Review

Treatment of Low Back Pain with Different Methods: A Systematic Review and Meta-Analysis

Vanja Dimitrijević , Bojan Rašković * , Nikola Jevtić , Borislav Obradović , Theodoros B. Grivas , Dejan Viduka , Samra Pjanić , Nachiappan Chockalingam , Tijana Šćepanović , Patrik Drid

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Treatment of low back pain with different methods: A systematic review and meta-analysis

Vanja Dimitrijević [1], Bojan Rašković [1,*], Nikola Jevtić [2], Borislav Obradović [1], Theodoros B. Grivas [3], Dejan Viduka [4], Samra Pjanić [5], Nachiappan Chockalingam [6], Tijana Šćepanović [1] and Patrik Drid [1]

[1] Faculty of Sports and Physical Education, University of Novi Sad, Novi Sad, Serbia
[2] Scolio Centar, Novi Sad, Serbia
[3] Orthopaedic and Traumatology Department "Tzaneio" General Hospital of Piraeus, Piraeus, Greece
[4] Faculty of Applied Management, Economics, and Finance in Belgrade, University of Business Academy, Novi Sad, Serbia
[5] Institute for physical medicine and Rehabilitation "Dr. Miroslav Zotović" Banja Luka, Bosnia and Herzegovina
[6] Centre for Biomechanics and Rehabilitation Technologies, Staffordshire University, UK
* Correspondence: bojan.raskovic@yahoo.com

Abstract: To systematically assess the effect size of different methods for patients with low back pain. PubMed, Cochrane Library, Web of Science, and Google Scholar. databases were searched in January 2023. This study has been developed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement. The key search terms were: "Low back pain", "Back pain", "SF-36", "VAS", "VASP", "Roland-Morris", "Oswestry Disability Index", and "conservative treatment". The risk of bias was determined for each randomized trial using the Cochrane Risk of Bias Tool, and the methodological index for non-randomized studies (MINORS). The outcomes included SF-36 Mental, SF-36 Physical, VAS, Roland-Morris, and Oswestry Disability Index. R 4.0.5 software was used, and standardized mean difference (SMD) and 95% confidence intervals (CI) were calculated for continuous outcomes, random model. Twenty-five studies were included. Depending on the outcome being measured, the effect size of different methods in treating low back pain varies from small to large as follows: SF-36 Mental (SMD = 0.39, $p < 0.0001$), SF-36 Physical (SMD = 0.55, $p < 0.0001$), VAS (SMD = -0.84, $p < 0.0001$), Roland-Morris (SMD = -0.45, $p < 0.0001$), and Oswestry Disability Index (SMD = -0.61, $p < 0.0001$). Our meta-analysis indicates the positive effects of applying different methods in the treatment of low back pain. PROSPERO registration number: CRD42022371282

Keywords: low back pain; SF-36; VAS; Roland-Morris; Oswestry Disability Index; meta-analysis

1. Introduction

Back pain is the most common musculoskeletal cause of physical problems, and 80% of the affects are located in the lumbar region [1]. 50 to 80% of the population is affected by lower back pain during their lifetime, which makes it a public health issue in modern society [2–5]. Others important aspect is the high public and private costs of absenteeism, insurance, and health care [6]. There are different definitions of low back pain depending on the source. Low back pain (LBP) is discomfort or pain located above the inferior gluteal folds or below the rib cage and is accompanied by leg pain or no pain[7,8]. Another definition recalls that LBP is pain that occurs at the back in the area between the lower edge of the ribs and the proximal part of the thighs [9]. LBP can be divided into 3 subtypes: acute, subacute and chronic [8,10]. A basic distinction made by a number of writers is between specific and non-specific low back pain [11–13]. About 70%–85% of the population experiences non-specific low back pain in their lifetime, and about 10% of them develop chronic low back pain [14–16]. In the West and throughout the world in the second half of the 20th century, LBP is one of the main problems of the health care system [17–20]. Individuals who do not seek medical attention do not differ significantly from those who seek care in terms of the

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frequency or intensity of LBP [21]. Although the percentage of health care resources used for LBP is large, few people with the problem seek health care [22,23].

That exercise and intensive multidisciplinary pain management programs are effective in low back pain is supported by strong evidence [24,25]. Exercises useful for LBP usually include warm-ups, well-known exercises that target the back extensors, abdominals, lateral glutes, trunk rotators, leg muscles, obliques, as well as flexibility exercises [26].

