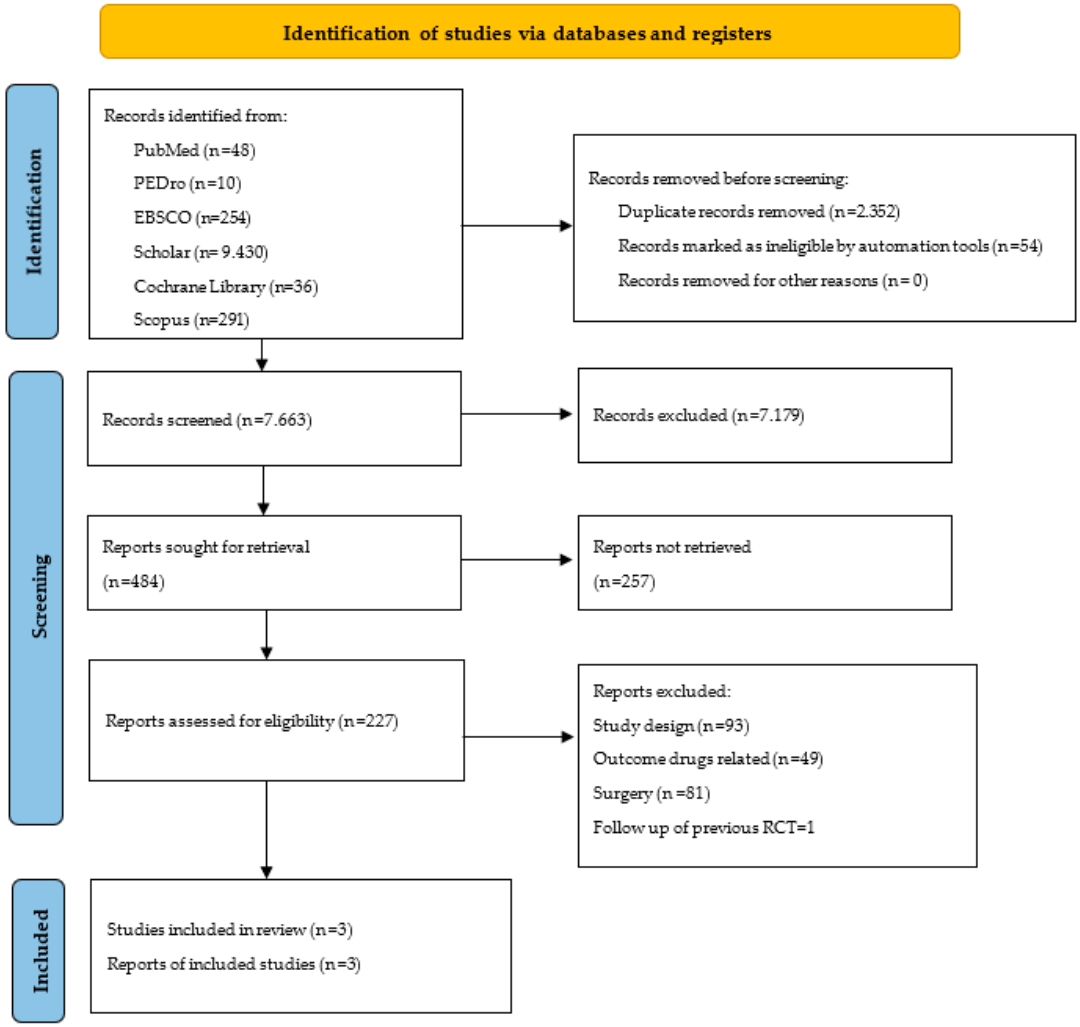

Figure 1. Results selection and inclusion according to the PRISMA 2020 flow diagram for databases and registers. As shown, a total of 10,069 records emerged in the overall search. In the first screening, duplicates (2352) and ineligible results (missing/not retrieved data, 54) were excluded. Using a double assessor title/abstract evaluation strategy, a further total of 7179 was excluded. Full-text retrieval was so applied to 484 articles; of these, only 227 were finally evaluated through full-text reading. Adherence to inclusion criteria determined the exclusion of 224 records, with final admission for three articles.

Each article's extracted data are shown in Table 2.

