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Meta-analysis
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Effectiveness of Manual Therapy on Function in Neck Pain Patients: A Systematic Review and Meta-Analysis

Faizah Nashrillah Reyhana, Wahyuni Wahyuni

Faculty of Health Sciences, Physiotherapy Study Program Universitas Muhammadiyah Surakarta

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ABSTRACT

Background: Neck pain is a musculoskeletal disorder that occurs in the neck due to various factors such as incorrect ergonomic position when carrying out an activity. One intervention that can be carried out to improve the function of neck pain sufferers is by providing manual therapy. This study aims to determine the effectiveness of manual therapy for functional use in patients with neck pain.
Subjects and Method: This was a meta-analysis study using PICO as follows, P=Patients with neck pain, I=manual therapy, C=non-manual therapy, O=functional improvement. The articles used in this research were obtained from several databases such as Google Scholar, NCBI, PubMed, Springer Link, Science Direct. The keywords used are "Randomized control trial" AND "neck pain" OR "cervical pain" OR "Cervicalgia" Upper cervical pain" AND "manual therapy" OR "Manipulation treatment" OR "thoracic manipulation in neck pain" OR "Cervical spine manipulation" OR "Passive therapy" OR "Ostheopathic" OR "neck pain rehabilitation" AND "Disability" OR "Functional" OR "Neck pain disability index". The articles included in this research are full text articles with the study design used being a Randomized Controlled Trial. The full text review application uses PRISMA flow diagrams.
Results: A total of 8 articles that have been analyzed come from Spain, the Netherlands, Minensota, Canada, Australia and Turkey. This study shows that there is an effect on neck pain sufferers who are given manual therapy intervention - 0.08 units of influence compared to non-manual therapy, this effect is not statistically significant on function and this effect has a statistically significant effect (SMD = - 0.08; CI 95% CI= -0.35 to 0.20; p= 0.590).
Conclusion: The manual therapy has an impact on mobile range of motion of the joint in neck pain patients compared to those without manual therapy.

Keywords: Manual therapy, neck pain, functional.

Correspondence:
Faizah Nashrillah Reyhana. Study Program of Physiotherapy, Faculty of Health Sciences, Universitas Muhammadiyah Surakarta, Jl. A. Yani, Mendungan, Pabelan, Kec. Kartasura, Kabupaten Sukoharjo 57169, Central Java, Indonesia. Email:faizahnashrillahreyhana@gmail.com. Mobile: 089604220954.

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BACKGROUND

Humans are increasingly carrying out activities to meet their needs. Physical, mental, spiritual and social and cultural needs such as working, exercising, going to school, worshiping, doing social activities and many more (Haryatno and Kuntono, 2016). The use of technology that requires humans to work using machines such as computers and gadgets. One of the consequences of this habit is Musculoskeletal disorders. This can affect the structural and functional aspects of the human body, structurally in hard tissue and soft tissue such as the spine, joints, muscles and ligaments (Ghodrati et al., 2017). This disorder is like neck pain. As stated in QS. Al-maidah verse 3 "Indeed, Allah has sent down diseases along with their medicine, and He has made every disease have a cure, so seek treatment, but do not seek treatment that is haram." From this verse, there is a cure for all diseases that come down in this world.

Neck pain is a common Musculoskeletal pain experienced by two thirds of the population at some point in life (Hasnah, Irianto and Sri, 2019). Surveys show that there were 1.6 billion worldwide in 2010, an increase from 670 million in 2008. In 2012, neck pain had an impact on work absenteeism among 25.5 million Americans, who missed an average of 11.4 days of work. (Kazeminasab et al., 2022). In 2017, the global prevalence based on age standards and the incidence rate of neck pain were 3551.1 and 806.6 per 100,000, respectively (Safiri et al., 2020). This has a huge economic burden due to neck pain and affects productivity and work-related problems (Kazeminasab et al., 2022).

The increased risk of neck pain is caused by incorrect working posture. The percentage results from research on staff with a sitting posture show that Musculoskeletal disorders are most often experienced in the neck with a percentage of 61.5% of incidents in the back, 59.6% and 57.6% in the waist. This occurs greatly influenced by factors such as work duration, workload, unergonomic positions and muscle tension which results in neck pain (Motimath and Ahammed, 2017; Putra and Pristianto, 2023). The main factor in workers is the duration of work accompanied by a hunched sitting position at work which causes neck pain (Genebra et al., 2017).

Determining the effect of neck pain on each individual is something that affects the individual's performance in daily activities. The implications of neck pain itself are caused by factors such as injury, work factors and non-work factors (Kudsi, 2015). Neck pain causes reduced muscle use which has an impact on reducing repetitive movements in the upper body because it has the potential to trigger pain. This affects an individual's posture due to muscle fatigue, muscle speed, muscle output, and ability to complete repetitive movements (Constand and MacDermid, 2013).