Various questionnaires, scales and indexes are used to assess the condition of patients. The 36-Item Short Form Survey (SF-36) is a commonly used outcome measure for self-reported health. It stems from a study called the Medical Outcomes Study[27] for an objective measure of quality of life. It consists of 36 questions covering eight health domains[28]. The SF-36 was designed in clinical practice to measure individual health and population-level research [28]. It has been carried out in thousands of studies so far[29]. The Visual Analogue Scale (VAS) is one of the pain assessment scales that was first used in 1921 by Hayes and Patterson [30]. It is often used in epidemiological and clinical research to measure the intensity or frequency of various symptoms. The patient may experience pain that ranges from none to extreme pain. Their pain does not go through specific jumps, but is continuous from the patient's point of view. The VAS is designed to track and recognize a basic continuum[31]. The Roland-Morris Disability Questionnaire (RM) is a disability questionnaire first published in 1983 and revised in 2000 [30]. Designed to assess self-rated physical disability caused by low back pain [31]. The RM is most sensitive for patients with mild to moderate disability due to acute, subacute, or chronic low back pain [32,33]. For patients with severe disabilities, the Oswestry Disability Index (ODI) is recommended [34,35]. The ODI is a questionnaire that provides a subjective percentage of the level of function (disability) in activities of daily living in those rehabilitating from low back pain36. Most effective for long-term severe disability, while the RM is better for mild to moderate disability [34]. The questionnaire examines the perceived level of disability in 10 daily activities of daily living.

The goal of our research is to determine the effects of applying various conservative (non-surgical) treatments, mostly based on the use of certain motor movements (exercises), on patients with LBP using a meta-analysis. By means of the previously mentioned questionnaires, scales and indices, it will be assessed what size of effect certain applied methods had.

2. Methods

This paper has been developed and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [37], and it was registered in the PROSPERO database (CRD42022371282).

A search strategy was developed to identify all relevant studies evaluating the effect of different methods in the treatment of LBP. Our systematic search included the PubMed, Cochrane Library, Web of Science, and Google Scholar databases. We used combinations of subject headings “Low back pain”, “Back pain”, “SF-36”, “VAS”, “VASP”, “Roland-Morris”, “Oswestry Disability Index”, and “conservative treatment”. Figure 1 shows the search strategy.

PICOS (Population, Interventions, Comparators, Outcomes, Study Designs) eligibility criteria described in PRISMA were adopted for inclusion/exclusion of the studies [37]. P (population): subjects diagnosed with LBP, I (intervention): different conservative methods, C (comparison): the control group without treatment or received some other conservative treatment, O (outcome): SF-36 Mental and Physical, VAS, Roland-Morris Disability Questionnaire, and Oswestry Disability Index, S (study design): comparative studies published after 2000. Inclusion of studies was not limited by language. Studies excluded were systematic reviews, meta-analyses, study protocols, books, book reviews, and conference publications. Four databases were searched (PubMed, Cochrane Library, Web of Science and Google Scholar) in January 2023. Inclusion/exclusion of studies was done by two investigators – RB and VD.

After selecting studies based on all inclusion and exclusion criteria in the meta-analysis, two investigators independently performed data extraction. The following variables are tabulated: authors, year of publication, program type, number of participants, age, outcomes, sessions per week, duration, type of back pain, and country.

Two investigators independently assessed the quality of studies. Risk of bias was assessed for each randomized trial using the Cochrane Risk of Bias Tool [38] which assesses seven sources of bias. Each

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study was examined and rated as low risk, high risk, or unclear risk. Methodological qualities and risk of bias were evaluated by the methodological index for non-randomized studies (MINORS) [39]. MINORS score ≥ 14 was set as the level of inclusion. MINORS involves 12 items.

Meta-analysis and statistical analysis were performed using R 4.0.5 software with the meta package. Effect sizes were estimated for SF-36, VAS, RM and ODI outcomes. For each study, standardized mean difference (SMD) and 95% confidence intervals (CI) were calculated for continuous outcomes, random model. According to Cohen's guide, values of ≥0.2, ≥0.5, and ≥0.8 show small, medium, and large effect sizes, respectively [40]. $P < 0.05$ was considered statistically significant. Heterogeneity was assessed using the Higgins I^2 test and p values. Egger's test investigated publication bias.

