

The Short-, Mid- and Long-Term Effect of Back Orthoses on Pain and Related Disability in Adults with Non-specific, Mechanical Back Pain: An Overview of Systematic Reviews

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*Thesis presented in fulfilment of requirements for the degree of Master in
Physiotherapy in the Faculty of Medicine and Health Science, Stellenbosch*



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April 2019

DECLARATION

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ABSTRACT

Background: Non-specific, mechanical low back pain is one of the most prevalent musculoskeletal conditions that commonly results in disability in adults younger than 45 years, second only to arthritis in those aged 46 to 65 years. In industrialized countries, LBP accounts for 20% to 30% of all lost time claims in the workplace, costing the world billions every year. Conflicting opinions exist amongst clinicians regarding the use of back orthoses as a management and prevention tool for non-specific, mechanical LBP. Given the contradicting evidence for the use of back orthoses, that it is common practice for patients to use back orthoses, regardless of the presence of LBP and that many systematic reviews exist on this topic, all current evidence can be collated in an attempt to derive an overview for clinicians and the general population regarding the evidence for the use of back orthoses for non-specific, mechanical LBP as prophylactic treatment or actual treatment.

Method: A comprehensive search of the electronic databases was conducted between August 2017 and March 2018 at PubMed, Medline, Cochrane, Science direct and Elsevier. The following search terms were used and combined using Boolean terms to build electronic search strategies for each database: low back pain, back pain, mechanical low back pain, lumbar support, corset, orthoses, pain, and disability. Systematic reviews investigating the effect of back orthoses on related pain and disabilities among adults with non-specific, mechanical LBP were sought and reviewed. Studies were limited to those published in the English language. The Critical Appraisal Skills Program (CASP) were used to appraise the included studies. The results for each review were classified as either positive (for the use of orthoses), negative (against the use of orthoses) or neutral (neither for nor against the use of orthoses) and used to derive a useful and concise overview of the literature.

Result: Fourteen systematic reviews were found appropriate for inclusion in this review. Three studies were of high quality, eight studies showed moderate quality and three studies showed low quality. The included systematic reviews were conducted between 1997 and 2018. The total sample size for the included studies was approximately 116,443. Both male and female adults, aged over 18

years, were included in the included studies. The majority of the participants were workers. The majority (50%) of the included studies were against the use of back orthoses while three studies showed neutral result and four studies showed a positive result.

Conclusion: The main finding of this review regarding the effect of back orthoses as either a management strategy or prophylactic treatment on pain and related disability in adults with non-specific, mechanical LBP in the short-, mid- and long term, was that the use of back orthoses is generally not suggested.

ACKNOWLEDGEMENTS

I would like to thank the following people for the roles they played in conducting and completing my thesis:

- My wife (Sally), son (Adam), daughter (Nadine) and extended family, for their continuous support, inspiration and encouragement.
- Dr. Linzette Morris for her undying belief and motivation for me to complete this master's degree and the Division of Physiotherapy, Department of Health and Rehabilitation Sciences at Stellenbosch University, for their incredible support, advice, guidance and patience throughout the study process.
- To Prof. Fatima Hegazy, I express my sincere gratitude to her for supervision and providing her invaluable guidance and suggestions through the course of the study at the Department of Physiotherapy, college of Health Sciences, Sharjah University, United Arab Emirates.

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LIST OF ABBREVIATIONS

LBP	Low back pain
NSLBP	Non-specific low back pain
NHMRC	National Health and Medical Research Council
MSDs	Musculoskeletal disorders
LSO	Lumbo-Sacral Orthoses
CASP	Critical Appraisal Skills Program
No, n	Number
GIT	Gastro-Intestinal Tract
VAS	Visual Analogue Scale
NPRS	Numerical Pain Rating Scale
RM-DQ	Roland-Morris LBP Disability Questionnaire
ODI	Oswestry Disability Index
BS	<i>Back school</i>
NI	<i>No intervention</i>
LS	<i>Lumbar support</i>