One intervention that is usually applied is manual therapy. In its therapy, physiotherapy offers 'manual therapy', with the aim of increasing joint movement in the spine and restoring range of motion (Verhagen, 2021). Manual therapy is a category of generic therapy that includes a variety of procedures directed at Musculoskeletal structures in the treatment of mechanical pain. This therapy involves joint movement and therapy that does not involve joint movement, these two subcategories are the main categories of manual therapy (Humphreys, 2016). In research conducted by Humphreys 2016, the results showed that manipulation was effective in treating neck pain. The effect of manual therapy given in resolving musculoskeletal pain such as neck pain has varying results or effects ranging

from small, medium, large or failure (Bialosky et al., 2018). Despite variability in reported results, a number of current clinical guidelines positively support manual therapy in the treatment of neck pain.

Based on the background description that has been explained, comprehensive research is needed from various primary studies regarding the effectiveness of manual therapy on function in neck pain patients systematically and through a meta-analysis approach. Based on the population and large impact, the researchers analyzed with the aim of investigating relevant studies in assessing the effectiveness or influence of manual therapy on the function of neck pain patients.

Data obtained from many studies will be analyzed using systematic reviews and meta-analysis by synthesizing the results of studies conducted to reduce bias.

SUBJECTS AND METHOD

1. Study Design

This was a systematic review and meta-analysis. Several databases used to search for this research article are Google Scholar, NCBI, PubMed, Springer Link, Science Direct. To search for this research article the keywords used are: "Randomized control trial" AND "neck pain" OR "cervical pain" OR “Cervicalgia upper cervical pain" AND "manual therapy" OR "Manipulation treatment" OR "thoracic manipulation in neck pain” OR “Cervical spine manipulation” OR “Passive therapy” OR Ostheopathic OR “neck pain rehabilitation” AND Disability OR Functional” OR “Neck Pain Disability Index”.

2. Inclusion Criteria

The article design used in this research is a full text article using a Randomized Controlled Trial (RCT) study. The subjects of this research were patients with neck pain aged 18-70 years. The interventions in the selected articles are based on functional therapy manuals for neck pain patients .

3. Exclusion Criteria

The exclusion criteria for the articles used were articles that were not in English, research designs other than RCTs, articles not full text, articles published after 2000.

4. Study Variables

The dependent variable is functional or disability. The independent variable is manual therapy.

5. Operational Definition of Variables

Researchers search for articles by considering the relevance criteria determined by the PICO model. The population in this study were patients with neck pain, the intervention used was manual therapy, the outcome in this study was functional improvement with the Neck Disability Index.

Manual therapy is a completely passive intervention carried out to assist in rehabilitation and recovery. Instrument: therapy manual with categorical measurement scale.

Functional or quality of life is an assessment of subjective physical and mental health, which is greatly influenced by the values and culture of the surrounding environment as well as the economic aspects of each individual. Instrument: questionnaire with categorical measurement scale.

6. Study Instrument

Reports of studies that have been identified, then each study is assessed based on eligibility criteria. Results are strongly influenced by the quality and design of the studies analyzed in the meta-analysis. The quality assessment system in this research uses critical appraisal tools randomized controlled trials (RCT) published by CEBM University of Oxford 2014.

a. Does the research address the focused statement/problem clearly?

b. Is the Randomized Controlled Trial research method suitable for answering the research questions?
c. Were there enough subjects in the study to determine that the findings did not occur by chance?
d. Are subjects randomly allocated to experimental and control groups? If not, could this introduce bias?
e. Are inclusion/exclusion criteria used?
f. Were the two groups comparable at the start of the study?
g. Are objective and unbiased outcome criteria used?
h. Are objective and validated measurement methods used to measure the results? If not, were the results assessed by someone blind to group assignment (i.e. were assessments blinded)?
i. Is effect size practically relevant?
j. How precise is the effect estimate? Is there a confidence interval?
k. Could there be confounding factors that have not been taken into account?
l. Can the results be applied to your research?

7. Data analysis

Data processing was processed using Review Manager (RevMan 5.3) to conduct a systematic review on functional neck pain. Next, calculate the mean difference in the NDI (Neck Disability Index) functional score in determining the research model which is combined to form the final results of the meta-analysis.