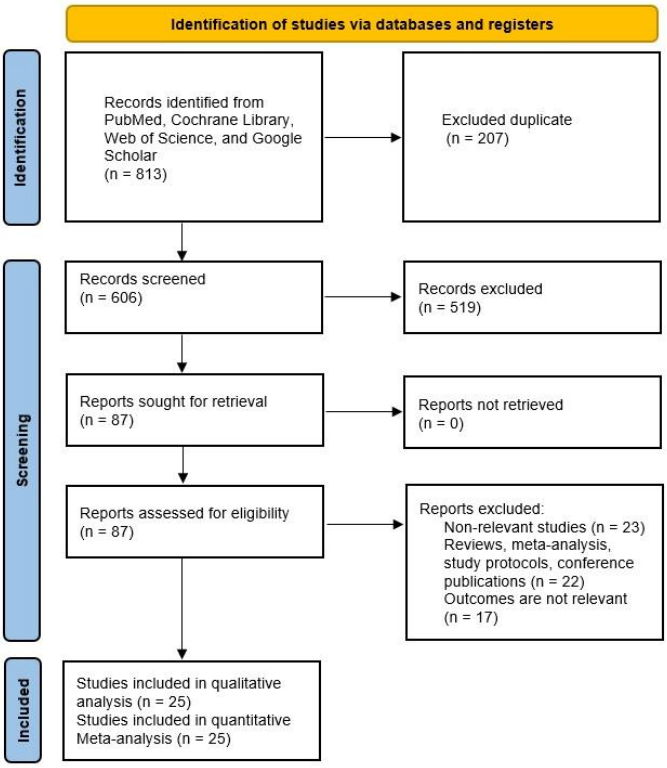

Figure 1. Flow diagram

Figure 1. Flow diagram.

3. Results

Based on the search strategy, a total of 813 studies were selected from the initial database search. Of that number, 207 duplicate studies were first excluded, therefore 606 studies were selected for further analysis. A total of 519 studies were excluded after screening the abstracts and titles because they did not meet the inclusion criteria. The remaining 87 studies were fully reviewed. 62 studies were excluded after full-text review. The remaining 25 studies that met all criteria were included in this review article and meta-analysis. The flow diagram is shown in Figure 1.

Table 1 shows the characteristics of the included studies. A total of 1440 respondents participated in twenty-five studies, the sample ranged from 20 to 150, while the respondents were from 18 to 65 years old. The total length of treatment ranged from 3 weeks to 13 weeks.

Figure 2 shows the risk of bias for randomized studies, while Figure 3 the risk of bias for non-randomized studies. Of the 25 included studies, 20 were randomized, while 5 studies were non-randomized. Concealment of allocation was high risk in 12 out of 20 randomized studies. Physiotherapists and participants could not be blinded due to the way the intervention was applied, so all randomized studies were assessed as unclear risk. For the outcome "Blinding of outcome assessment", ten studies had a low risk. Studies by [41–43] present data as median (min-max), which represents a problem in data processing, and it is this outcome assessed as high risk. In 20 randomized studies, a low risk of bias was

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considered in the outcome data. All non-randomized studies were comparative and had a minimum score of 16 and a maximum score of 20 out of a possible 24.

