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Health Outcomes of Backward Walking in Patients with Low Back Pain: A Scoping Review

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Abstract: There has been growing interest in clinical use and research in backward walking (BW) exercise intervention in low back pain (LBP) in recent years. Studies have reported wide beneficial and potential positive impact on health related outcomes. This scoping review aimed to explore the health outcomes of BW in LBP and determine knowledge gaps for future studies. The Preferred Reporting Items for Systematic reviews and Meta-Analysis extension for Scoping Reviews (PRISMA-ScR) guidelines were applied and a systematic literature search was conducted in seven electronic databases. Relevant articles were screened and assessed for eligibility using the Covidence web-based software. Data were extracted, summarized and appraised using the modified version of a Downs and Black checklist and the findings were reported narratively. A total of 3 articles were included in the final analysis of the present study of which 67% were findings India and 33% South America. All included studies revealed evidence of positive impact on physical dimension of health especially, reduction in pain intensity followed by increase in spinal muscle activity, strength and range of motion. None of the studies reported adverse effects. Evidence from this review corroborate that BW can positively impact health related outcomes in LBP. Limitation in literature and lack of strong methodological quality motivate for more and methodologically rigor studies in future research to better understanding the effects on other health dimensions and wider context.

Keywords: Backward Walking, Health Outcomes, Low Back Pain, Physical Exercise, Scoping Review

1. Introduction

Low back pain (LBP) remains a leading cause of disability globally impacting negatively health and social systems [1]. Recent literature suggest, backward walking (BW) training may improve health outcomes in individual with LBP [2]. BW roots in ancient China where it was used for physical fitness and well-being [3]. It has extensively been used as an exercise intervention in many health conditions to improve various health outcomes. In the last decade, BW in LBP has received increasing attention with some scholars advocating for its inclusion in regular physiotherapy rehabilitation protocols [4].

Numerous beneficial effects of BW have been reported in many conditions such as, Parkinson's disease and Cerebral palsy and improvement in gait characteristics, balance and general performance has been reported [5-7]. For example children with hemiplegic Cerebral palsy who participated in a 12 week intervention of BW added to conventional physiotherapy had greater improvement in spatiotemporal

gait parameters and gross motor function than those who participated in forward walking [8]. Similarly, in orthopedic cases, BW has been reported to improve pain, functional disability, quadriceps muscle power and physical performance [9]. BW has also demonstrated to influence many body structures that has been the basis for many recommendations of its use in clinical practice. A study conducted in India among women with LBP revealed that BW is effective in reducing pain and improving core strength when compared to protocols without BW [10].

Several mechanistic factors have been attributed to the beneficial effects of BW in LBP. For instance in a study on EMG activities of Erector spinae and Multifidus muscles in adults with chronic LBP, Ansari *et al.,* [11] observed that EMG activities increased more in the BW group and was a more favourable activity in enhancing lumbar paraspinal muscle recruitment and increased Hamstrings flexibility [12].

Despite these potential positive effects on a variety of health outcomes, researchers are demanding for further clarity on the benefits of BW in LBP [11]. To our knowledge there are inadequate reviews around this topic which suggests the need to explore the impact of BW in LBP in a broad health framework, socioeconomic and geographical scope. By synthesizing literature, a review may provide insight in understanding the general or common characteristics of individuals and communities involved in BW and how this intervention affects their health. This study aimed to explore the impact of BW on health outcomes and identify knowledge gaps for future studies by conducting a scoping review on all available literature. Further, to ascertain the reported effects of BW on health outcomes in adults with LBP and methods used by scholars to assess the effects of BW on health outcomes.

2. Methods

This scoping review was conducted in accordance with the Preferred Reporting Items for Systematic reviews and Meta-Analysis extension for Scoping Reviews (PRISMA-ScR) guidelines [13]. This is because a wide range of health outcomes, novelty of the subject and variety of methods used in BW research suggest the use of scoping review as directed by PRISMA guidelines. A scoping study design allows a broader search strategy while allowing reproducibility, transparency and reliability on the state of current literature.

