

# A systematic review and meta-analysis on the efficacy of physiotherapy intervention in management of lumbar prolapsed intervertebral disc

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## ABSTRACT

**Objective:** The objective of this meta-analysis and systematic review is to analyze the efficacy of physiotherapy interventions in management of lumbar prolapsed intervertebral disc (PIVD).

**Method:** Randomized controlled trials (RCTs) were searched in PubMed and Cochrane Library using related keywords and advanced option, from commencement to January 2019. Quality of researches was assessed by PEDro scoring. Risk of bias and homogeneity were assessed using Cochrane risk of bias tool and  $I^2$  value, respectively. Meta-analysis of included study was done using “Review manager (Software, version 5.3).”

**Results:** Eleven RCTs were included in this systematic review. Six RCTs were excluded from meta-analysis due to insufficient data availability. Meta-analysis reveals significant decrease in pain ( $P = 0.001$ , mean difference (MD)  $-0.91$ ; 95% confidence interval (CI)  $-0.35$  to  $-1.48$ ) and disability ( $P < 0.0001$ ; MD  $-5.76$ ; 95%CI;  $-3.18$  to  $-8.34$ ) with moderate heterogeneity ( $I^2=40\%$ ;  $P = 0.17$ ,  $I^2=54\%$ ;  $P = 0.09$ , respectively). There was non-significant improvement in straight leg raise (SLR),  $P = 0.07$ ; MD  $7.96$ ; 95%CI;  $-0.59$ – $16.51$  with moderate heterogeneity ( $I^2=56\%$ ;  $P = 0.11$ ).

**Conclusion:** Physiotherapy interventions are effective in management of lumbar PIVD. Physiological and biomechanical factors such as correction of the displaced disc, opening of the foramina, increase in intervertebral space, and reduction in herniation size with negative intradiscal pressure may be possible mechanisms.

**Keywords:** Lumbar disc herniation, Lumbar prolapsed intervertebral disc, Physiotherapy intervention, Sciatica

## Introduction

Low back pain (LBP) is a heterogeneous group of musculoskeletal disorders that affect 65–85% of the population globally.<sup>[1,2]</sup> Lumbar prolapsed intervertebral disc (PIVD) or herniation among LBP patients is one of the most prevalent musculoskeletal disorders, affecting approximately 10% of the population.<sup>[3-5]</sup> Prevalence is higher in men as compare to women and most of the individuals are between 30 and 50 years of age.<sup>[3]</sup> This is a common problem that leads to job-related disability and is also a leading contributor of absenteeism.<sup>[6]</sup> In 2013, estimated cost of back pain in the United States alone was between 119 and 238 billion dollars.<sup>[7]</sup> Obesity, smoking, sedentary lifestyle, and socioeconomic conditions are associated risk factors.<sup>[8,9]</sup>

Disc prolapse is more frequently seen in the lumbar region as compared to any other region and most common at L4-L5 and

L5-S1 level.<sup>[8,10-12]</sup> Radicular pain is one of the most common and disabling symptoms.<sup>[3,4,13]</sup> It may lead to sensory and motor deficits and leaves the person incapacitated.<sup>[14,15]</sup> Diagnostic evaluation is very challenging and sometimes physicians are left with no choice but to make the diagnosis of LBP with symptoms only. Magnetic resonance imaging is one of the choices of examination for diagnosis, as it has high sensitivity and specificity.<sup>[16,17]</sup>

Both conservative and surgical interventions are used for the treatment.<sup>[5,18-21]</sup> In the last decade, efforts have been done to minimize the need for spinal surgery.<sup>[22,23]</sup> As per clinical guidelines of the “National Institute for health & care excellence 2016,” first preference should be given to conservative treatment, such as medicine, support, advice, and exercise therapy.<sup>[1]</sup> Other interventions such as traction, taping, neural mobilization, and electrotherapy are also recommended for conservative treatment.<sup>[1,2,24-27]</sup>