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CHAPTER 1

1. 1 INTRODUCTION

Low back pain (LBP), as a symptom, is one of the most prevalent and costly musculoskeletal conditions with a prevalence that has increased, from 2006 to 2016, by 18% and a reported lifetime prevalence of 84% (1). Years lived with disability caused by LBP has increased between 1990 and 2015 by 54% where low- and middle-income countries has seen the greatest increase (1). A large proportion, commonly cited as 90%, of LBP cases are non-specific low back pain (NSLBP) cases (1). High costs are imposed on the health care system by chronic LBP (2). There are between 3 and 7 million general practitioner (GP) consultations a year for back pain (3).

There is a substantial amount of literature examining various interventions for LBP including medication, surgical intervention, various physical therapy interventions; cognitive therapy, education, spinal manipulation, hot / cold therapy, exercises, and back supports or orthoses (2,4–6). Back orthoses are often prescribed as an aid to prevent or to rehabilitate back pain and are relatively inexpensive modalities. Anecdotal reports indicate that back orthoses can decrease patient's symptoms and increase their confidence to undertake physical activity (7).

1.2 BACK ORTHOSES AS AN INTERVENTION FOR LBP

Historically, external back braces (known as back orthoses or lumbar supports) have been used by different civilizations, and date back as early as the fifth Egyptian Dynasty (2750 to 2625 B.C.) to decrease back pain and spinal deformity (8). The fundamental principles of many of the current back orthoses we use today can therefore be traced back to these devices used by Hippocrates and Armorers in the middle ages (8). In modern times, the use of the back orthoses has become more common in certain manual occupations which require heavy lifting and bending activities such as warehouse work, construction, and even nursing (9). Anecdotal evidence suggests that people suffering from LBP tend to feel "safer" and more stable during physical exertions when wearing back

orthoses (10). Patients also report less pain and are more willing to undertake more physical activity when wearing back orthoses (11). Weight lifters have also used back orthoses for years as prophylactic treatment and have been reported to perform repetitions at a given weight faster and more comfortably with the orthoses than without, therefore improving performance (9).

The supposed mechanisms by which lumbar supports or orthoses may reduce or prevent LBP are that; 1) they provide support of the trunk, preventing pain-producing events caused by hyperflexion; 2) they remind the wearers to lift correctly; 3) maintain correct posture, 4) they increase intra-abdominal pressure and decrease intradiscal pressure, and 5) they improve proprioception or kinesthesia (12–18). As a prophylactic treatment, the use of back orthoses therefore helps prevent injuries when lifting heavy objects (5,16,19) and if the person already has LBP, the use of orthoses may help to reduce the pain, make it possible for the person to continue with normal duties and prevent further injury (12). On the contrary, other studies have shown that back orthoses actually restrict spinal motion, and result in back and abdominal muscle weakness by providing passive stiffness to trunk, reducing the activity of antagonist muscles (10,20–22), elevating blood and intra-abdominal pressure (12,23), increasing spinal rigidity by limiting end range movement (24), increasing heart rate and also causing gastrointestinal tract (GIT) disorders (18). Conflicting evidence therefore exists for the use of back orthoses for non-specific, mechanical LBP as management or as a prophylactic treatment (4,18,20,23,25–27)

1.3 RATIONALE FOR THIS STUDY?

Despite the conflicting evidence, and the general guideline consensus that back orthoses should not be prescribed, patients continue to use back orthoses in practice as prophylactic treatment and a source of comfort (24,28–30) and some clinicians continue to advise patients to wear back orthoses as conservative treatment for the management of LBP (14,18,31,32). There is thus a divide amongst clinicians in the prescription of back orthoses.

Furthermore, guidelines for LBP management do provide recommendations, but the recommendations are focused more on the use of back orthoses as a management strategy, and

less as a prophylactic strategy. The following study is aimed at providing an evidence-based overview and clarity on the effect of back orthoses as either a management strategy or prophylactic treatment on pain and related disability in adults with non-specific, mechanical LBP in the short, mid- and long term.