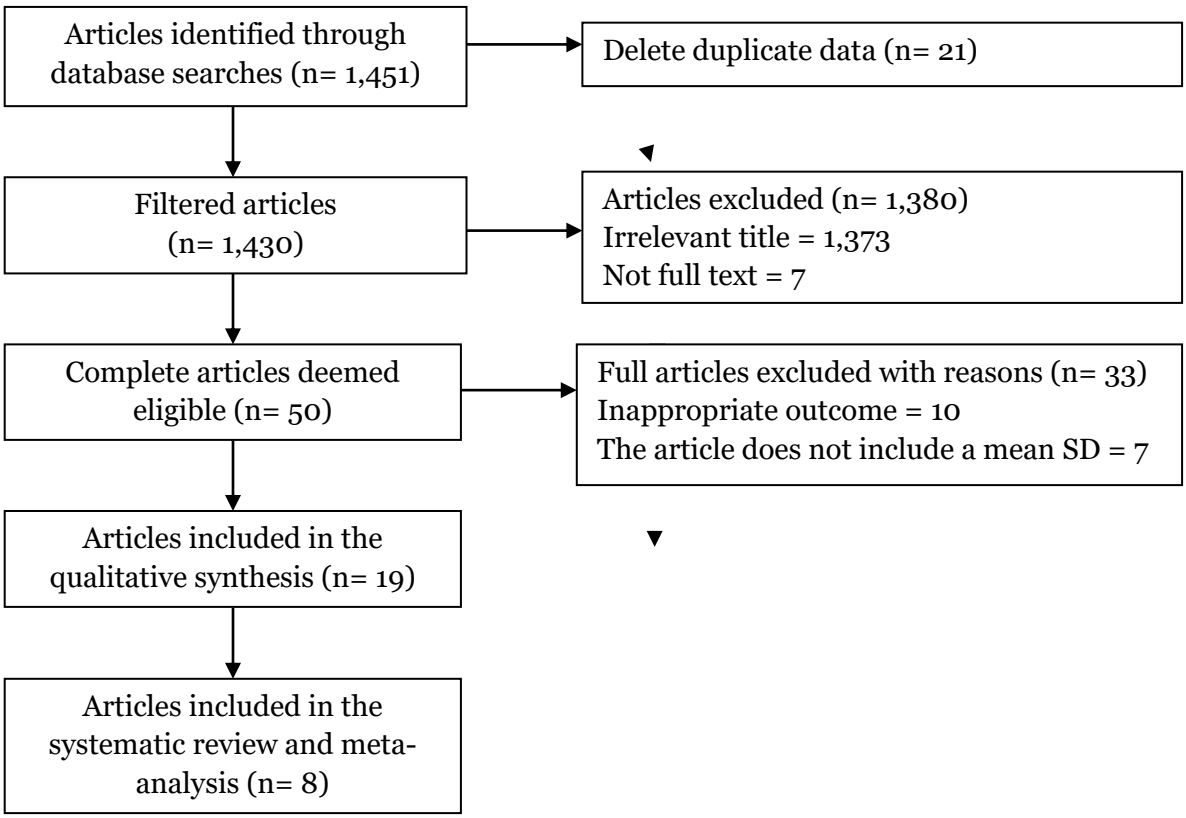


Figure 1. PRISMA flow diagram

Table 1. Study quality assessment based on Critical Appraisal Tools Randomized Controlled Trial (RCT) published by CEBM University of Oxford 2014

Questions of Checklist	Publication (Author and Year)							
	(Bernal-Utrera *et al.*, 2020)	(Rodríguez-Sanz *et al.*, 2020)	(Westaway, 2003)	(Groeneweg *et al.*, 2017)	(Evans *et al.*, 2012)	(Martel *et al.*, 2011)	(Leaver *et al.*, 2010)	(Corum *et al.*, 2021)
Does this research address a clear research focus?	1	1	1	1	1	1	1	1
Is the Randomized Controlled Trial research method suitable for answering the research questions?	1	1	1	1	1	1	1	1
Were there enough subjects in the study to determine that the findings did not occur by chance?	1	1	1	1	1	1	1	1
Are subjects randomly allocated to experimental and control groups? If not, could this introduce bias?	1	1	1	1	1	1	1	1
Are inclusion/exclusion criteria used?	1	1	1	1	1	1	1	1
Were the two groups comparable at the start of the study?	0	1	1	1	1	1	1	1
Are objective and unbiased outcome criteria used?	1	1	1	1	1	1	1	0
Are objective and validated measurement methods used to measure the results? If not, were the results assessed by someone blind to group assignment (i.e. were assessments blinded)?	1	1	1	1	1	1	1	1

Questions of Checklist	Publication (Author and Year)							
	(Bernal-Utrera *et al.*, 2020)	(Rodríguez-Sanz *et al.*, 2020)	(Westaway, 2003)	(Groeneweg *et al.*, 2017)	(Evans *et al.*, 2012)	(Martel *et al.*, 2011)	(Leaver *et al.*, 2010)	(Corum *et al.*, 2021)
Is effect size practically relevant?	1	1	1	0	0	1	0	0
How precise is the effect estimate? Is there a confidence interval?	1	1	1	1	1	1	1	1
Could there be confounding factors that have not been taken into account?	0	0	0	0	0	0	0	0
Can the results be applied to your research?	1	1	1	1	1	1	1	1
Score	10	11	11	10	10	11	10	9