2.1. Eligibility Criteria

For eligibility, original articles had to meet the four criteria which include; BW as an exercise intervention involving participants with LBP; the focus of the study was BW defined as walking backwards either on a treadmill or on the ground; at least one outcome investigated or reported was a health outcome in any of the health domains such as, physical, mental or social and only original articles that describe original quantitative and mixed methods were considered. Systematic reviews, grey literature, commentaries, and reports were all excluded. However, the reference list were carefully screened for additional relevant studies.

2.2. Search Strategy

The search strategies were developed in collaboration with an Information Specialist (MP) and organized according to the relevant concepts of the PICO framework encompassing Problem, Intervention, Comparisons, and Outcomes. Valid subject headings as appropriate for each database were utilized, as were free text terms pertinent to each topical concept. This scoping review required the use of two PICO concepts (P & I). Low back pain (P) was the Problem of concern and the Intervention (I) was walking but an Intervention Qualifier was used as only backward or retro walking. No date or language limits were applied. Original articles published from inception of data base to July 2021 were obtained from the systematic searches of electronic data bases including APA PsycInfo (Ovid), CINAHL Complete (EBSCOhost), Embase (Ovid), Emcare Nursing (Ovid), Global Index Medicus, Medline ALL (Ovid; includes PubMed non-Medline records), and Web of Science Core Collection. The full Medline search strategy is shown in additional file 1.

2.3. Selection of Sources of Evidence

Following the database search, all identified citations were collated and uploaded into Covidence systematic review software (Australia). By applying the eligibility criteria, two reviewers (JB with background in physiotherapy, fitness instructing and occupational rehabilitation) and KEM with background in physiotherapy and specialization in neuro-rehabilitation) independently screened the titles and abstracts against the selection criteria and identified potentially relevant articles. In the second selection process, identified articles were returned for full text evaluation. Any disagreements that arose between the reviewers at each stage of the selection process were resolved through discussion until consensus was reached. Reasons for exclusion of sources at full text screening were recorded. Additionally, the reference list of included studies was examined to capture materials not found through database searching. Articles identified from reference searching were subjected to the same screening and selection criteria. The reference search was repeated on all newly identified articles until no additional articles were found.

2.4. Data Extraction Process

A data extraction form (additional file 2) was used to collect specific details on methodology and outcome variables from each study. The following details were collected: Author's names, year of publication, country, setting, characteristics of participants (age and sex), sample size, study design, mode of BW, outcome reported, key findings and funding. Two reviewers (JB and SH) independently performed data extraction. Any discrepancies

were resolved by consensus.

2.5. Collating, Summarizing and Reporting Findings

A narrative account of included studies was prepared to present the patterns of BW impact on health and numerical analysis presented the number, geographical distribution and type of BW of included studies. Outcomes were synthesized thematically to health domains as physical, psychological or social. Additionally the outcome was recorded on overall impact on health as positive or adverse.

2.6. Quality Assessment

For quality assessment of included articles, critical appraisal was performed independently by two reviewers JB and SH using the modified version of a Downs and Black checklist which is composed of 27 items with a possible maximum score of 28 [14]. Study scores were categorised using previously reported categories by Hooper and colleagues (2008) as follows: 26 to 28 was excellent, 20 to 25 was good, 15 to 19 was fair and below 14 was poor [14]. Two reviewers (JB & SH) independently scored the studies using the checklist and any conflicts were resolved through consensus before assigning a final score to all included studies.

3. Results

3.1. Identification of Potential Studies

The searches from the seven electronic databases yielded a total of 26 records. A total of 14 articles were screened for titles and abstracts and from the 4 eligible articles and 1 identified from reference searches of eligible studies, 3 were included in this review. Figure 1 illustrates the study identification and selection process.