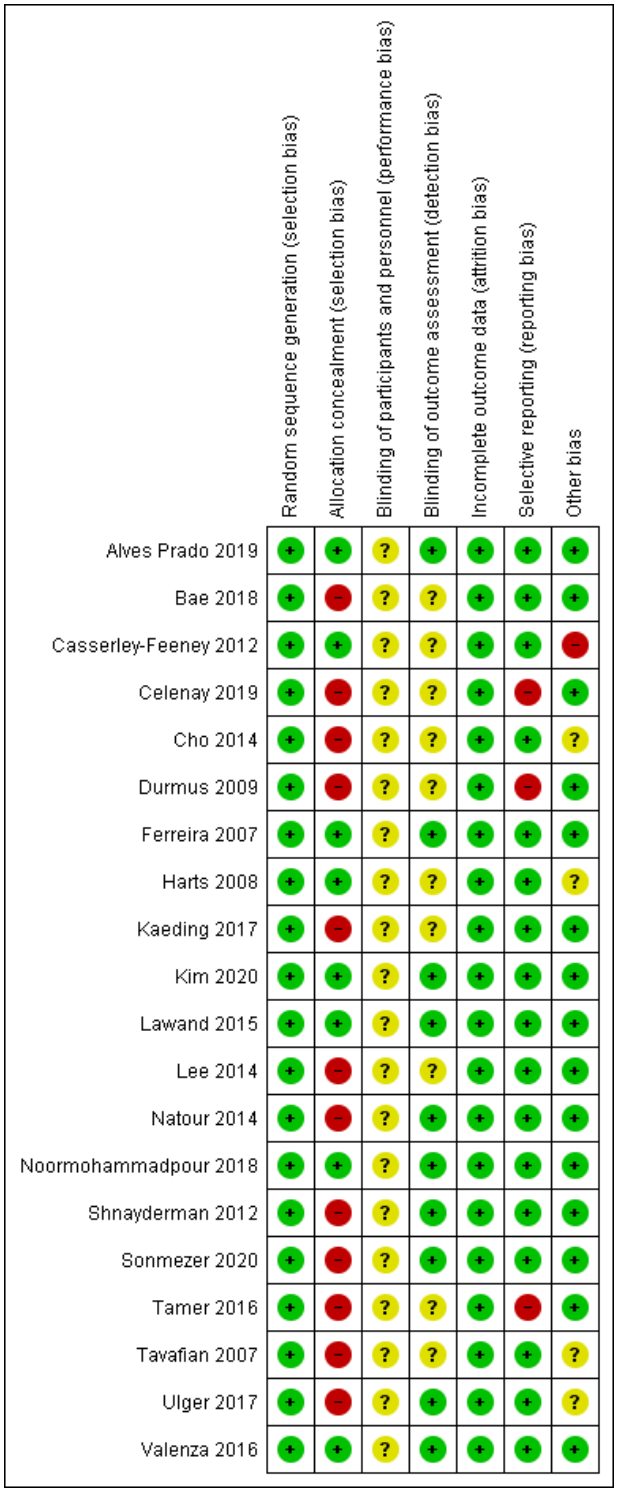

Figure 2. Risk of bias for randomization studies.

	Methodological items												
Study	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total score**
Adorno 2013	2	2	2	2	0	2	2	0	2	2	2	2	20
Hwangbo 2015	2	2	2	2	0	0	0	0	2	2	2	2	16
Karaarslan 2021	2	2	2	2	1	2	1	0	2	2	2	2	20
Kim 2015	2	2	2	2	0	0	0	0	2	2	2	2	16
Lee 2015	2	2	2	2	0	1	1	0	2	2	2	2	18

Figure 3. Risk of bias for non-randomization studies.

Table 1. Charateristics of included study.

Study	Type of exercise program	N	Age	Outcomes	Exercise time per week	Exercise program duration	Type of back pain	Country
Adorno [44]	Isostretching method Global Postural Reeducation	20	19-60	SF - 36	2x60 min	12 weeks	NLBP	Brazil
Alves Prado [45]	Isostretching exercise program C.g. (no treatment)	54	35±9.8 33±11.3	SF - 36 VAS RM	2x45 min.	6 weeks	CLBP	Brazil
Bae [46]	Core stabilization exercises Sit-up exercise	36	32.4±10.7 32.7±6.1	VAS ODQ RM	3x30 min.	4 weeks	NLBP	Republic Korea
Casserley-Feeney [47]	Public hospital physiotherapy Private clinic physiotherapy	113	41.79±12.74 40.78±12.99	SF - 36 RM	N/A	N/A	LBP	Republic of Ireland
Celenay [41]	Connective tissue massage + SPP Sham massage + SPP	42	40–65 39–63	SF - 36 ODQ	5x (N/A)	3 weeks	CLBP	Turkey
Cho [48]	Tai chi Stretching	40	N/A	VAS	3x60 min.	4 weeks	ALBP	Republic Korea
Durmus [42]	Electrical stimulation + exercises Ultrasound therapy + exercises C.g. (only exercises)	59	49±7.87 48.31±8.95 47.05±12.46	SF - 36 ODQ	3x45 min.	6 weeks	CLBP	Turkey
Ferreira [49]	Motor control exercise Spinal manipulative therapy	150	51.9±15.3 54.0±14.4	RM	12 treat. (60 min.)*	8 weeks	CLBP	Australian
Harts [50]	High-intensity training group C.g. (no treatment)	45	18-54	SF - 36 RM	first two weeks x 2 six weeks x 1	8 weeks	NCLBP	Netherlands
Hwangbo [51]	Trunk stability exercise Combined exercise	30	34.5±4.0 34.0±2.9	VAS	3x60 min	6 weeks	CLBP	Republic Korea
Kaeding [52]	WBV training C.g. (no treatment)	41	46.4±9.3 44.6±9.1	SF - 36 RM	2.5x (30-45 min.)	12 weeks	CLBP	Germany