Surgical intervention is required, when the patient does not respond to conservative treatment.<sup>[28,29]</sup> Lumbar discectomy is the most commonly used surgical procedure.<sup>[14]</sup> Surgical management has several complications and non-significant differences in long-term outcome.<sup>[30-32]</sup> Discectomy, a standard surgical procedure for lumbar PIVD, can have complications such as pain, dural tear, post-operative paralysis, and superficial wound infection.<sup>[31,33]</sup> Recurrent or persistent herniation and reoperation at the same level are the complications of “Automated Percutaneous Discectomy.”<sup>[34,35]</sup> Conservative interventions like physiotherapy do not have such complications and are cost effective too.<sup>[31]</sup> Keeping this in view, the present review evaluated the efficacy of physical therapy intervention such as electrotherapy, exercise therapy, lumbar traction, and manual therapy in management of lumbar PIVD.

Lumbar PIVD results in significant disability, pain, and loss of productivity.<sup>[36]</sup> Therefore, an evidence-based treatment technique for the management of lumbar PIVD has immense clinical significance. This systematic review and meta-analysis aim to analyze the effect of physiotherapy interventions on pain, disability, and neural mobility in patients suffering from lumbar PIVD. The PICO search strategy was adopted for the study (Participant – lumbar PIVD; Intervention – physical therapy; Comparator – control group; and Outcome – pain, disability, and neural mobility).

## Methods

### Study design

In this systematic review and meta-analysis, guidelines of the “Preferred Reporting Item for Systematic Reviews and Meta-Analyses” 2015 statement were followed with a pre-defined registered protocol in “International Prospective Register of Systematic Reviews” (PROSPERO), (Identification no. CRD42019124568).

### Selection criteria

Inclusion criteria were randomized controlled trial (RCTs) on efficacy of physical therapy management in lumbar PIVD; published in English language; from inception to January 2019. All the case reports, editorials, letters, meta-analysis, systematic reviews, reviews, and comments were excluded from the study.

### Search strategy

Cochrane database and PubMed were searched for studies from commencement to January 2019. Keywords used were lumbar PIVD, lumbar disc herniation, physiotherapy, spinal manipulation, spinal mobilization, Mulligan, Maitland, exercise therapy, and related terms. Detailed search strategy is provided in supplementary data. “MeSH (Medical Subject Headings) terms,” similar keywords, and “Boolean operators

(“OR” and “AND”) using Advanced search options” were included. Mendeley was used as literature management tool to remove duplicates. Detailed methodology of systematic review is explained in the form of flow diagram [Figure 1].

Three authors independently monitored abstracts and titles. Any disagreement was settled with discussion among all the authors. If the study data were not available, corresponding author or the first author listed in the included articles was contacted for missing data to complete the meta-analysis.

### Data extraction and quality assessment

Three authors autonomously extracted the data, using MeSH terms and keywords. Collected information was cross-checked for any discrepancy. To evaluate treatment efficacy, mean change in pain using visual analog scale (VAS), disability using Oswestry Disability Index (ODI), and neural mobility using straight leg raise (SLR) were included in meta-analysis.

Information extracted from included studies were first author, country, study duration, number of participants, interventions, and finding. Biasing of publication was examined by visual scrutiny of funnel plot for outcomes. Forest plots were made using “Review manager (Software, version 5.3).”

Missing data of standard deviation for change from baseline were imputed using correlation coefficient. The  $I^2$  was used to evaluate the heterogeneity of the studies: “0–25% was considered as low heterogeneity, 26–75% as moderate heterogeneity, and 76–100% as substantial heterogeneity.” Sensitivity analysis was also done, to measure potential sources of heterogeneity. The PEDro rating scale was used to evaluate the internal quality and validity of the randomized control trials.