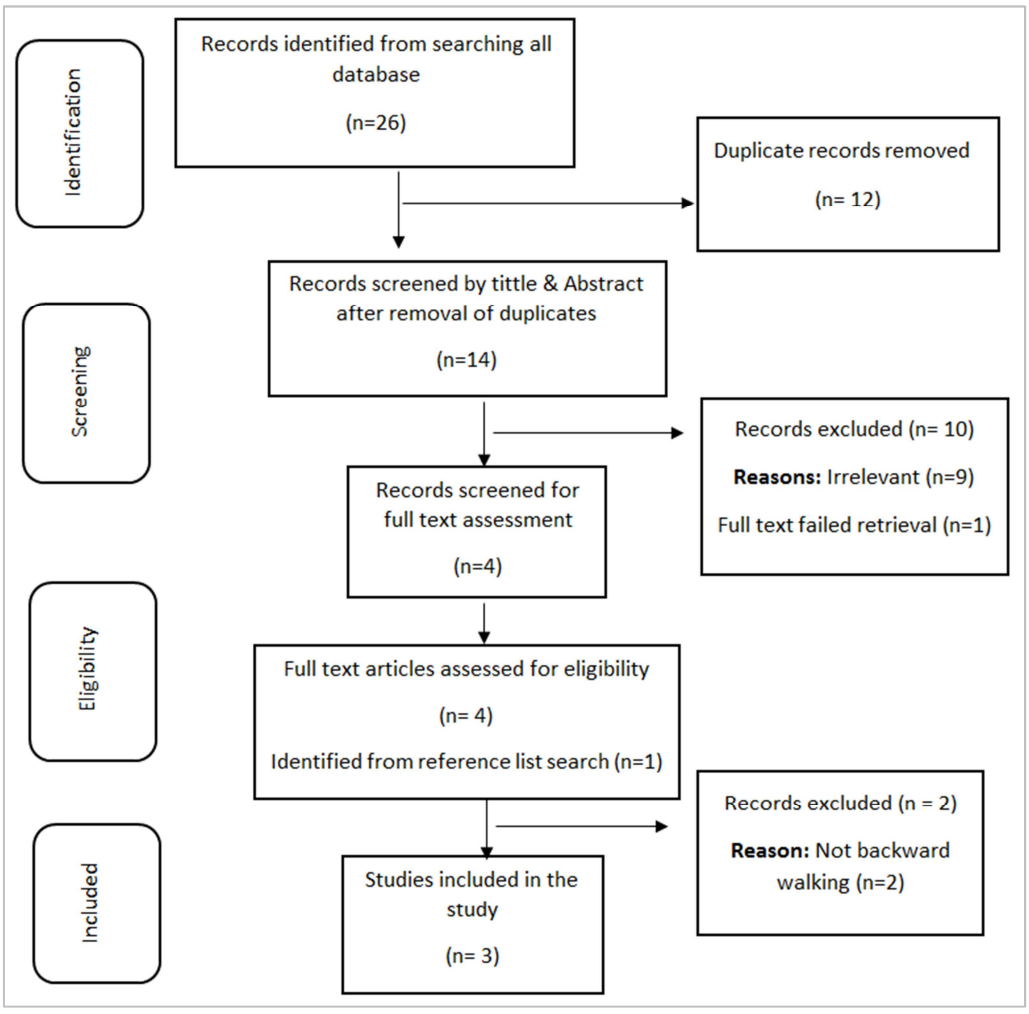

Figure 1. *Flow chart of the study identification and selection process.*

3.2. Characteristics of Included Studies

Three full text articles [Dufek *et al.,* 2011; Manisha *et al.,* 2017; Ansari *et al.,* 2018] on BW in LBP were included in the review (Table 1) Notably literature is recent and has increased over time with 67% of included studies having been done in the last 6 years of the current review. Methodological design of studies included Pre-post [Dufek *et al*., 2011] and Quasi-experimental [Manisha *et al*., 2017; Ansari *et al.,* 2018].