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Karaarslan [53]	Peloid therapy + home exercises Home exercises	106	49.66±9.26 44.74±11.92	SF - 36 VAS ODQ	5x30 min.	3 weeks	CLBP	Turkey
Kim [54]	Lumbar stability mat exercises Therapeutic climbing exercises	30	33.6±7.2 34.9±6.4	SF - 36	3x30 min.	4 weeks	CLBP	Republic Korea
Kim [55]	Stretch group	66	47.50±9.70	SF - 36	3x30 min.	6 weeks	NLBP	Republic Korea
	Strengthen group		47.04±9.48	VAS				
	Sham group		47.75±8.51	ODQ				
Lawand [56]	Global postural reeducation	60	49.4±12.0	SF - 36	1x60 min.	12 weeks	CLBP	Brazil
	C.g. (no treatment)		47.5±11.9	VAS				
				RM				
Lee [57]	PNF	40	34.75±0.85	VAS	4x (N/A)	6 weeks	CLBP	Republic Korea
	Ball exercise		34.20±0.69					
Lee [58]	Hip-joint exercises + lumbar stabilization exercises	39	54.9±10.6	ODQ	3x20 min.	6 weeks	CLBP	Republic Korea
	Lumbar stabilization exercises		50.0±11.4					
Natour [59]	Pilates method	60	47.79±11.47	SF - 36	2x50 min.	13 weeks	CLBP	Brazil
	C.g. (no treatment)		48.08±12.98	VAS				
				RM				
Noormohammadpour [60]	Core stability exercises	20	43.3±7.5	SF - 36	N/A	8 weeks	CLBP	Iran
	C.g. (no treatment)		41.3±6.4	VAS				
				RM				
Shnayderman [61]	Walking group	52	18–65	ODQ	2x20 min.	6 weeks	CLBP	Israel
	Muscle strengthening exercise							
Sonmezer [62]	Pilates exercise	40	29±2.75	ODQ	2x60-70 min.	8 weeks	LBP	Turkey
	C.g. (no treatment)		28±2.10					
Tamer [43]	Osteopathic manual therapy	39	29–47	SF - 36	2x (N/A)	5 weeks	NCLBP	Turkey

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	Osteopathic manual therapy		34–51	VAS				
	and visceral methods			ODQ				
Tavafian [63]	Back School Programme	91	42.9±10.7	SF - 36	N/A	3 weeks	LBP	Iran
	C.g. (no treatment)		44.7±10.8					
Ulger [64]	Manual therapy	113	41.6±12.9	SF - 36	N/A	6 weeks	CLBP	Turkey
	Spinal stabilization therapy		43.1± 14.3	VAS				
				ODQ				
Valenza [65]	Pilates exercise	54	37.62±12.14	RM	2x45 min.	8 weeks	NCLBP	Spain
	C.g. (no treatment)		40.27±15.84	VAS				
				ODQ				

C.g. – Control group; NLBP - Nonspecific low back pain; CLBP - Chronic low back pain; LBP - Low back pain; ALBP - Acute Low Back Pain;

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Meta-analysis

SF-36 Mental

Of the twenty-five included studies, fourteen studies used the SF-36 Mental as an outcome. After pooled the results, statistical significance was shown (SMD = 0.39; 95% CI = 0.27, 0.51; p < 0.0001) and heterogeneity (I2 = 0%, p = 0.6) (Figure 4). Egger's test showed that there was no obvious statistical significance of publication bias (intercept 1.42; 95% CI = -0.31, 3.15; p = 0.13).