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CHAPTER 2

The following chapter presents an article formatted for submission to BMC Musculoskeletal Disorders.

The Short-, Mid- and Long-Term Effect of Back Orthoses on Pain and Related Disability in Adults with Non-specific, Mechanical Back Pain: An overview of Systematic Reviews

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ABSTRACT

Background: Non-specific, mechanical low back pain (LBP) is a common musculoskeletal condition found amongst adults worldwide. Despite the conflicting evidence, and the general guideline consensus that back orthoses should not be prescribed, back orthoses for prophylactic treatment, comfort and conservative treatment for LBP management is still used. There is thus a divide amongst clinicians in the prescription of back orthoses as either a management strategy or prophylactic treatment for non-specific, mechanical LBP.

Purpose of the Study: This study aims to provide an evidence-based overview of the effect of back orthoses as either a management strategy or prophylactic treatment on pain and related disability in adults with non-specific, mechanical LBP in the short, mid- and long term.

Study Design: An overview of systematic reviews.

Method: A comprehensive search of the following electronic databases was conducted between August 2017 and March 2018: PubMed, Medline, Cochrane, Science Direct and Elsevier. The following search terms were used and combined to build electronic search strategies per database: *low back pain, back pain, mechanical low back pain, lumbar support, corset, orthoses, pain, and disability*. English systematic reviews investigating the effect of back orthoses on pain and related disabilities among adults with non-specific, mechanical LBP were sought and reviewed. The Critical Appraisal Skills Program was used to appraise the included studies. The results were classified as positive (for the use of orthoses), negative (against the use of orthoses) or neutral (neither for nor against the use of orthoses) and used to derive an overview of the literature.

Result: The eleven included systematic reviews, conducted between 1997 and 2018, met our selection criteria. Of the studies, 3 were high quality, 8 showed moderate quality and 3 studies showed low quality. The total sample size for the included studies was approximately 116 443. Both males and females, aged over 18 years, were included. Most of the participants were workers.

The majority (50%) of the included studies showed negative results while three studies showed neutral result and four studies showed a positive result.

Conclusion: The main finding of this review regarding the effect of back orthoses as either a management strategy or prophylactic treatment on pain and related disability in adults with non-specific, mechanical LBP in the short-, mid- and long term, was that the use of back orthoses is generally not suggested.

Keywords: *low back pain, orthoses, lumbar supports, non-specific, mechanical*

2.1 INTRODUCTION

Low back pain (LBP) is one of the costliest health problems affecting the population globally (1,2). It costs ¥1.2 trillion per year in lost productivity in 2017 in Japan (3). LBP affects all ages and races and is experienced by up to 80% of the population during their lifetime (4). LBP is one of the major reasons for work disability and it is exceeded only by the common cold as a cause of lost work time (5). According to the Global Burden of Disease 2010 report, LBP causes more disability than any other condition globally, with a prevalence and LBP-related burden that increases with age (3).

A distinction is made between Acute (less than 4 weeks), Subacute (between 4 weeks and 3 months), and Chronic (more than 3 months) LBP (6). Chronic LBP is present in 3% to 7% of the population in industrialized countries (7) and is responsible for 6.9% of consultations with physicians in cities (6). A wide variation of treatment and prevention approaches are available for LBP including medication, surgical interventions, various physical therapy interventions; cognitive therapy, education, spinal manipulation, hot / cold therapy, exercises, and back orthoses (8).

Many health practitioners believe that back orthoses or braces, also known as lumbar supports, can be used effectively in the treatment and prevention of musculoskeletal disorders of the lumbar spine (9), particularly non-specific, mechanical LBP. An orthosis is an externally applied device used to modify the structural and functional characteristics of the neuromuscular and skeletal systems (10). At present, several studies advise patients to use back orthoses as it provides abdominal and back support, reduces intradiscal pressure (10,11) and maintains correct posture (12).