*The question in item number 11 was given a score of 0 because it was given a positive value

Effectiveness of manual therapy on function in neck pain patients

8 articles prove the effectiveness of manual therapy intervention on function in neck pain patients

Table 2. Description of primary studies included in the primary studies meta-analysis

Author (Year)	Country	Study Design	Sample		P (Population)	I (Inter-vention)	C (Compa-rison)	O (Outcome)	Nilai	
			Total	Inter-vention					Mean	SD
(Bernal-Utrera et al., 2020)	Spain	Randomized Controlled Trial	26	23	69 individuals with non specific neck pain. with ages 18-50 years	Manual Therapy	Exercise therapy	Functional	11.23	8.42
(Rodríguez-Sanz et al., 2020)	Spain	Randomized Controlled Trial	58	29	Patients aged over 18 years with chronic neck pain, 17 men and 41 women.	Manual Therapy	Exercise	Functional	6.25	5.96
(Westaway, 2003)	Netherland	Randomized Controlled Trial	119	60	Patients aged 18-70 years with non-specific neck pain	Manual Therapy	Physical therapy active	Functional	7.8	7.0

Author (Year)	Country	Study Design	Sample		P (Population)	I (Inter-vention)	C (Compa-rison)	O (Outcome)	Nilai	
			Total	Inter-vention					Mean	SD
							exersice			
(Groeneweg et al., 2017)	Netherland	Randomized Controlled Trial	181	90	Neck pain patients with an age range of 18-70 years	Manual Therapy	Physical therapy exercise	Functional	6.8	5.7
(Evans et al., 2012)	Minnesota	Randomized Controlled Trial	177	90	Patients with the main complaint of mechanical and non-specific neck pain aged 18-65 years	Manual Therapy and exercise therapy	Low-dose home exercise	Functional	19.3	10.9
(Martel et al., 2011)	Canada	Randomized Controlled Trial	65	36	Patients with non-specific chronic neck pain for more than 2 weeks, men and women aged 18-70 years	Spinal manipulation	No intervention	Functional	13.7	12.1
(Leaver et al., 2010)	Australia	Randomized Controlled Trial	177	89	Patients with non-specific neck pain lasting less than 3 months range in age from 18-70 years and are suitable for manipulation treatment.	Neck manipulation/ manual therapy	Neck mobilizatio n	Functional	6.8	6.2
(Corum et al., 2021)	Turkey	Randomized Controlled Trial	39	15	Patients with complaints of neck pain and TTH ranged in age from 19-48 years	Cervical spinal manipulation	Exercise	Functional	6.7	5.8

*Variables included in the meta-analysis

RESULTS

Figure 1 shows the process of searching a journal database to find articles. There were 1,451 articles identified from the database. After the process of eliminating duplicate articles, 1,430 articles were accepted, 50 of which met the research requirements, resulting in 8 articles being included in the synthesis and meta-analysis study.

There were 8 articles from 4 continents, namely America, Europe, Australia and Asia. 2 studies from the American Continent, 4 studies from the European Continent, 1 study from the Australian Continent and 1 study from the Asian Continent.