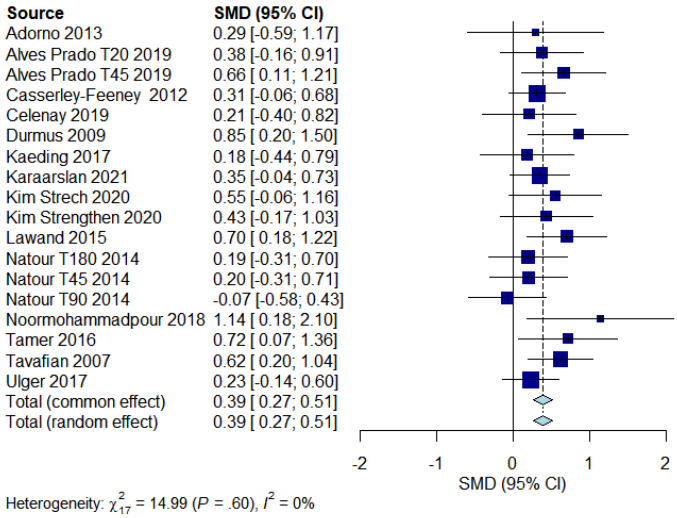

Figure 4. Forest plot for outcome SF-36 Mental.

SF-36 Physical

Fifteen studies used the SF-36 Physical as an outcome. After pooled the results, statistical significance was shown (SMD = 0.55; 95% CI = 0.40, 0.69; p < 0.0001) and heterogeneity (I2 = 20%, p = 0.2) (Figure 5). Egger's test showed that there was no obvious statistical significance of publication bias (intercept 0.005; 95% CI = -2.14, 2.15; p = 1).

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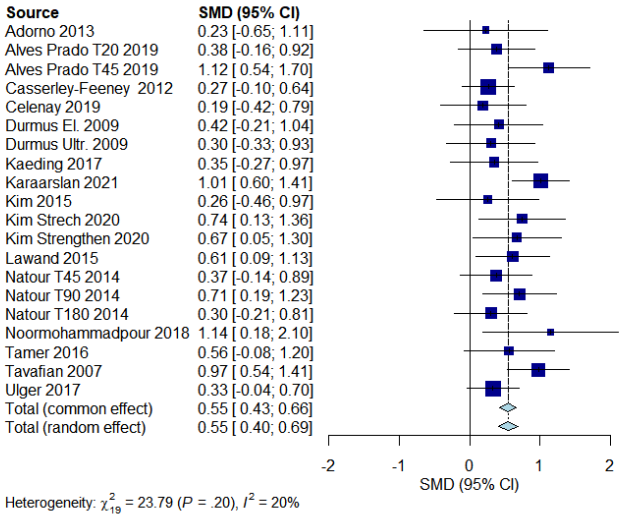

Figure 5. Forest plot for outcome SF-36 Physical.

VAS

Nine studies used VAS as an outcome. After pooled the results, statistical significance was shown (SMD = -0.84; 95% CI = -1.01, -0.67; p < 0.0001) and heterogeneity (I2 = 8%, p = 0.36) (Figure 6). Egger's test showed that there was no obvious statistical significance of publication bias (intercept 1.61; 95% CI = -1.83, 5.05; p = 0.38).

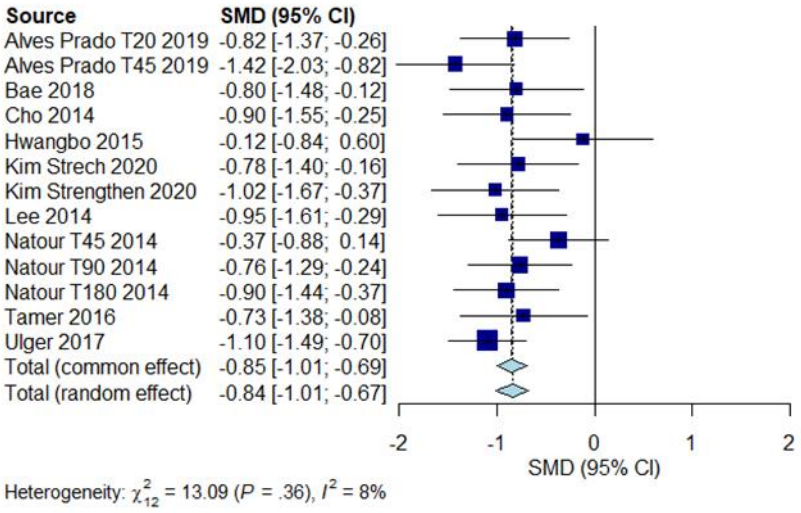

Figure 6. Forest plot for outcome VAS.