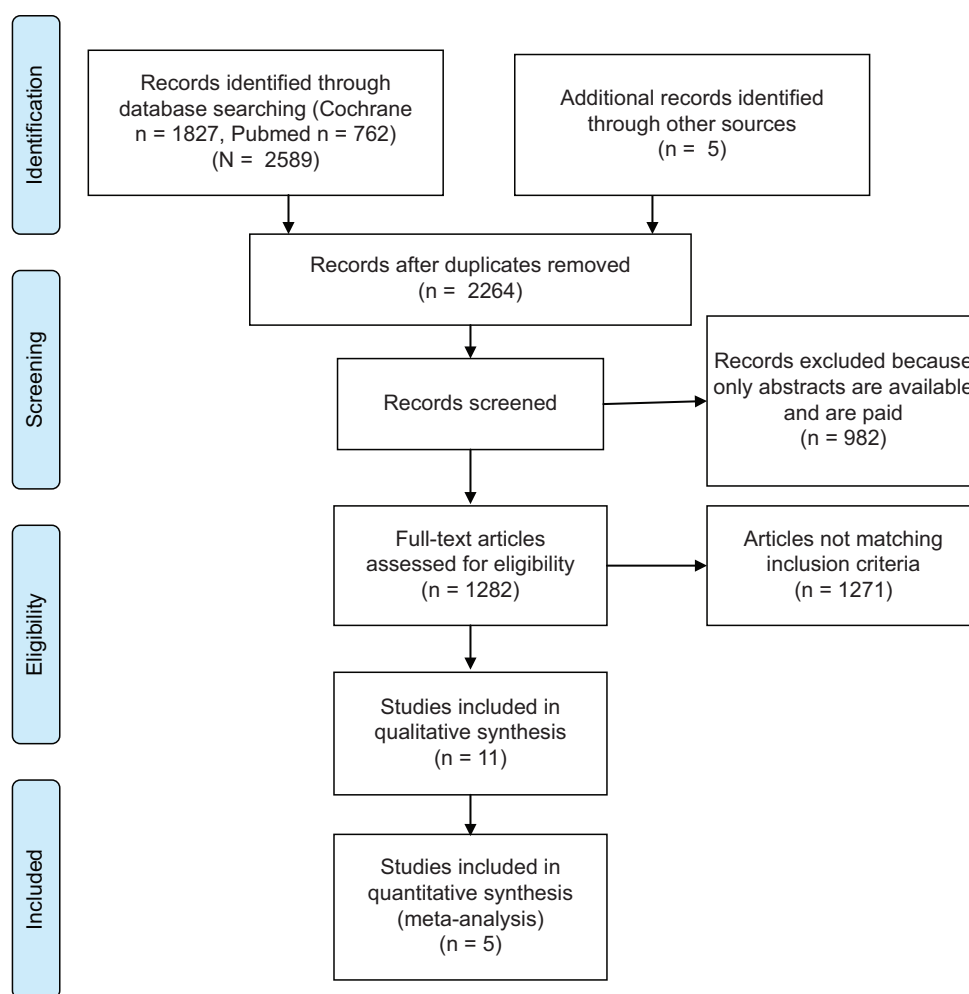
## Results

### Study selection

A total of 2594 researches were collected from database searches, of which 11 fulfilled the selection criteria [Figure 1]. Six researches were excluded from the meta-analysis as required data could not be retrieved. The remaining 4 out of 5 studies comprising 104 participants in study group and 97 subjects in control/placebo group were included in meta-analyses of pain (VAS). Four out of five studies comprising 96 subjects in the study group and 85 subjects in the control/placebo group were included in meta-analysis of disability (ODI). Three out of five studies comprising 70 subjects in the study group and 62 subjects in the control/placebo group were included for meta-analysis of neural mobility (SLR).

### Study characteristics

Overview of listed researches is shown in Table 1. Two researches were done in India,<sup>[1,37]</sup> two in Turkey,<sup>[2,8]</sup> and one



**Figure 1:** Preferred reporting item for systematic reviews and meta-analyses flowchart of study selection process

each in Brazil,<sup>[3]</sup> United State of America,<sup>[4]</sup> China,<sup>[38]</sup> United Kingdom,<sup>[39]</sup> Pakistan,<sup>[40]</sup> Spain,<sup>[34]</sup> and Egypt.<sup>[11]</sup> Manual therapy was applied in seven studies.<sup>[1,4,34,37-40]</sup> Electrotherapy was applied in six studies<sup>[1,3,8,11,34,40]</sup> and traction in three studies.<sup>[2,8,11]</sup> All researches assessed alteration in pain, neural mobility, and disability.