Table 1. *Characteristics of included studies.*

Author	Country of study	Objective	Study design
Dufek *et al.,* [2011]	United states of America (USA)	To assess the therapeutic effectiveness of BW in treatment of LBP in athletes	Pre-post test
Manisha *et al.,* [2017]	India	To find the effect of retro-walking on mechanical LBP in women	Quasi- experimental
Ansari *et al.,* [2018]	India	To investigate the electromyography activity of lumbar multifidus and Erector spinae muscles during FW and BW in participants with and without LBP	Quasi-experimental

Geographically, the included studies were from 2 world regions Asia 67% and North America 33% (Figure 2). In terms of income per capital, majority of studies (67%) were conducted in a lower middle income country (India).

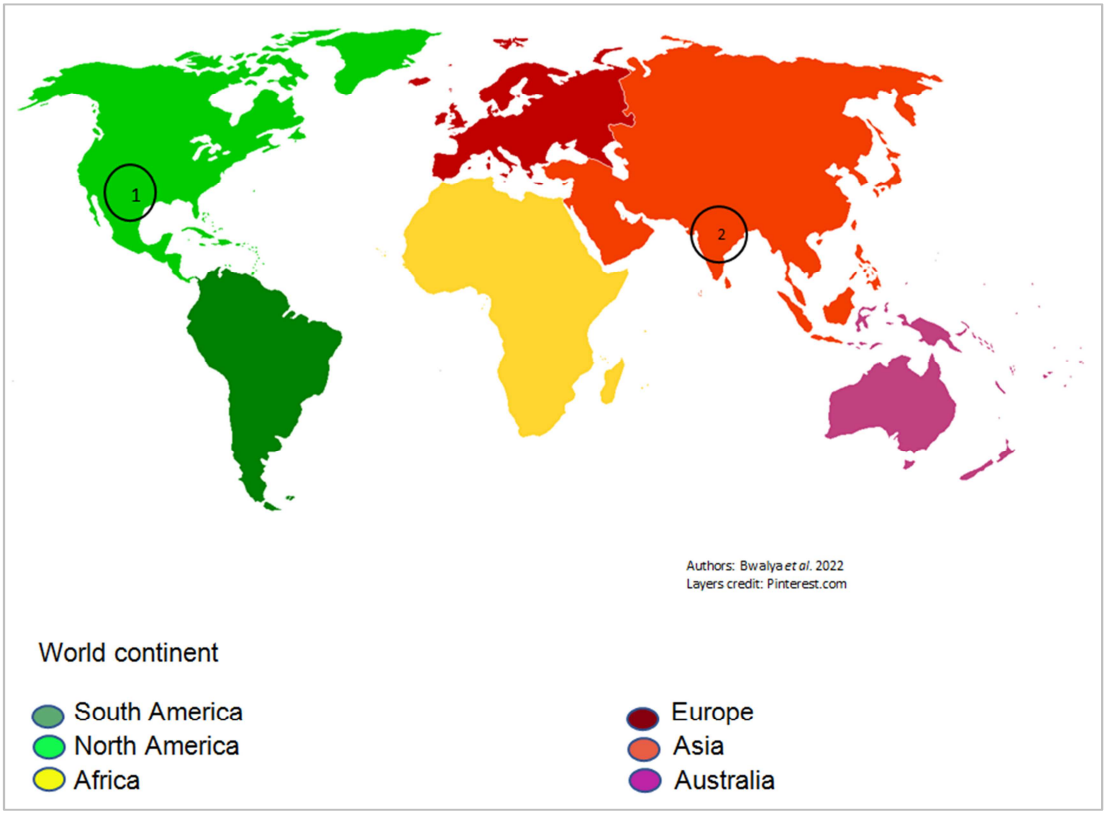

Figure 2. *Number of included studies by world regions.*

3.3. Characteristics of Health Outcomes Assessed by Included Studies

Table 2 shows the summary of characteristics of health outcomes assessed in the included quantitative studies.