Roland-Morris

Eleven studies used the RM as an outcome. After pooled the results, statistical significance was shown (SMD = -0.45; 95% CI = -0.60, -0.30; p < 0.0001) and heterogeneity (I2 = 12%, p = 0.32) (Figure 7). Egger's test showed that there was an obvious statistical significance of publication bias (intercept -2.56; 95% CI = -4.78, -0.34; p = 0.04).

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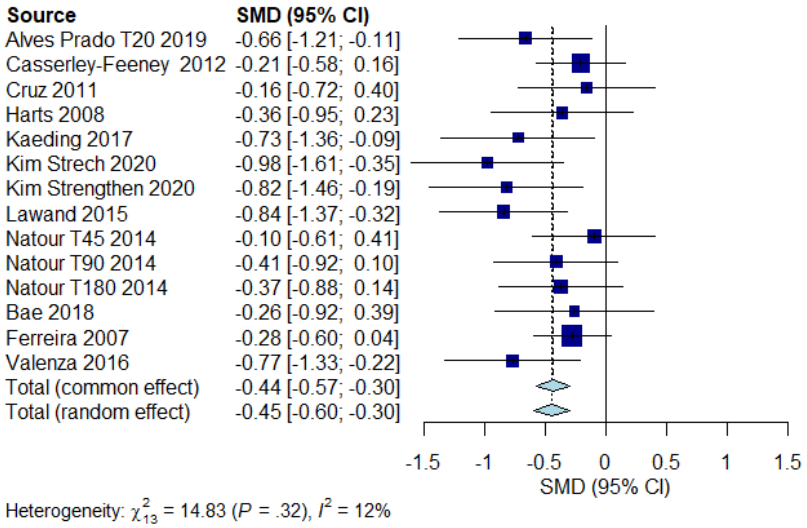

Figure 7. Forest plot for outcome Roland-Morris.

Oswestry Disability Index

Nine studies used the ODI as an outcome. After pooled the results, statistical significance was shown (SMD = -0.61; 95% CI = -0.80, -0.42; p < 0.0001) and heterogeneity (I2 = 0%, p = 0.54) (Figure 8). Egger's test showed that there was no obvious statistical significance of publication bias (intercept -0.37; 95% CI = -3.72, 2.99; p = 0.84). Egger's test may lack statistical power to detect bias when the number of studies is small (ie, k<10).

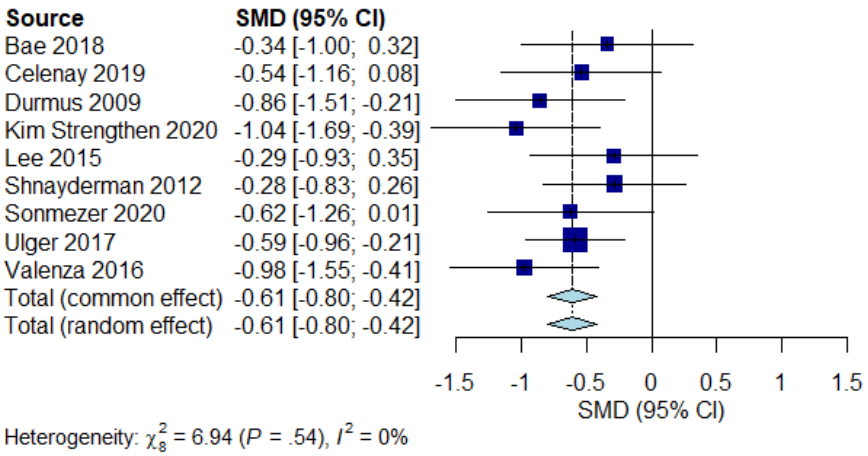

Figure 8. Forest plot for outcome Oswestry Disability Index.

4. Discussion

In our meta-analysis, we pooled the results of 25 studies to obtain the effect size of different methods for treating LBP in subjects, which was also the goal of the research. We presented effect sizes for five outcomes. For the SF-36 Mental outcome, there was statistical significance of the effect size (SMD = 0.39, ≥0.2 - small effect size) (Figure 4), and also for SF-36 Physical outcome (SMD = 0.55, ≥0.5 - moderate effect size) (Figure 5). For the VAS outcome, the results show statistical significance

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(SMD = -0.84, ≥0.8 large effect size) (Figure 6), and RM outcome was statistical significance (SMD = -0.45, ≥0.5—almost moderate effect size) (Figure 7). The effect size for the ODI outcome was also statistically significant (SMD = -0.61, ≥0.5 moderate effect size) (Figure 8).