### Quality assessment

All included researches ranked high on PEDro scoring. One study scored 11,<sup>[1]</sup> one study scored 10,<sup>[8]</sup> three studies scored 9,<sup>[4,34,39]</sup> three studies scored 8,<sup>[2,3,11]</sup> and three studies scored 7.<sup>[37,38,40]</sup>

### Risk of bias

Risk of bias of included researches is compiled in Figure 2. This assessment tool consists of seven primary sources for bias: “Random sequence generation, allocation concealment, selective reporting, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, and other sources of bias.” These were used independently by the authors to classify as “high risk,” “low risk,” or “unclear risk.”

“Random sequence generation” was explained appropriately in all studies.<sup>[1-4,8,11,34,37-40]</sup> “Allocation concealment” was done in six studies.<sup>[1,4,8,11,39,40]</sup> “Blinding of participants and personnel” was described in five studies.<sup>[1-3,8,34]</sup> “Blinding of outcome assessment” was described in four studies.<sup>[1,2,8,34]</sup>

### Meta-analysis

In primary outcome analysis of the studies, four studies were considered for meta-analysis of pain (VAS) and disability (ODI) while three studies were considered in meta-analysis of neural mobility (SLR). Physical therapy interventions resulted in decrease in pain (VAS) after intervention (pre-post experimental group mean difference [MD] 3.45; 95% confidence interval [CI] 3.15–3.75). Similarly, experimental group significantly reduced pain than control group (MD 0.91; 95% CI 0.35–1.48;  $P = 0.001$  and  $I^2=40\%$ ) with moderate heterogeneity [Figure 3]. Baseline characteristics of outcome measures of included studies in meta-analysis were compared [Table 2].

There was a significant pre-post disability reduction in experimental group as measured by ODI (MD –26.05; 95%