Table 2. *Characteristics of investigated health outcomes.*

Health dimension	N	Outcome	References & type of effect on outcome		
			Positive	Neutral	Adverse
Physical	3	Pain	[2[c], 10[b]]	[2]	
		Joint ROM	[2]		
		Muscle activity & power	[10[b], 11[c]]		
		Gait parameters	[2]		

[b] Study quality rated as good or excellent
[c] Study quality rated as fair.

As demonstrated in table 2, included studies reported positive outcomes on various physical health domain which included; reduced self-reported pain intensity [Manisha *et al*.; Dufek *et al*.], increased lumbar spine sagittal and coronal plane range of motion [Dufek *et al*.], electromyography (EMG) activity of multifidus and erector spinae muscles [Ansari et al.] and core strength [Manisha *et al*.] in individuals with LBP. Additionally, improved gait stride and speed was also reported [Dufek *et al*.]. None of the included studies reported any adverse effect of BW in LBP.

3.4. Quality Appraisal of Included Studies

Methodologically the quality of studies included was appraised as fair [Ansari *et al.,* 2018; Dufek *et al.,* 2011] and good [Manisha *et al.,* 2017] (see additional file 3). Mostly the studies appraised as fair did not provide sufficient information on internal validity particularly managing bias and confounding factors. Additionally, they did not report or indicate blinding, randomization or concealment in their methodologies and no adjustment for confounders were reported in the analysis.

3.5. Backward Walking Modality Studied in Included Studies

The included studies used two terminologies to study BW. Commonly used terminology was backward walking [Ansari *et al*., 2018; Dufek et al., 2011] and Retro-walking [Manisha *et al*., 2017]. Modality of backward walking was either treadmill [Ansari et al.; Dufek *et al*] or ground BW [Manisha *et al*.]. Duration of BW in a session was 1 minute [Ansari *et al*.], 10 minutes [Manisha *et al*] and 15 minutes [Dufek *et al*.]. Treatment period was once off [Ansari *et al*.], 3 weeks [Dufek *et al*.] and 4 weeks [Manisha *et al*.]. No follow up assessment of impact post intervention was done in any of the study.

3.6. Types of Health-Related Outcomes Studied

Quantitative outcomes assessed were assessed and grouped into three categories based on dimensions of health as identified by WHO as physical, mental and social wellbeing of an individual. All studies [Dufek *et al.,* 2011; Manisha *et al.,* 2017; Ansari *et al.,* 2018] investigated only physical outcomes of health such as pain, joint range of motion, muscle strength and gait as indicated in table 2. In addition to pain outcome reported by most of included studies, other physical outcomes investigated included joint range of motion, muscle activity; EMG activities of multifidus and Erector spinae and core muscles and gait. The reported health effects were largely positive on each of the outcomes investigated.

4. Discussion

In this scoping review, a standardized method of evidence synthesis was used to identify, select and synthesise findings of 3 studies that reported the effects of BW on health outcomes in adults with LBP. The scope of literature has been documented by analysing the geographic scope, BW modality, type of outcomes and findings on the main reported health dimensions. The discussion below provides information on implications of the findings and highlight on the gaps that emerged from the results of this review that maybe relevant to clinicians and researchers. The results from included studies reveal that literature on BW in LBP is fairly new and very scanty. The novelty of literature and increased number of publications in the last two decades collaborate previous observation that BW is gaining popularity in rehabilitation especially in developing countries were the economic costs associated with investing in pieces of equipment for management of LBP my not be feasible [15, 16, 4].

All dimensions of health are important and according to Blake and Plant [17], multidimensional assessments of health outcomes are needed to better understand changes in health status of an individual post intervention. Among the 3 dimensions (physical, mental and social), only physical health has be investigated with a positive impact reported on all of its related outcomes. It is evident from this review that BW impact positively on pain, muscle power and gait in individuals with LBP most probably due to previously reported observation including increase in Hamstrings flexibility and range of motion in the lumbar region [18], increased EMG activities in back extensor muscles [11] and enhanced spinal drive and recruitment of further spinal circuits following BW.