Table 2. Data extraction table. Abbreviations: LSS: lumbar spinal stenosis; exp: experimental; Cont: control; ODI: Oswestry Disability Index; SPWT: Self-Paced Walk Test; SPPB: short physical performance battery; CES-D: centre epidemiological studies depression scale; FES: falls efficacy scale; NRS: Numerical rating scale; JOABPEQ: Japanese Orthopaedic Association Back Pain Evaluation Questionnaire; HADS: Hospital Anxiety and Depression scale; PCS: pain catastrophizing scale; PASS-20: Pain anxiety symptoms scale; SF-36: short form-36.

Author	Year	Country	Sample	Intervention	Outcome and Tools	Critical Appraisal Score
Ammendolia C et al. [29]	2018	USA	104 patients with LSS, randomly divided in experimental [n = 51] or control arm [n = 53].	Exp: 6-week comprehensive physiotherapy protocol (which involved education, active exercises, manual therapy, stretching exercises) Cont: 6-weeks autonomous rehabilitation programme with standard activities Follow up at 8 weeks and 3/6/12 months	Walking ability: SPWT test General movement ability: SPPB Disability LSS related: ODI/Zurich questionnaire Pain: NRS for back, legs and numbness Depression: CES-D Fear of Falls: FES	Pedro score 8/10 Jadad Score 4/5
Minetama M et al. [30]	2019	Japan	86 patients with LSS assigned to experimental [n = 43] or control arm [n = 43].	Exp: supervised 6-weeks physiotherapy programme (manual therapy, stretching and strengthening exercises, cycling, body weight supported treadmill sessions) Cont: standard lumbar flexion exercise protocol Follow up at 6 weeks	Walking ability; SPWT test and n. of daily steps Disability LSS related: Zurich questionnaire and its sub-areas Pain: NRS scale for back, legs and numbness; JOABPEQ questionnaire Depression: HADS scale Mental wellbeing: PCS, PASS-20 Kynesiophobia: Tampa scale Quality of Life: SF-36 Pedometer (only control group)	Pedro score 9/10 Jadad Score 4/5
Marchand AA et al. [32]	2021	Canada	68 patients with LSS awaiting for spinal surgery. Thy were randomly assigned to experimental [n = 35] or control group [n = 33]	Exp: supervised physiotherapy 6-weeks treatment [mainly based on isometric/isotonic reinforcement exercise with increasing difficulty and treadmill training] Cont: Standard usual care protocol [written instructions given to the patient] Follow up at post intervention, post-surgery, 3/6 months	Disability LSS related: ODI; French-Swiss spinal stenosis questionnaire Clinical improvements: Isometric endurance strength of trunk flexor/extensor and knee extensor muscles; active lumbar ROM; get up and go test and sit to stand test repetition Pain: NRS for back, legs, Numbness Depression: Beck Index Kynesiophobia: Tampa scale Quality of life: Euroqol-5D Perception of treatment: 7 points scale for global impression of Change	Pedro score 9/10 Jadad Score 4/5

3.1. Critical Appraisal

According to the Pedro scale and Jadad score administration, our three articles had high methodological quality, thus preventing bias risk:

- Ammendolia et al. [32] Pedro scale 8/10; Jadad score 4/5
- Minetama et al. [33] Pedro Scale 9/10; Jadad score 4/5
- Marchand et al. [34] Pedro scale 9/10; Jadad score 4/5

The only criticality regarded the patients'/physiotherapists' blinding strategy, as it was not possible to make the therapist's direct intervention on the patient indistinguishable from those performed in self-management.

3.2. Study Results

The included study involved a global population of 258 patients [32–34], of which 124 were males and 134 females; the mean age at the time of study varied from 66 to 72 years. Studies have been conducted in three different countries: the USA, Canada, and Japan. All included studies were two-brace RCTs [32–34].

As for physiotherapy intervention, similar treatment strategies were represented among the included trials: Ammendolia et al. [32] compared the effect of a 6-week comprehensive physiotherapy protocol (which involved education, active exercises, manual therapy, and stretching exercises) or a 6-week autonomous rehabilitation programme with standard activities. Similarly, Minetama et al. [33] compared a supervised 6-week physiotherapy programme (manual therapy, stretching and strengthening exercises, cycling, and body-weight-supported treadmill sessions) with a standard lumbar flexion exercise protocol. This approach was further shared in the Marchand [34] trial, in which a supervised 6-week physiotherapy treatment (mainly based on isometric/isotonic reinforcement exercise with increasing difficulty and treadmill training) was compared to a standard usual care protocol (written instructions given to the patient). In this last study [34], we considered only interventions and results in a short time period (baseline and 6 weeks) as all patients were then operated on.