**Table 1:** Major characteristics of included studies

S. No.	Author	No. of participants	Country	Study duration	Treatment	Outcome measures	Findings
1	Ozturk <i>et al.</i> , 2006	<i>n</i> = 46, Treatment group ( <i>n</i> = 24) and control group ( <i>n</i> = 22)	Turkey	15 days	Lumbar traction	Pain, ROM and CT scan	No significant difference in pain Improvement in ROM of treatment group as compare to control group
2	de Carvalho <i>et al.</i> , 2016	<i>n</i> = 49, laser 904 ( <i>n</i> = 18), placebo ( <i>n</i> = 13), and LED ( <i>n</i> = 18)	Piaui, Brazil	15 days	LASER 904 nm, LED 945 nm	Pain, ROM, and functional capacity	Improvement in pain, hip mobility, and functional disability in treatment group than control
3	Thackeray <i>et al.</i> , 2010	<i>n</i> = 44, experimental group ( <i>n</i> = 21) and control group ( <i>n</i> = 23)	Salt Lake City, Utah, USA	4 weeks	Selective nerve root block, physical therapy	Pain and disability	Decrease in pain and disability but no significant difference in between groups
4	Burton <i>et al.</i> , 1999	<i>n</i> = 40, experimental ( <i>n</i> = 20), control ( <i>n</i> = 20)	Huddersfield, UK	12 months	manipulation, chemonucleolysis	Pain and disability	Improvement in pain and disability but no significant difference between groups
5	Demirel <i>et al.</i> , 2017	<i>n</i> = 20, treatment and control group	Ankara, Turkey	3 months	Non-invasive spinal decompression, electrotherapy, and exercise	Pain, functional restoration, and disc herniation	Improvement in pain, but no significant difference between groups
6	Moustafa and Diab, 2012	<i>n</i> = 64, experimental ( <i>n</i> = 32), control group ( <i>n</i> = 32)	Cairo University, Egypt	2 years	Traction, IFT, Hot pack	Absolute rotatory angle, ODI, H-reflex, IVM, modified Schober test, back and leg pain	Significant difference in pain, disability and intervertebral movements in treatment group as compare to control group
7	Satpute <i>et al.</i> , 2019	<i>n</i> = 60, experimental ( <i>n</i> = 30), control group ( <i>n</i> = 30)	Pune, India	6 months	SMWLM, exercise, and electrotherapy	Leg pain intensity, ODI score, SLR, ROM, and GROC	Significant difference in pain, disability, and ROM in SMWLM group
8	Kiran <i>et al.</i> , 2017	<i>n</i> = 40, experimental ( <i>n</i> = 20), control group ( <i>n</i> = 20)	Olatpur, Cuttack, India	3 weeks	Mobilization, soft tissue manipulation exercise	Visual analog scale, ODI, and modified Schober test	Significant improvement in pain, function, and lumbar ROM in treatment group than control group
9	Mobeen <i>et al.</i> , 2018	<i>n</i> = 44, experimental ( <i>n</i> = 23), control group ( <i>n</i> = 21)	Rawalpindi, Pakistan	22 weeks	Decompression therapy, mobilization, TENS, IRR, treadmill	MODI, NPRS, ROM, walking time	Significant improvement in lumbar ROM, NPRS, and MODI in treatment group as compare to control
10	Fan and Zhao, 2015	<i>n</i> = 158, experimental ( <i>n</i> = 86), control group ( <i>n</i> = 72)	Beijing, China	20 days	Feng's spinal manipulation, NSAIDs, bed rest	ODI, PS, RS	Improvement of ODI, PS, and RS scores in treatment group than control group
11	Lopez <i>et al.</i> , 2016	<i>n</i> = 30, experimental ( <i>n</i> = 15), control group ( <i>n</i> = 15)	Barcelona, Spain	4 months	POLD method, electrotherapy, and exercise therapy	ROM, visual analog scale	Improvement in pain, ROM, and centralization in treatment group as compare control

#CT scan: Computed tomography scan, GROC: Global rating of change, IFT: Interferential therapy, IRR: Infrared radiation, IVM: Intervertebral movement, MODI: Modified Oswestry index, NPRS: Numeric pain rating scale, NSAIDs: Nonsteroidal anti-inflammatory drugs, ODI: Oswestry Disability Index, ROM: Range of motion, SLR: Straight leg raise, SMWLM: Spinal mobilization with leg movement, TENS: Transcutaneous electrical nerve stimulation, VAS: Visual analog scale

CI -22.15–29.95). Meta-analysis shows that there was statistically significant reduction in experimental group disability (ODI) as compared to control (MD-5.76; 95% CI-3.18–8.34;  $P < 0.0001$ ;  $I^2=54\%$ , respectively) with moderate heterogeneity [Figure 4].

Physiotherapy interventions increased SLR range (pre-post MD 25.34; 95% CI 21.69–28.99). However, this improvement was non-significant when it compared with control group (MD 7.96 degree; 95% CI -0.59 to 16.51;  $P = 0.07$ ;  $I^2 = 56\%$ ) with moderate heterogeneity of  $I^2 = 56\%$  [Figure 5].

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Burton AK et al 2000	+	+	+	+	+	+	+
De carvalho MEIM et al. 2016	+		+	-	+	+	-
Demirel A et al. 2017	+	+	-	-	+	+	+
Fan Y et al. 2015	+			-	+	+	+
Kiran R et al. 2017	+				+	+	+
Lopez J. 2016	+	-	+	+	+	+	+
Mobeen A et al. 2018	+	+			+	+	+
Moustafa IM et al. 2012	+	+			+	+	+
Ozturk B et al 2006	+		+	+	+	+	+
Satpute K et al. 2019	+	+	+	+	+	+	+
Thackeray A et al. 2010	+	+	-	-	+	+	+