However, studies have also found that back orthoses actually restrict spinal motion, and results in back and abdominal muscle weakness by providing passive stiffness to the trunk, reducing the activity of antagonist muscles (5,10,11,13), elevating blood and intra-abdominal pressure (6, 11), increasing spinal rigidity by limiting end range movement (14). Conflicting evidence therefore exists for the use of back orthoses for non-specific, mechanical LBP (8,15,16) Despite this, in practice,

patients continue to use back orthoses as prophylactic treatment and a source of comfort (1,2,17) and clinicians continue to advise patients to wear back orthoses as conservative treatment (1,2,10,18).

Since it remains common practice for patients to use back orthoses, regardless the presence of LBP; contradicting messages regarding the use of back orthoses; a divide between clinicians exists; and many systematic reviews exist on this topic, it is important to collate all the current evidence in an attempt to derive an overview for clinicians and the general population regarding the evidence for the use of orthoses for non-specific, mechanical LBP as a prophylaxis or treatment intervention. Furthermore, guidelines for LBP management do provide recommendations, but the recommendations are focused more on the use of back orthoses as a management strategy, and less as a prophylactic strategy.

2.1.1 Research question

What is the overall effect of back orthoses as either a management strategy or prophylactic treatment on pain and related disability in adults with non-specific, mechanical LBP?

2.1.2 Research aim

The aim of this overview was to provide an evidence-based overview of the effect of back orthoses as either a management strategy or prophylactic treatment on pain and related disability in adults with non-specific, mechanical LBP in the short-, mid- and long term.

2.1.3 Research objectives

The objectives of this review were:

1. To systematically search the literature for systematic reviews reporting on the effect of back orthoses as either a management strategy or prophylactic treatment on pain and related disability in adults with non-specific, mechanical LBP in the short-, mid- and long term.

2. To critically appraise the literature reporting on the effect of back orthoses as either a management strategy or prophylactic treatment on pain and related disability in adults with non-specific, mechanical LBP in the short-, mid- and long-term.

To ascertain the short-, mid- and long-term effect of back orthoses as either a management strategy or prophylactic treatment on pain in adults with non-specific, mechanical LBP.

2.2 METHODOLOGY

2.2.1 Search Method

The search focused on sourcing systematic reviews on the effect of back orthoses as either a management strategy or prophylactic treatment on pain and related disability in adults with Non-specific mechanical LBP in the short-, mid- and long term. A comprehensive search was conducted in the following electronic databases through the Stellenbosch Medical Library website: PubMed / MEDLINE, Scopus, OVID, CINAHL, Embase, PEDro, Google, and Cochrane Library. The search was conducted between August 2017 and March 2018. The reference lists of eligible papers were searched and experts in the field of LBP management were consulted to identify any potentially relevant studies that may have missed, also known as PEARLing (19).

The only limitations placed on the searches was to include studies evaluating adults only, studies published in the English language only, and systematic review study designs. No publication date limits were placed on the search. Electronic search strategies were constructed based on the following combined keywords: *low back pain, back pain, non-specific, mechanical low back pain, lumbar support, corset, orthoses, pain, and disability*.

Medical subject heading (MeSH) terms were used where possible, and all subheadings were included to encompass all related search terms and ensure exhaustiveness. Therefore, the search strategy of this review was a combination of MeSH terms and free-text words. The

Boolean command OR was used to include synonyms. In retrieving all possible variations of a specific root word, truncations were also used. To optimize the strategy for each of the other databases, appropriate changes were made in the basic search strategy.

2.2.2 Criteria for Considering Studies

Types of studies

Systematic reviews reporting on the effect of back orthoses as either a management strategy or prophylactic treatment on pain and related disability in adults with non-specific, mechanical LBP in the short-, mid- and long-term were included. Systematic reviews had to have been published in English but could have been published at any time.

Types of participants

Systematic reviews which included participants, between the ages of 18 and older and who were working in any occupation, was of any race and culture etc. were included in this study. Both healthy people and patients reporting LBP were included in the study. Participants who had undergone back surgery or had LBP due to specific conditions such as cancer or disc lesions, etc. were excluded.