Evidence supporting positive health outcomes of BW in LBP remain largely uncontended with no adverse effects and in a wide sense is similar to previously reported effects of BW in other health condition such as osteoarthritis and stroke [9, 5, 6, 7]. For instance following a 6 weeks randomised controlled trial (RCT) of BW, reduction in pain, functional disability and improved quadriceps muscle strength performance was reported [9]. Additionally, Chen *et al*., [19], reported improvement in gait velocity following BW and a previous study [18] proposed a variety of mechanistic mediator for the reported findings including increase in hamstring flexibility and low back range of motion.

Clearly, from the above evidence, BW impacts positively on physical health in individuals with LBP. This evidence nonetheless, should be interpreted with caution due to some limitations in methodological quality. Majority of included studies in this review were predominantly rated as fair quality as they did not provide sufficient information regarding sample justification, ethical issues, and handling of bias and confounders in their designs and reports. Further, there is lack of methodological rigor in studies on BW in LBP and evidence remains very narrow. This suggests that more and rigorous studies with stronger methodological qualities are needed to corroborate the reported health benefit of BW in LBP.

4.1. Strengths and Limitations

A systematic and rigorous search strategy was used to retrieve articles relevant to our review objectives. Multiple well known electronic databases related to human health and medicine were used as primary sources with elements of the PICOS framework searched with multiple keywords in order to retrieve targeted articles. All study designs and publications in all languages from inception of data bases were included in the search. It is important to note that this review excluded articles in languages other than English therefore, valuable data which could have further informed the current review was left out.

4.2. Implications for Practice

Our study has revealed the need for more and rigorous studies to effectively demonstrate the effect BW on health outcomes in LBP. Furthermore, consideration for other designs and research approaches including qualitative designs may advance the current understanding of the effects of the intervention and better inform its growing popularity. By exploring both positive and adverse effects that BW has on health outcomes, the review has taken a holistic approach and provided insight for clinicians to apply necessary cautions when promoting and using BW in their practice.

5. Conclusions

The current review demonstrates the worldwide picture of evidence on effects of BW on health outcomes and provides insight in the direction for future studies and the reported beneficial effects remain completely unchallenged. Thus, BW can be recommended as an intervention with positive effects on the dimensions of health. However, the narrowness of literature and lack of strong methodological quality of included studies is sure evidence that more and robust studies are need to corroborate reported effects of BW on health in LBP and better inform the growing popularity of BW in the field of physiotherapy. Nonetheless, the substantial evidence from this review validates the positive effect on a variety of outcomes on the physical health dimension particularly pain, spine range of motion, muscle power and gait in individuals with LBP. In addition to physical health benefits, there are other social and mental benefits of BW that were inadequately reported in the articles. Therefore, holistically, current evidence on the effects of BW on health suggest a multi-dimensional research on positive effects or adverse effects.

List of Abbreviations

BW	Backward Walking
LBP	Low Back Pain
WHO	World Health Organisation
ICF	International Classification of Function
PRISMA	Preferred Reporting of Systematic Reviews and Meta-analysis Extension for Scoping Reviews
PICO	Population, Intervention, Comparator and Outcome

Declarations

Availability of Data and Materials

All datasets generated and used and /analysed during the current study are available from the corresponding author on reasonable request.

Competing Interests

Authors have no conflicts of interest.

Author's Contributions

The authors confirm contribution to the paper as follows: JB, BCC, MB and KEM contributed to the conceptualization of the idea, design and implementation of the review was done by LAN. MP developed and implemented the search strategy. Screening and selection of sources was conducted by JB and KEM. Data was extracted by JB & SH analysed and interpreted by JB, BCC and KEM. All authors contributed to the draft and final version of the article. Approval of the final manuscript was given by all authors.