**Figure 2:** Risk of bias summary. Studies in green or + are at low risk of bias, red or - high risk of bias and rest are unclear risk of bias

### Sensitivity analysis

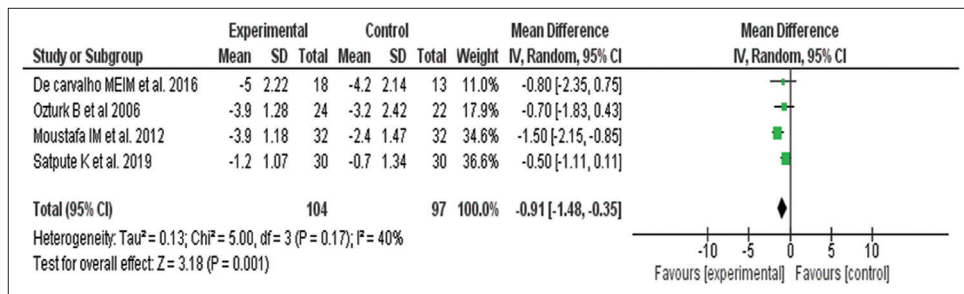
Sensitivity analysis revealed significant improvement in SLR after changing the value of correlation coefficient( $r$ ). However, heterogeneity increased in the sensitivity analysis [Figure S1-S3].

### Discussion

LBP is a common disability across the globe.<sup>[41]</sup> Lumbar PIVD is one of the common causes contributing to LBP, which prompting individuals to seek medical help.<sup>[18,42-44]</sup> It has a significant effect on society in terms of epidemiology and economy, so there is a need for cost-effective and evidence-based interventions in the treatment of lumbar PIVD.

Physiological and biomechanical factors may play a significant role in the management of lumbar PIVD through physiotherapy interventions.<sup>[45]</sup> McMorland *et al.* stated that spinal manipulation can be a treatment of choice in case of failed medical management, as it improves 60% of cases in failed medical management of lumbar PIVD.<sup>[46]</sup> Manipulation decreases pain and improves spinal mobility.<sup>[39]</sup> The probable mechanism of manipulation in the management of PIVD can be the correction of the displaced disc and entrapped synovial fold.<sup>[7,42]</sup>

A study done by Tambekar *et al.*, 2015, concluded that Mulligan and Butler techniques improve SLR and decrease pain.<sup>[30]</sup> Traction improves disc height by opening the foramina and increasing in intervertebral space.<sup>[2,8]</sup> Decrease in herniation after a certain degree due to traction might be the reason for symptomatic clinical improvements in lumbar PIVD.<sup>[2,46]</sup> Traction restores normal mechanics that decrease stress on neural tissue and makes a significant change in H-reflex.<sup>[11]</sup> Non-surgical spinal decompression therapy can decrease intradiscal pressure, mobilize joint, and stimulate joint

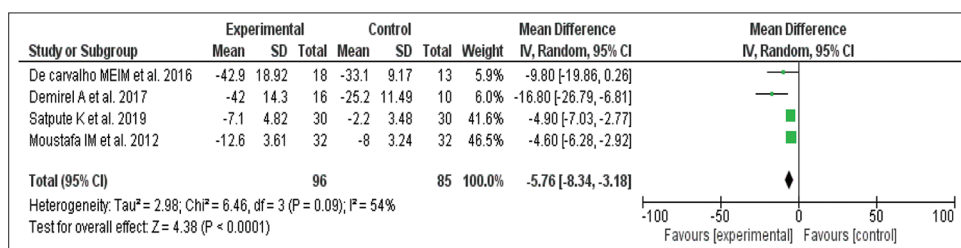
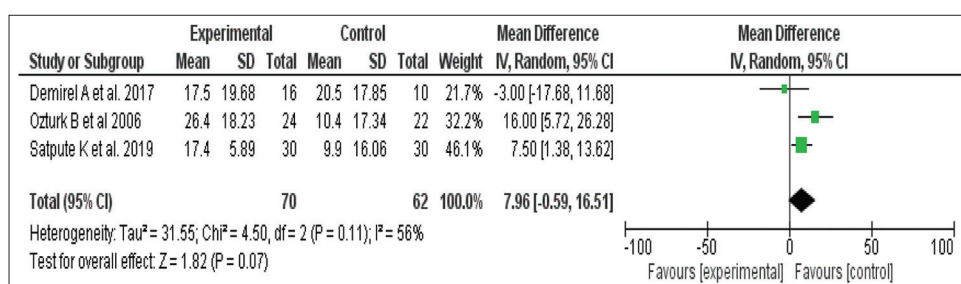