In our systematic review, subjects with different types of LBP were examined. Different corrective program methods have been used in the treatment of LBP. Due to the large number of different methods, it was not possible to perform a subgroup analysis according to the applied methods, in order to compare which corrective programs have better effects on subjects with LBP. The respondents were from 18 to 65 years old. Although there was a wide range of ages, we were unable to perform a subgroup analysis by age factor to determine how different methods affected different age categories. In 25 studies, we managed to do a meta-analysis for five outcomes, which we consider a good source on which conclusions can be drawn about the application of different methods for LBP. The results of our meta-analysis send a good message to respondents with LBP, and prove that by applying different corrective programs, such problems can be solved well. According to the different outcomes measured, the effect size was from small to large (SMD = 0.39 to 0.84).

Of the 25 included studies, 20 were randomized control trials, while 5 studies were non-randomized. Of the randomized studies, three studies had high risk in two items. High risk appears mostly in the item "allocation concealment", while non-randomized studies that were all comparative had a satisfactory score so that they could be included in the analysis. In all the measured outcomes, the homogeneity of the included studies was not violated, because all those studies whose results, according to our estimates, lead to heterogeneity, were not even included in the analysis. The results of certain included studies that would lead to heterogeneity in certain outcomes, such results were excluded from those outcomes. In our opinion, the principle of homogeneity of the included studies gives a better picture of the actual the effect size, which increases with increasing heterogeneity. For these reasons, we were not faced with solving the problem of heterogeneity and there was no need in any of the outcomes to do a leave one out meta-analysis, in order to draw a conclusion as to how each individual study affects the results of the effect size. Negligible heterogeneity values of 20, 12 and 8% which do not affect the effect size appear in the SF-36 Physical, VAS, and RM outcomes.

We undertook a comprehensive search based on four databases, and there was no language restriction. The SF-36 outcome has eight domains, of which we calculated effect sizes for only two domains. The problem was that some studies do not provide results for certain domains, while they do provide results for certain domains. Only the study by Kim54 report no results for the SF-36 Mental outcome, of all studies that used the SF-36 outcome, while all others report results for both the SF-36 Mental and SF-36 Physical outcomes. For these reasons, we decided to examine only these two domains through a meta-analysis, which can represent potential biases in our research. Studies [41–43] present data as median (min-max), which represents a problem in data processing, although these studies are not excluded from the meta-analysis, those problems were already solved with the recommendations of Higgins [38], Furukawa [66], and Hozo [67]. In this case, we did not perform a sensitive Leave one out meta-analysis because the recommendations given by the mentioned studies solve this problem well. Due to the number of included studies and their outcomes, we were not able to perform any subgroup analysis, either by difference in treatment, duration of treatment or age, which may reduce the quality of the results obtained, but this did not depend on us but on the results of the included studies.

Our meta-analysis is the only such study that evaluated the effect size of different low back pain treatment methods based on these outcomes. Meta-analyses by Coulter [68], Franke [69], Hu [70], Quentin [71], Searle [72] also address LBP problems, however, these meta-analyses were not designed like our meta-analysis which evaluates the effect size according to the outcomes; SF-36 Mental, SF-36 Physical, VAS, RM, and ODI, so we could not compare our results with their results. We did not comment on the result values of the individual studies that were included in our meta-analysis because the aim of this work was to obtain an overall effect size through pooled results, for those outcomes that we measured. The results of our meta-analysis, as well as the results of our previous

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meta-analyses [73–76], encourage all subjects with LBP, and other spine problems to use conservative treatment methods.

The biggest limitation of our meta-analysis is that we did not perform any subgroup analysis, and this will be our biggest incentive for future research. A limitation is that we did not compare the results with other meta-analyses, but that was not up to us.

5. Conclusions

Our meta-analysis indicates the positive effects of different methods applied in the treatment of LBP. The effect size ranged from small to large (SMD = 0.39 to 0.84) depending on the outcome we assessed. We think that our comprehensive analysis included a sufficient number of studies, and that the effect size was estimated on a sufficient number of outcomes. In the future, we should work on the limits we mentioned. We sincerely believe that this meta-analysis will be of benefit to many people dealing with LBP, especially physiotherapists, exercise specialists and clinicians, and will stimulate future research.

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Conflicts of Interest: The authors declare that there is no commercial or financial relationship that could be interpreted as a potential conflict of interest.

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