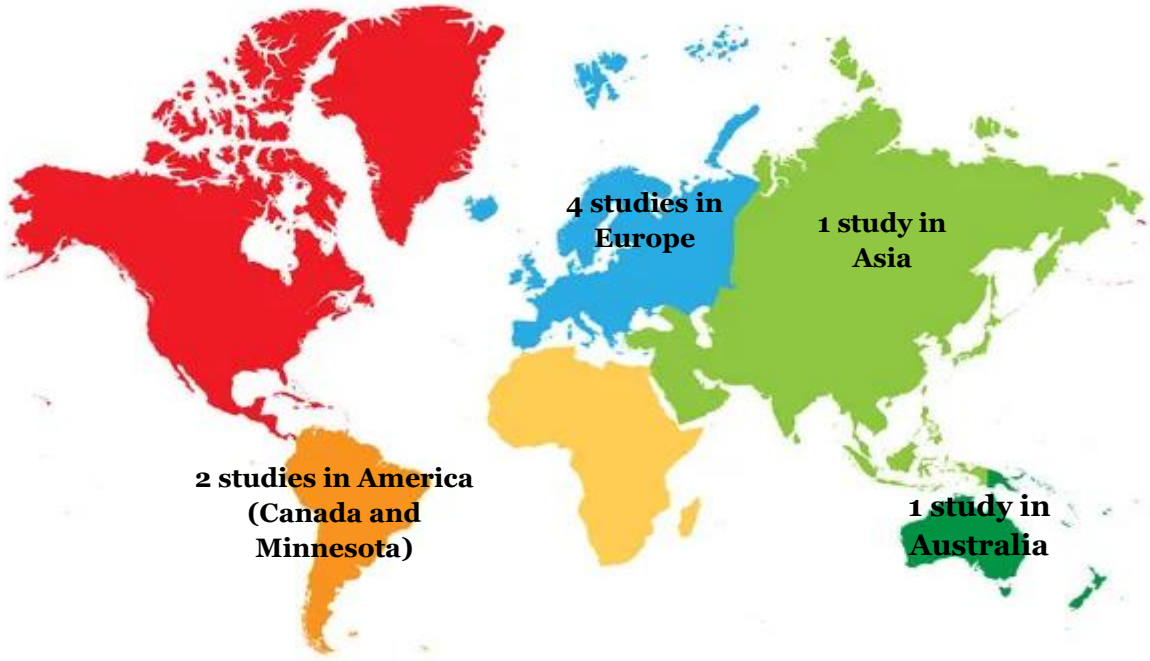
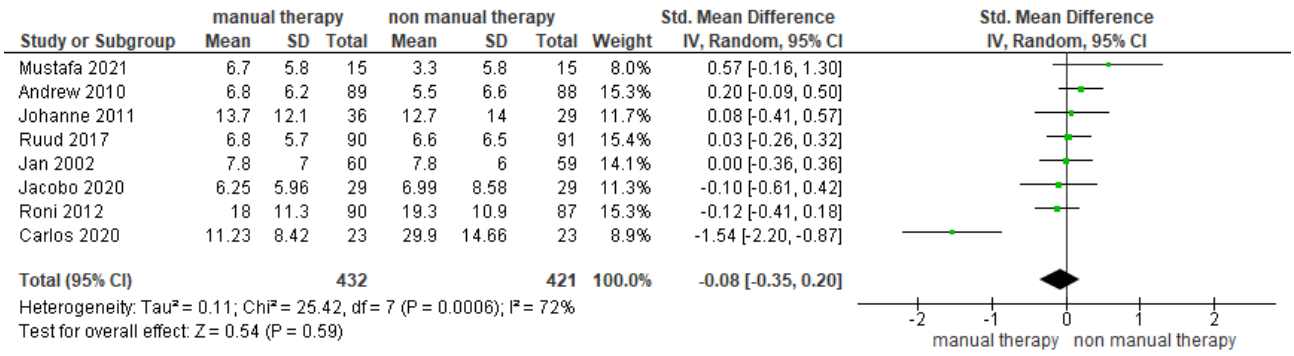


Figure 2. Map of the functional effectiveness of manual therapy in neck pain patients

1. Forest Plot



Study or Subgroup	manual therapy Mean	SD	Total	non manual therapy Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
Mustafa 2021	6.7	5.8	15	3.3	5.8	15	8.0%	0.57 [-0.16, 1.30]
Andrew 2010	6.8	6.2	89	5.5	6.6	88	15.3%	0.20 [-0.09, 0.50]
Johanne 2011	13.7	12.1	36	12.7	14	29	11.7%	0.08 [-0.41, 0.57]
Ruud 2017	6.8	5.7	90	6.6	6.5	91	15.4%	0.03 [-0.26, 0.32]
Jan 2002	7.8	7	60	7.8	6	59	14.1%	0.00 [-0.36, 0.36]
Jacobo 2020	6.25	5.96	29	6.99	8.58	29	11.3%	-0.10 [-0.61, 0.42]
Roni 2012	18	11.3	90	19.3	10.9	87	15.3%	-0.12 [-0.41, 0.18]
Carlos 2020	11.23	8.42	23	29.9	14.66	23	8.9%	-1.54 [-2.20, -0.87]
Total (95% CI)			**432**			**421**	**100.0%**	**-0.08 [-0.35, 0.20]**

Heterogeneity: Tau² = 0.11; Chi² = 25.42, df = 7 (P = 0.0006); I² = 72%
Test for overall effect: Z = 0.54 (P = 0.59)

Figure 3. Forest Plot of the effectiveness of manual therapy for functional use in neck pain sufferers.

Based on the results of the forest plot (figure 3), it shows that manual therapy -0.08 units has an effect on function in neck pain sufferers compared to non-manual therapy and is not statistically significant, the effect is statistically significant, and this effect is statistically significant (SMD= -0.08; CI 95% CI=-0.35 to 0.20; p=0.590 >0.001). Heterogeneity of estimates between studies in this meta-analysis is high with I^2= 72%, thus the synthesis of estimates of the overall effect of primary studies was carried out using a random effects model approach.