**Figure 3:** Forest plot showing effect of physiotherapy management on visual analog scale in patients of lumbar prolapsed intervertebral disc

**Table 2:** Baseline characteristics of studies included in meta-analysis

S. No.	Author	Pain	Disability	Neural mobility
1	de Carvalho <i>et al.</i> , 2016	E Pre 7.0 ± 2.0 C Pre 6.0 ± 2.1	E Pre 63.4 ± 19.5 C Pre 50.6 ± 12.6	
2	Ozturk <i>et al.</i> , 2006	E Pre 6.3 ± 1.4 C Pre 6.8 ± 1.1		E Pre 42.7 ± 18.8 C Pre 53.6 ± 16.4
3	Moustafa and Diab, 2012	E Pre 6.2 ± 1.0 C Pre 5.9 ± 1.6	E Pre 32.4 ± 3.2 C Pre 31.7 ± 4.4	
4	Satpute <i>et al.</i> , 2019	E Pre 3.5 ± 1.4 C Pre 3.9 ± 1.4	E Pre 24.5 ± 5.1 C Pre 23.4 ± 4.8	E Pre 48.43 ± 4.51 C Pre 45.87 ± 4.15
5	Demirel <i>et al.</i> , 2017		E Pre 51.8 ± 16.1 C Pre 37.0 ± 14.4	E Pre 58.0 ± 22.8 C Pre 52.5 ± 19.6

#Data (mean±standard deviation) of outcome variables (E – experimental group, C – control group)

**Figure 4:** Forest plot showing effect of physiotherapy management on Oswestry Disability Index in patients of lumbar prolapsed intervertebral disc**Figure 5:** Forest plot showing effect of physiotherapy management on straight leg raise in patients of lumbar prolapsed intervertebral disc

capsule receptor.<sup>[8]</sup> Reduction of herniation size with negative intradiscal pressure facilitates nucleus pulposus migration to the center of intervertebral disc.<sup>[8,45-50]</sup>

In lumbar PIVD patients, “spinal mobilization with leg movement” (SMWLM) results in improvement in pain management, SLR, patient satisfaction, and a decrease in disability overtime.<sup>[1]</sup> Additional benefit of SMWLM may be due to sympathoexcitatory response and mobilization applied to the lumbar spine, which may facilitate decompression of nerve root along with hypoalgesic effect.<sup>[1]</sup>

The result of the present meta-analysis shows significant improvement in pain and disability after physiotherapy management in patients of lumbar PIVD [Figures 3 and 4, respectively]. In contrast to this meta-analysis, Thackeray *et al.* did not find any additional reduction in pain and disability after physiotherapy intervention. There was a non-significant change in SLR [Figure 5]. However, result of sensitivity analysis showed significant improvement in SLR, the heterogeneity was high [Supplementary Figures S1-S3]. Physiotherapy interventions do

not have complications and are cost effective too in comparison to surgical treatment. Therefore, evidence-based physiotherapy management of lumbar PIVD is of immense clinical significance and it can be used as the first line of management before proceeding to invasive surgical procedures.

### Strength of study

This study had several notable strengths. First, as per the available information, it is the first review that assessed the efficacy of physiotherapy interventions in the management of lumbar PIVD. Second, all included studies were of low risk of bias and high quality. Third, the present study included only RCT's which are considered as gold standard in experimental studies.