Types of intervention

Systematic reviews reporting on the investigation of any type of lumbar orthoses/supports/braces used for non-specific mechanical LBP management or prophylaxis were included. Lumbar orthoses/supports/braces included in the reviews could have been flexible or rigid. Systematic reviews reporting on special types of orthoses used for Scoliosis or Kyphosis, as well as any kind of supports used after surgeries, were excluded.

Types of comparisons

Systematic reviews which compared lumbar/back orthoses to no comparison or to other

interventions such as exercise, education, etc. were included.

Types of outcomes

Systematic reviews reporting on the following outcomes and outcome measurement tools were included:

1. The short-, mid- and long-term effect of back orthoses on pain. Pain, as measured by, but not confined to, the Visual Analogue Scale (VAS), Numeric Pain Rating Scale (NPRS), etc. Pain in this instance could have been defined as pain in the lower region of the back.
2. The short- mid- and long-term effect of back orthoses on related disability. Related disability, as measured by, but not confined to, the Roland-Morris LBP disability questionnaire (RM-DQ), Oswestry Disability Index (ODI) etc.

2.2.3 Study selection procedure

Two of the authors (AI and LM) independently reviewed all titles, abstracts and full texts identified by electronic search to determine eligibility of studies. The inclusion criteria were applied to all the relevant full text articles. An independent reviewer cross-checked the searches, inclusion of studies and extraction of data. Disagreements were resolved by consensus.

2.2.4 Level of evidence

The National Health and Medical Research Council (NHMRC) Evidence Hierarchy (20), Appendix 1, was used to categorize the level of evidence of studies considered suitable for inclusion in this review.

2.2.5 Methodological Quality Assessment

Special criteria recommended by the “The Critical Appraisal Skills Program” (CASP) were used to

appraise the included studies (Table 1). The scores were calculated out of 10 criteria (with a 23 points full score). Every criterion of the quality list was scored as “ ✓ ” which refers to one score gained for that point or “ × ” which refers one score lost. The final quality score being the sum of “ ✓ ” responses.

2.2.6 Categorization of evidence

Evidence extracted from included studies were categorized according to the following categories:

Positive: The study's results support the use of back orthoses.

Negative: The study's results do not support the use of the back orthoses.

Neutral: There is not enough evidence to support or negate the use of back orthoses.

2.2.7 Data Extraction and Analysis

The following data was of interest and collected from each included study: Authors, Year of Publishing, Title, Sample Size, Participants, Gender, Objectives, Intervention, Comparison, Results and Conclusion. Data were collated and tabulated.

2.3 RESULTS

2.3.1 Search procedure and results

The search process began with the major search engines, where PubMed provided most of the search results, and more than 3000 titles and abstracts were identified searching related systematic reviews. Only 180 abstracts were retrieved, and after reviewing, 73 studies were excluded, and then a further 71 studies were excluded after revising the total contents as the studies did not conform to the inclusion criteria.

Thereafter, 36 studies were assessed for eligibility and a further 25 studies were excluded as they were either not full-text articles, where duplicates or on further investigation did not conform to the inclusion criteria. The remaining 11 studies evaluating back orthoses met the selection criteria were the included systematic reviews (15,21–30). Figure 1 illustrates the search result and selection process.