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Appendix

Search Strategy

Search Strategy: Ovid MEDLINE (R) ALL <1946 to July 27, 2021>

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1 [Problem: Low Back Pain]
2 Low Back Pain/ (23494)
3 Sciatica/ (5087)
4 (sciatic* or lumbago or lumbalg* or lumbodynia* or ischiagia*).tw,kw. (31942)
5 ((low or lower) adj3 (back pain* or backpain* or back ache* or backache*)).tw,kw. (32308)
6 ((lumbal or lumbar or lumbosacr* or ischia*) adj3 (pain* or syndrome or strain*)).tw,kw. (6187)
7 or/2-6 (73863)
8 [Intervention: Walking]
9 exp Walking/ (58891)
10 (walk* or locomot*).tw,kw. (189971)
11 9 or 10 (210691)
12 [Intervention Qualifier: Backward/Retro Walking]
13 (retrowalk* or retro walk* or retro-walk*).tw,kw. (8)
14 ((walk* or locomot*) adj3 backward*).tw,kw. (619)
15 13 or 14 (624)
16 7 and 11 and 15 (4)
****

Data Extraction Tool

Citation	Setting	Participant Age	Sex of participants	LBP status	Sample size	study design	mode of BW	Comparator	Outcome	Key finding	Fund	Research gap

Modified Downs and Black Quality Assessment Tool

	DOWNS & BLACK CHECKLIST ON SCOPING REVIEW ON BACKWARD WALKING IN ADULTS WITH LBP			
Reviewers	Justin Bwalya & Simon Himalowa			
		ANSARI *et al.*, 2019	DUFEC *et al.*, 2011.	RATHI *et al.*, 2017
REPORTING				
Q1	Hypothesis/aim/objective clearly described	1	1	1
Q2	Main outcomes in Introduction or Methods	1	1	1
Q3	Patient characteristics clearly described	1	1	1
Q4	Interventions of interest clearly described	1	1	1
Q5	Principal confounders clearly described	0	0	0
Q6	Main findings clearly described	1	1	0
Q7	Estimates of random variability provided for main outcomes	1	1	1
Q8	All adverse events of intervention reported	1	1	1
Q9	Characteristics of patients lost to follow-up described	1	1	1
Q10	Probability values reported for main outcomes	1	1	1
EXTERNAL VALIDITY				
Q11	Subjects asked to participate were representative of source population	0	0	1
Q12	Subjects prepared to participate were representative of source population	0	0	1
Q13	Location and delivery of study treatment was representative of source population	1	1	1
INTERNAL VALIDITY - BIAS				
Q14	Study participants blinded to treatment	0	0	1
Q15	Blinded outcome assessment	0	0	0
Q16	Any data dredging clearly described	1	1	1
Q17	Analyses adjust for differing lengths of follow-up	1	1	1
Q18	Appropriate statistical tests performed	1	1	1
Q19	Compliance with interventions was reliable	1	1	1
Q20	Outcome measures were reliable and valid	1	1	1
INTERNAL VALIDITY - CONFOUNDERS				
Q21	All participants recruited from the same source population	0	0	1
Q22	All participants recruited over the same time period	1	1	1
Q23	Participants randomized to treatment(s)	0	0	1
Q24	Allocation of treatment concealed from investigators and participants	0	0	0
Q25	Adequate adjustment for confounding	0	1	0
Q26	Losses to follow-up taken into account	1	1	1
POWER				
Q27	Any information concerning sample calculation, margin of error or effect size?	1	1	1
TOTAL SCORE		**18/28**	**19/28**	**22/28**
QUALITY RATING (Hooper *et al.*, 2008)		**Fair**	**Fair**	**Good**

Figure 3. *Methodological quality of included studies.*

The checklist can evaluate both randomized controlled and non-controlled trials. Each item is rated 0 for absence or partial and one for present items. Item 5 is scored 2 if confounders are reported in both groups and 1 if reported only in one group. Item 27 is scored based on presence or absence of a report on power instead of the level of power

reported. Thus, there is a total possible maximum score of 28 for each study.

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