2. Funnel Plot

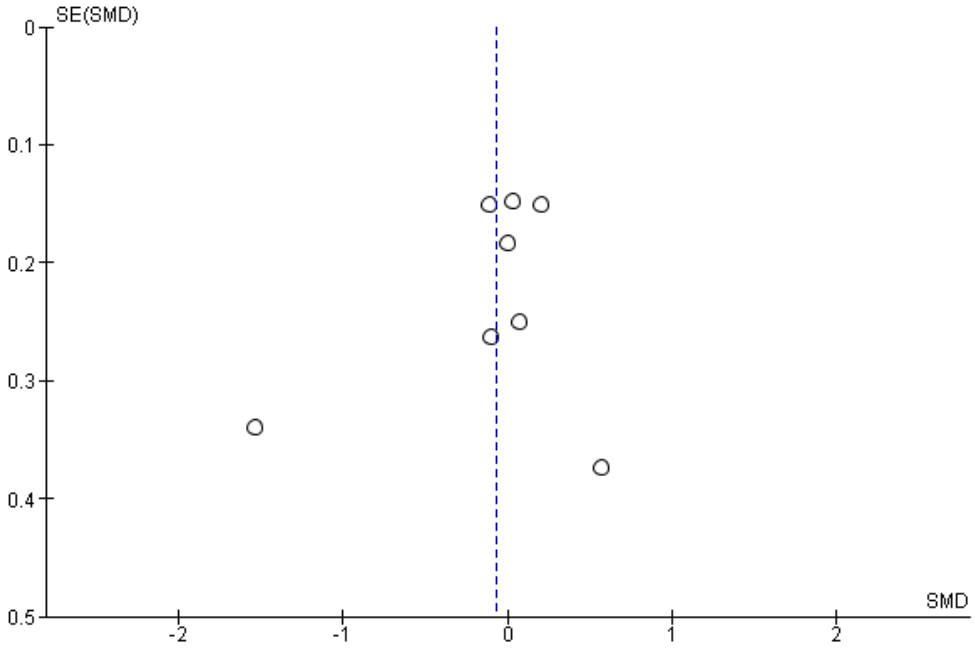


Figure 4. Funnel plot of the effectiveness of manual therapy for functional use in neck pain sufferers.

The funnel plot (Figure 4) shows that there is potential for publish bias which is characterized by asymmetry between the left plot and the right plot. in the right plot it is 5 while in the left plot it is 3. Publication bias reduces the true effect because the direction of bias is to the right of the zero vertical line, as opposed to the diamond mean in the effect estimate, which is to the left of the zero vertical line (underestimate).

DISCUSSION

This research study is a systematic and meta-analysis that discusses the theme of the effectiveness of manual therapy on function in neck pain patients. Research that discusses improving functional manual therapy interventions for neck pain sufferers is important to discuss because this problem is a problem that often occurs in various countries. Both developed and developing countries.

Manual-based interventions to improve functionality were processed using RevMan 5.3 with the continuous method. This method was used to analyze the effect size or standardized mean difference in bivariate data for two groups which had been controlled for confounding factors by randomization.

Forest results showed that neck pain sufferers who received manual therapy intervention had -0.08 units of influence on the function of neck pain sufferers compared to non-manual therapy (SMD= -0.08; 95% CI= -0.35 to 0.20; p= 0.590) and statistically there was no significant. Heterogeneity of research data shows I^2=72% so the distribution is said to be heterogeneous (random effect model).

Corum et al. (2021) giving manual therapy showed improvement in neck pain. NDI scores were found to be statistically different from baseline measurements in the manipulation group (Mean= 6.7; SD= 5.8 Vs. Mean= 19.1; SD= 5.8) with changes in NDI scores (p<0.001) and at the third month of follow-up (p=0.007). The statistically significant improvements shown in the manual therapy group on all criteria indicated good results. This is because the reduction in pain has an impact on the level of disability or functional scale in sufferers of neck pain accompanied by TTH. That this manipulation provides pain modulation in the trigeminal area by reducing nociceptive input to the TCC and specific neurophysiological responses in the upper spinal segments.

Leaver et al. (2010) found that manual therapy intervention to neck pain sufferers did not result in faster functional recovery in new neck pain compared to mobilization (Mean= 5.3; SD= 6.2 Vs. Mean= 5.5; SD= 6.6) in the manual group, P = 0.866 but in recovery from neck pain, participants experienced faster recovery with manual therapy intervention compared with mobilization (HR= 9.8; 95% CI= 66 to 1.46; p= 0.909). This is reported to be non-specific neck pain that is persistent and often recurrent. These findings suggest that there is reason for practitioners and patients to reevaluate the use of manual therapy for patients with new onset neck pain.