3.3. Self-Reported Disability

The first investigated domain regards symptom-related disability, with three instruments employed: the Oswestry disability index (ODI) [32,34], the Zurich claudication questionnaire [32,33], and the French-Swiss Spinal Stenosis questionnaire [34]. These questionnaires were proposed at baseline, 6 weeks after the intervention, and at the 3/6-month follow-up [34]. In Minetama's study [33], the same measure was repeated at the 1-year follow-up [34]; follow-ups at 6 and 12 months were also previewed in Ammendolia's study [32].

The disability domain results were mainly assessed through self-reported questionnaires, with some common issues for all identified tools [35–37]:

- The study of pain and its location in the back/leg (with a deep focus on pain influence in everyday life for the French-Swiss questionnaire)
- Investigation of activities of daily living, such as washing, eating, walking different distances, sleeping, weightlifting, and sexual activity (deepened in the ODI index)
- General mobility, in a home setting and on trips
- Balance (French-Swiss questionnaire and Zurich in depth).

3.4. Clinical Tests

In our included works [32–34], there were some attempts to conduct an objective evaluation of changes in lower back function; the self-placed walk test-SPWT [32] was specifically considered in three articles [32–34] while the measurement of the isometric endurance strength of trunk flexor/extensor and knee extensor muscles was carried out in Marchand's work [34], together with the active lumbar range of motion [ROM], the get-up-and-go test, and sit-to-stand test repetition. Minetama [33] instead considered the number of daily steps as representative of a patient's ability to walk medium-long distances (only in the primary study). Lastly, the short physical performance battery [SPPB] test was considered to describe overall lower extremity functions [32]. A deep explanation of the clinical tests as referred to within articles [32–34] is reported in Table 3.

Table 3. Clinical tests reported in included articles. Description was conducted according to test objective and action required to the patient.

Test	Objective	Action Required
Self-placed walk test (SPWT)	Evaluate the longest distance the patient is able to walk in a maximum time of 30 min	Walk on a flat surface until LSS symptom hinder the activity
Short physical performance battery (SPPB)	Evaluate general lower extremity function	The test is composed by different tasks: (1) Ability to stand for 10 s with feet in 3 different positions (together side-by-side, semi-tandem, and tandem) (2) Two timed trials of a 3-m or 4-m walk (fastest recorded) (3) Time to rise from a chair five times
Isometric measurements	Evaluate isometric contraction of back flexors/extensor muscles and knee extensors	Perform modified Sorensen test (back extensor), maximum trunk flexion maintenance, knee active extension maintenance
Active Range of motion Testing (AROM)	Quantifying active lumbar movement	Perform all pain free movements with low back (flexion, extension, lateral inclination, rotation)
Get up and go test	Identify fall risk	From a sitting position, stand without using arms to support. Walk 10 feet, turn, and return to the chair Sit back in the chair without using arms for support
Sit to stand test	Test leg strength and endurance	From a sitting position go stand and then return (5 times)

3.5. Pain

Pain was considered the most compromising symptom of lumbar spinal stenosis, and all authors [32–34] considered its measurement central to describing the effects of physiotherapy. The numerical pain rating scale (NRS, eleven or ten points version) was common to all articles in its leg/back/overall score [32–34], while the JOABPEQ (Japanese orthopaedic association back pain questionnaire) was used in the Minetama study [33]. While the NRS describes a precise value of suffered pain the patient experiences in a certain moment [38], the JOABPEQ [39] is developed through five sub-areas and 25 items, dealing with:

- Reconstruction of pain during the day and at night
- Requiring assistance from a caregiver
- Endurance and pain during gait and stairs
- Emotional concerns and depression

3.6. Mental Wellbeing and Kynesiophobia

A widely employed outcome regarding mental perception related to LSS symptoms, particularly fear to move, was assessed by two articles [33,34] using the Tampa Scale (TSK) in its extended [34] or short 11-item form [33]. This questionnaire is developed with 11/17 demands and a four-point Likert scale, two main areas are generally identified [40]:

- Fear of (re)injury and avoiding exertion to not worsen pain
- Somatic tract (such as consideration of proper condition by others)

Other secondary outcomes investigated were (scores expressed through 0–4-point scales):

- Pain severity was measured through the pain-catastrophizing scale (PCS) [33]
- Anxiety was measured using the pain-anxiety symptom scale (PASS-20) [33]
- Depression was measured using the Hospital Anxiety Depression Scale (HADS)/ Beck Index [34] /Center for Epidemiological Studies-Depression scale (CES-D) [32]

- Fear of falling was measured using the fall efficacy scale (FES) [32].