### Limitations

This study had few constraints. First, the present study involved only two database searches. However, additional number of articles using more number of databases may not affect the result as supported by two high-quality reviews.<sup>[49,50]</sup> Second,

the meta-analysis had limited sample size as few researches were excluded from meta-analysis because sufficient data were not available.

## Conclusion

This systematic review and meta-analysis concludes that physiotherapy interventions are effective in decreasing pain and disability. Physiological and biomechanical mechanisms such as correction of the displaced disc, opening of the foramina, and increase in intervertebral space may lead to improved spinal mobility. Further, reduction in herniation size with negative intradiscal pressure facilitates nucleus pulposus migration to the center of intervertebral disc restores normal mechanics. However, effects of physiotherapy interventions on neural mobility were not significant in this meta-analysis. Therefore, future studies can be performed to evaluate the effects of long-term physiotherapy interventions on neural mobility. Good quality studies on effect of physiotherapy interventions like manual therapy on thoracic spine should also be evaluated on neural mobility for establishing any evidence of regional interdependence.

## Authors' Declaration Statements

### Ethical approval

Ethical approval/patients consent statements is not required for the study.

### Declaration of interest

The authors report no conflict of interest.

### Funding Statement

The study was not funded by any funding agency.

### Authors' Contributions

Conception and design of study: JK, VS; Acquisition of data: VS; Analysis and/or interpretation of data: MM, VS; Drafting the manuscript: VS, JK; Revising the manuscript critically for important intellectual content: JK, MM; Approval of the version of the manuscript to be published: VS, MM, JK, KV, SP.

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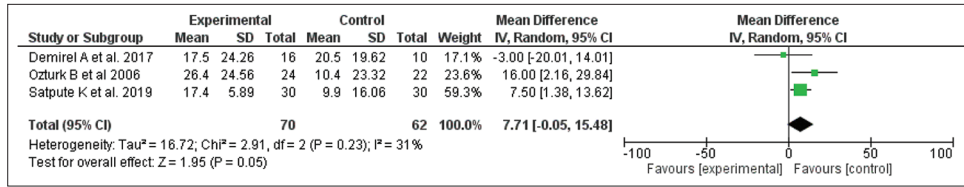
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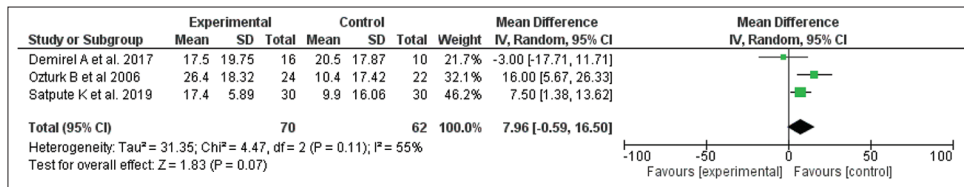
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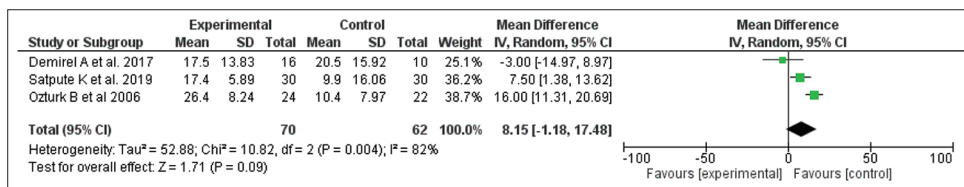
Supplementary Figures



**Figure S1:** Forest plot showing effect of physiotherapy management on straight leg raise in patients of lumbar prolapsed intervertebral disc (sensitivity analysis, r=0.1)



**Figure S2:** Forest plot showing effect of physiotherapy management on straight leg raise in patients of lumbar prolapsed intervertebral disc (sensitivity analysis, r=0.5)



**Figure S3:** Forest plot showing effect of physiotherapy management on straight leg raise in patients of lumbar prolapsed intervertebral disc (sensitivity analysis, r=0.9)