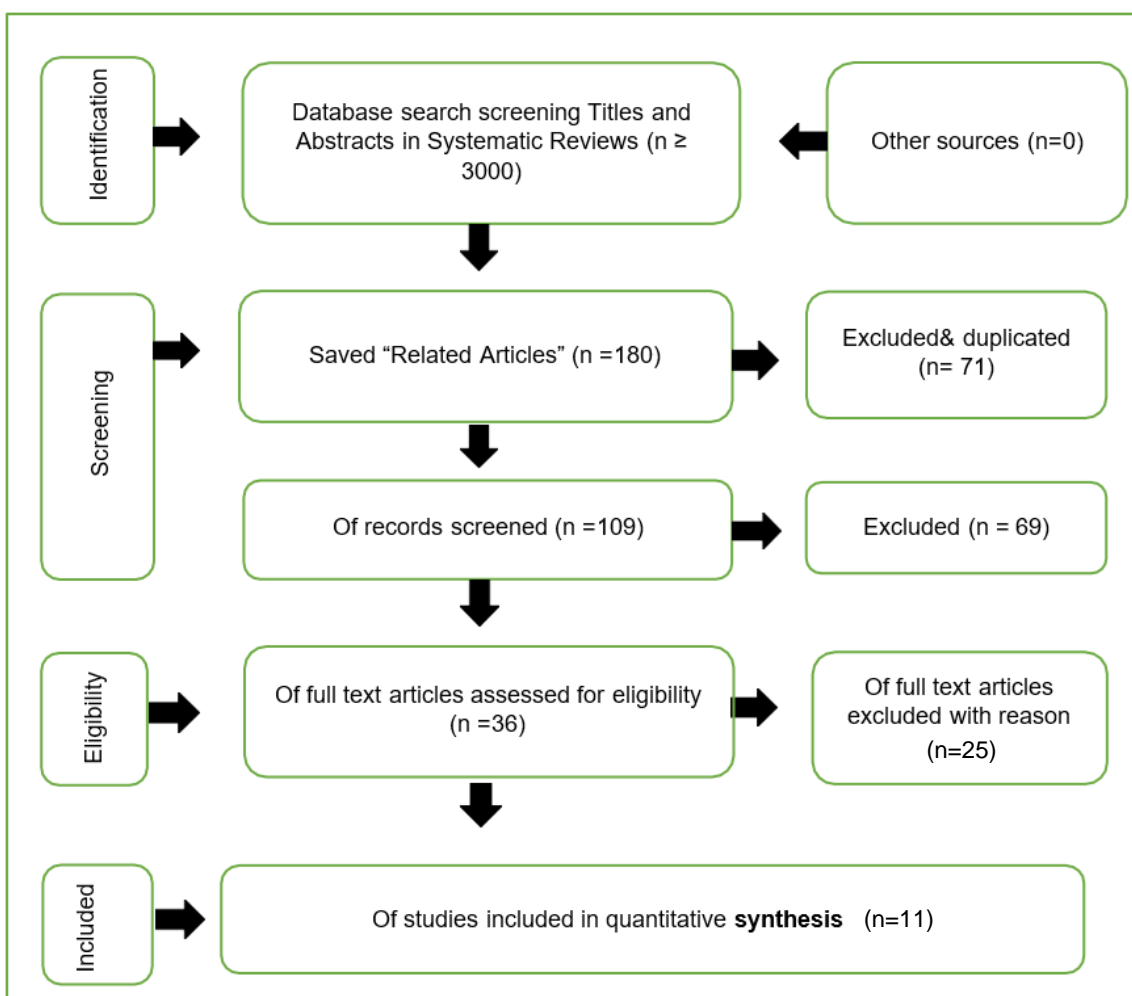


Figure 1: Search procedure and results

2.3.2 Description of studies

The included systematic reviews were conducted between 1997 and 2018. There were two studies (25,27) published after 2016, eight studies (15,21–24,26,29,30) between 2000-2011 and one study before 2000 (28)

All 11 studies were published in developed countries (15,21,30,22–29) - four in the Netherlands, three in Australia, three in USA and one in Sweden. The total sample size for the included studies was approximately 116 443. Both males and females, over 18 years of age, were included in the selected studies. Most of the participants were noted as employed. Table 1 further describes the selected studies.

The outcome measurement tools used in the 11 included systematic reviews is described in Table 2 (a-c).

The interventions and comparisons investigated in each included systematic review are described in Table 3.

2.33 Methodological quality of included studies

According to the CASP checklist applied to evaluate the quality of the included studies, most of the studies were within high to moderate quality methodologically. Of the studies, three were of high quality (15,21,25) five showed moderate quality (24,26–28,30) and three studies showed low quality (22,23,29). Table 4 illustrates the results for the methodological appraisal of the included studies.