The PCS [41] reflects the patient's perspective and posture regarding pain, with 13 items divided into three main sections: Rumination (feeling of not being able to stop thinking about pain), magnification (feeling anxious because something serious is about to happen), and helplessness (feeling that nothing can improve suffered pain).

The Pass-20 [42] describes behavioural issues related to anxiety and pain: cognitive elaboration of pain, escape conduct during worsening episodes, fear of suffering, and physiological body responses to pain.

As for depression questionnaires [43–45], in this case, a wide variety of sensations were investigated. Even with a different order of items, the CES-D, Beck Inventory, and HADS scales investigate symptoms and patient attitudes to depression, measuring mood, pessimism, self-dissatisfaction, guilt, punishment, self-dislike, self-accusation, sense of failure, suicidal ideas, irritability, social withdrawal, indecisiveness, crying, and changes in body image.

Finally, the FES [46] scale inserts the patient into real situations, asking him to identify the sense of fear of falling in imagining the execution of all activities described.

3.7. Quality of Life

The last domain reported was quality of life, which was assessed by a short-form questionnaire (SF-36) [32,33] and its sub-scales, and the Euroqol-5D questionnaire [34]. SF-36 [38] consisted of eight domains and thirty-six questions, which describe physical function, limitations due to illness, limitations due to cognitive issues, energy and fatigue, emotional wellbeing, social activities, pain, and general health perception. Euroqol 5D [47] instead synthetises, in five main issues, the study of quality of life: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression.

4. Discussion

This systematic literature review was conducted in accordance with the PRISMA statement; our aim was to determine the main rehabilitation outcomes in the literature with respect to rehabilitation treatment in patients with LSS, and whether measurements were patient-centred or objective. The strengths of this review are the high methodological quality of the included RCTs according to the PEDro Scale and Jadad Score. The profiles of LSS patients were precisely defined and similar in all articles [32–34] (age range, inclusion characteristics with regard to clinical symptomatology, when symptoms exacerbate and alleviate, the level of physical activity, how diagnosis occurred). The studies' design and methodology, furthermore, were fully explained: information about the randomisation and allocation of patients into respective groups was given; treatment goals, characteristics, and the frequency of home physiotherapy exercise sessions were reported. Follow-up losses were limited, thus allowing a complete analysis of treatment and outcome. Some weaknesses, however, are present in our review: a slight risk of bias due to the impossibility of blinding patients and therapists to allocation occurred. Additionally, the longer follow-up was at 12 months, and this could be not accurately reflected in a long-life condition which often shows sensitivity to conservative treatments only after months/years. This is a general lack in the literature since many randomised trials evaluating patients after rehabilitation treatment for LSS have only short-term follow-ups [48–51].

Regarding our RQ1, our research highlights the presence of five significant domains to be investigated after the rehabilitation of LSS patients: disability, clinical tests, pain, mental wellbeing and kynesiophobia, and quality of life. It is interesting to evaluate the time variation of these domains with a physiotherapy approach. A further study of the included evidence showed that:

- Disability (ODI, Zurich questionnaire, French-Swiss questionnaire) [32–34] tended to change at any given study time, with a trend of maintaining stable benefits in patients treated with complex rehabilitation plans (involving stretching/strengthening exercises, isotonic/isometric reinforcement, and manual therapy).

- A similar situation was observed for the pain questionnaire (NRS/JOABPEQ) [32–34], which mainly evolved with lower but stable improvements at all study times.
- In general lower extremity ability tests, the SPWT walked distance test seemed to be more sensitive to physiotherapy, showing significant changes. SPPB had no significant changes between groups. Instead, the functional test registered changes only for sit-to-stand repetitions. Muscle testing and active flexion ROM recognised minimal improvements at 6 weeks, while significance was reached only after surgery [34].
- Mental wellbeing and kynesiophobia declined in our included papers [32–34]: depression (HADS, CES-D, Beck Index), catastrophizing behaviours (PCS), fear of movement (TSK), anxiety (PASS-20), and falls (FES). These represented the less sensitive domains in LSS patients, with a general trend of remaining stable or minimally improving without significance.
- Finally, quality of life was measured through SF-36 [32,33] and Euroqol-5D [34]. Only SF-36 showed changes in treated patients, and only in a few sub-scales (pain, physical function, and mental health) in the long term. This was in accord with the assumption that all mental/social/wellbeing domains are not sensitive to pre/post measures, deserving a long follow-up time to demonstrate treatment efficacy.