Martel et al. (2011) providing manual therapy intervention or spinal manipulation did not provide a significant effect (Mean= 21.5; SD= 14.0; Mean= 13.7; SD= 12.1) but the combination of providing spinal manipulation with other interventions provided a significant effect on improving function in neck pain sufferers, This is proven by the results of primary and secondary measurement scores, one of which is the functional score on the Neck Disability Index. The lack of specific treatment effects is discussed in relation to placebo and patient-provider interactions in therapy manuals.

Groeneweg et al. (2017) providing manual therapy intervention to patients with complaints of neck pain did not find any statistically significant overall differences in both primary and secondary outcomes, the results of providing intervention for 7 weeks and 1 year did not show significant results statistically and also clinically. The results are (Mean= 12.5; SD= 6.8 Vs. Mean= 11.7; SD= 5.4, p= 0.26) with a regression coefficient (95% CI= -0.82 (-2.25 to 0.61). However, it is assumed that manual therapy (MTU) intervention is more effective based on the theoretical principles of chain mobilization and function in the joints of the spine, and extremities related movements and bones and movement patterns, but it is not confirmed compared to standard Physical Therapy (PT) treatments.

Westaway (2003) showed a functional increase in the group given manual therapy intervention. Within a period of 7 weeks the success rate in manual therapy was higher (68.3%) compared to the physical therapy group (50.8%). On the NDI functional scale the average increase over 7 weeks (Mean= 7.8; SD= 7.0 Vs. Mean= 6.0; SD= 7.0). Even though on a functional scale it

provides a small improvement, manual therapy is a more effective intervention compared to other interventions. The magnitude of the difference between manual therapy and physical therapy, as well as between manual therapy and follow-up care, is most pronounced in terms of perceived recovery. Because perceived recovery incorporates other outcomes, such as pain, disability and patient satisfaction, it may be the most responsive outcome measure.

Rodríguez-Sanz et al. (2020) found a significant increase on the functional scale using the neck disability index ($p<0.01$). Providing intervention in the form of manual therapy combined with exercise for a period of 6 months gave a significant increase in the functional scale (Mean= 4.76; SD= 5.96 Vs. Mean= 13.10; SD= 8.58; $p<0.001$ compared to short and medium term exercise.

Evans et al. (2012) the intervention in the form of manual therapy combined with exercise therapy provided a significant improvement in pain in neck pain patients, especially at week 12, a significant difference was recorded in this group compared to the group with HE (low- dose home exercise) ($p\leq0.001$). The reduction in disability or functional improvement was greater than the other groups ($P=0.001$) from the mean value on the functional scale (Mean= 18.0; SD= 11.3 Vs. Mean= 19.3; SD= 10.9). However, in this study, manual therapy combined with exercise therapy would have much better benefits. Because the supervised HE group did not have a significant effect in terms of patient-assessed outcomes, if it was added to manual therapy it would provide little additional benefit if added to supervised exercise in patients with neck pain.

Bernal-Utrera et al. (2020) in the intervention or experimental group, which was measured using a measurement scale, providing interventions measured using the NDI scale, both short and medium term, obtained a clinical improvement in the results of NDI measurements in the manual therapy group. In the intervention analysis Statistically, each group did not have a significant difference, including the manual group (Mean= 27.32; SD= 8.80 Vs. Mean= 29.90; SD= 14.6, $p= 0.001$) from week 1 of intervention to week 12. The manual group provided a decrease in pain perception before exercise therapy and exercise therapy were given. improve neck function before manual therapy is given.

AUTHORS CONTRIBUTION

Faizah was the main researcher who selected the topic, searched for and collected research data. Wahyuni was responsible for analyzing data and reviewing research documents.

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CONFLICT OF INTEREST

There is no conflict of interest in this study.

REFERENCE

Bernal-Utrera C, Gonzalez-Gerez, JJ, Anarte-Lazo E, Rodriguez-Blanco C (2020). Manual therapy versus therapeutic exercise in non-specific chronic neck pain: A randomized controlled trial. Trials. 21(1): 1–10. DOI:10.1186-/s13063-020-04610-w.

Bialosky JE, Beneciuk JM, Bishop MD, Coronado RA, Penza CW, Simon CB, George SZ (2018). Unraveling the mechanisms of manual therapy:

Modeling an approach. J Orthop Sport Phys. 48(1): 8–18. DOI:10.25-19/jospt.2018.7476.

Constand MK, MacDermid JC (2013). Effects of neck pain on reaching overhead and reading: A case-control study of long and short neck flexion. BMC Sports Science, Medicine and Rehabilitation. 5(1). DOI:10.1186/20-52-1847-5-21.

Corum M, Aydin T, Medin CC, Kesiktas FN (2021). The comparative effects of spinal manipulation, myofascial release and exercise in tension-type headache patients with neck pain: A randomized controlled trial. Complemen Ther Clin Prac. 43: 101319. DOI:-10.1016/j.ctcp.2021.101319.

Evans R, Bronfort G, Schulz C, Maiers M, Bracha Y (2012). Supervised exercise with and without spinal manipulation performs similarly and better than home exercise for chronic neck pain: A randomized controlled trial. Spine. 37(11):903–914. DOI:10.1097/BRS.-0b013e31823b3bdf.

Genebra CVDS, Maciel NM, Bento TPF, Simeão SFAP, Vitta A De (2017). Prevalence and factors associated with neck pain: a population-based study. Braz J Phys Ther. 21(4): 274–280. DOI:10.1016/j.bjpt.2017.05.005.

Ghodrati M, Mosallanezhad Z, Shati M, Rastgar Koutenaei F, Nourbakhsh M R, Noroozi M (2017). The effect of combination therap. manual therapy and exercise, in patients with non-specific chronic neck pain: A Randomized clinical trial. J Phys Ther. 7(2): 113–121. DOI:10.32598/ptj.7.2.113.

Groeneweg R, van Assen L, Kropman H, Leopold H, Mulder J (2017). Manual therapy compared with physical therapy in patients with non-specific neck pain: A randomized controlled trial. Chirop Man Therap. 25(1): 1–12. DOI:10.1186/s12998-017-0141-3.

Haryatno P, Kuntono HP (2016). Pengaruh pemberian tens dan myofascial release terhadap penurunan nyeri leher mekanik. Interest : Jurnal Ilmu Kesehatan. 5(2): 182–188. DOI:10.37-341/interest.v5i2.52.

Hasnah, Irianto, Sri SL (2019). The effect of freeletic sport to vo2 max levels on the freeletic community members. N (Nusant) Med Sci J. 4(1): 14–18. DOI: 10.20956/nmsj.v3i2.5776

Kazeminasab S, Nejadghaderi SA, Amiri P, Pourfathi H, Araj-Khodaei M (2022). Neck pain: global epidemiology, trends and risk factors. BMC Musculoskeletal Disorders. 23(1): 1–13. DOI:10.1186/s12891-021-04957-4.

Kudsi AF (2015). Faktor-faktor yang mempengaruhi kejadian nyeri leher pada operator komputer (factors that influence the incidence of neck pain in computer operators). J Agromedicine. 2(3): 257–262.

Leaver AM, Maher CG, Herbert RD, Latimer J, McAuley JH, Jull G Refshauge KM (2010). A randomized controlled trial comparing manipulation with mobilization for recent onset neck pain. Arch Phys M. 91(9): 1313–1318. DOI:10.1016/j.apmr.20-10.06.006.

Martel J, Dugas C, Dubois JD, Descarreaux, M (2011). A randomised controlled trial of preventive spinal manipulation with and without a home exercise program for patients with chronic neck pain. BMC Musculoskeletal Disorders. 12: 1–13. DOI:10.-1186/1471-2474-12-41.

Motimath B, Ahammed N (2017). Comparative Study on Effectiveness of Trigger Point Release Versus Cervical Mobilization in Chess Players with

Mechanical Neck Pain. International Journal of Physical Education. Sports and Health. 4(3): 207–211.

Putra BL, Pristianto A (2023). The relationship between sitting posture and neck pain incidence in educational staff at the Universitas Muhammadiyah Surakarta. Physical Therapy Journal of Indonesia. 4(1): 19–24. DOI:10.51559/ptji.v4i1.70.

Rodríguez-Sanz J, Malo-Urriés M, Corral-De-toro J, López-De-celis C, Lucha-López MO (2020). Does the addition of manual therapy approach to a cervical exercise program improve clinical outcomes for patients with chronic neck pain in short-and mid-term? A randomized controlled trial. Int J Environ Res Public Health. 17(18): 1–20. DOI:10.3390/ijerph17186601.

Safiri S, Kolahi AA, Hoy D, Buchbinder R, Mansournia MA (2020). Global, regional, and national burden of neck pain in the general population, 1990-2017: Systematic analysis of the Global Burden of Disease Study 2017. The BMJ. 368. DOI:10.1136/bmj.m791.

Verhagen AP (2021). Physiotherapy management of neck pain. J Physiother. 67(1): 5–11. DOI:10.1016/j.jphys.2020.12.005.

Westaway M (2003). Manual therapy, physical therapy, or care by a general practitioner for neck pain. Clinical Journal of Sport Medicine. 13(3): 197. DOI:10.1097/00042752-200305000-00019.