With respect to our RQ2, four out of five domains were assessed by self-compiled questionnaires. Outcome measures related to pain, disability, quality of life, and wellbeing factors were assessed by the same patient completing a form. Clinical tests were only partially used and produced less significant results in the short term. Although this represents a criticism of the literature, it also made it possible to answer the second research question of this systematic review by concluding that evidence predominantly recognises patient-centred outcomes rather than objective ones.

The present review adds some new considerations about rehabilitative evaluation for LSS patients: traditional outcomes supported by previous studies regarded functionality and quality of life. For example, the RCT by Schneider et al. [3] examined a combined physiotherapy/epidural injection approach, which evaluated physical function through the Swiss Spinal stenosis questionnaire and SPWT as the main outcome. A similar approach was employed by Weinstein et al [52], evaluating SF-36 and ODI as main medical outcome measures. On the other hand, our findings suggest a complex consideration of LSS that is not only reduced to these dimensions. First of all, LSS patients have great behavioural involvement through the presence of pain and fear during activities of daily life, and this progression induces a vicious circle in which the less a person moves, the more pain he has. Furthermore, in the long term, LSS provokes neuropathic/central sensitisation pain, with lower functional compensations and the search for progressively more flexed and shortened postures. Gait becomes even more unstable and precarious, and its cycle is affected by increasingly strong changes, highlighted by new sensors analysis [53,54]. In advanced forms, the patient becomes frail, physically deconditioned, and often depressed. Therefore, the physiotherapist has to deal with a complex condition, taking into account not only functionality and quality of life, but also pain in its different forms, social wellbeing, and movement fear issues in order to achieve a reliable and appropriate perception of his patient's motor and social disability, so establishing the best treatment strategy (sometimes with the help of other professionals). Our five-domain model could represent a feasible opportunity for physiotherapists, since in most cases scales are self-completed by the patient and only supplementary clinical tests would be subject to practitioner evaluation (thus allowing for the sustainability of the model and related costs). These considerations are in line with the recent literature: Delitto [55], in a double-arm RCT, evaluated functionality through the ODI index, general health using SF-36, and added NASS (North American Spine Society Pain and Disability, Neurogenic Symptoms, and Expectation) as a pain-related outcome. Moreover, studies by Fritz et al. [56] and even the Cochrane review by McGregor et al. [21] support the idea that the evaluation of function, pain, quality of life, and general health is crucial in LSS management. Finally, in his RCT on different

physiotherapy programs, Whitman underlines the patient's satisfaction and participation in activities as a further outcome [57].

In the future, subsequent studies should implement our five-domain model in different physiotherapy settings (intensive and extensive rehabilitation) and in large populations. This will allow further standardization of physiotherapy outcome measures, decreeing for each domain the most reliable instrument in different phases of care. Particularly, studies should demonstrate the gold standard for pain evaluation in the LSS population, since numerous scales in the present review included its quantification according to different models (nociception/neuropathy). Due to its central role in LSS, quantifying "when" and "how" in the evaluation of pain represents a mainstay for future research on rehabilitative approaches.

5. Conclusions

This systematic review demonstrated that a comprehensive and in-depth evaluation of LSS patients undergoing rehabilitation is needed. The literature showed the significance of a five-domain model (disability, pain, mental wellbeing and kynesiophobia, quality of life, and clinical testing). Four out of these were assessed through questionnaires or self-reported scales. Overcoming current assessment models, predominantly based on pain and disability, is the main novelty of our review work. The possibility of prevalent self-assessment makes the model sustainable and reproducible in every rehabilitation setting. Future studies should implement this model in clinical trials to finally confirm the significance of our findings. Other future challenges concern the identification of the most reliable instruments for domains with multiple questionnaires, particularly for pain evaluation in different clinical stages of LSS.

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