Table 1: Description of the included systematic reviews

Author and country	Objective of SR	Nr. of studies included	Methodological quality range	Total sample size	Population	Age	Gender
Systematic reviews investigating prevention interventions for LBP							
Maher, 2000 (22) Australia	To evaluate the effectiveness of workplace interventions to prevent LBP (exercise, braces and education)	13 RCTs	PEDro scale (range): 1-8 mean = 7,15	6007	Hospital workers; home care workers; factory workers; nurses; environmental service workers; airline baggage handlers; Dutch airline cargo workers; warehouse workers; mailing house workers	Unspecified working age	Males and females
van Poppel et al., 1997 (28) the Netherlands	Evaluation of the effectiveness of lumbar supports, education, and exercise in preventing back pain in the industry.	7 RCTs, 4 non-randomized CCTs <i>Total</i> = 11	Independent criteria: internal validity: 0-3/7	2186	Warehouse workers; healthcare and hospital workers; airline baggage handlers; postal workers; bus drivers; managerial and shop floor workers	Unspecified working age	Unspecified
Dawson et al., 2007 (15) Australia	To evaluate effectiveness of interventions for prevention back pain and back injury in nurses.	8 RCTs and 8 non-RCTs <i>Total</i> = 16	Independent criteria: Internal validity: 0-4.5/6 (mean=1,84/6); Internal validity + descriptive quality: 2,5-10/12 (mean=5,37/12)	2000	Health care workers; fleet service clerks; cargo department staff; warehouse workers; autoworkers; Insurers; postal workers; hospital secretaries; off work for LBP; primary care pts for LBP; city employees with LBP; light industrial company staff; kitchen units labourers; light sedentary workers at a printing company; home care service workers; tobacco company workers	Unspecified	Males and Females
Steffens et al., 2016 (25) USA	To investigate the efficacy of interventions for LBP prevention.	23 RCTs	PEDro scale (range): 0- 10	31112	Unspecified occupations	18-65 Years	Males and females
van Poppel et al., 2004 (24) The Netherlands	To update the evidence in the efficacy of lumbar supports, exercise and education in primary prevention of LBP at the workplace	10 RCTs and 5 non-randomised CCTs <i>Total</i> = 15	Independent criteria: Internal validity: 0-4/7 (mean=1,85); external validity: 1-8/8; Internal validity + external validity: 1-12/15 (mean = 6.26/15)	12297	Warehouse workers; health care workers; airline baggage handlers; airline freight handlers; material handling staff of retail stores; postal workers; bus drivers; managerial and shop floor workers; home care	18-65 Years	Males and females
Jellema et al., 2001 (23) Sweden and The Netherlands	To evaluate the efficacy of lumbar supports for preventing and management of non-specific LBP	5 RCTs and 2 non- RCTs (prevention) <i>Total</i> : 13	Cochrane Back Review Group for Spinal Disorders (range): 1 to 5/10	1639 (excl. an unknown control group)	Health care workers, manual material handler at airport, home attendants; fleet service clerks; warehouse workers,	18-65 years	Males and females

SR = Systematic review; LBP = Low back pain; RCT = Randomized controlled trial; CCT = Controlled clinical trials

Table 1: Description of the included systematic reviews (continued)

Author	Objective of SR	Nr. of studies included	Methodological quality range	Total sample size	Population	Age	Gender
Systematic reviews investigating prevention interventions for LBP							
Bigos et al., 2009 (30) USA	Evaluation of the efficacy of prevention interventions for BP episodes in working age adults	17 RCTs and 3 OCTs <i>Total = 20</i>	Cochrane Collaboration Back Review (range): 6- 9/11 (mean= 6.9/11)	33200	Military members; University employees and students; hospital staff; London residents; recruited participants; outpatients of the Brown Cancer Centre; Office workers; postal workers; Dutch employees; nurses and nurse's aides; manual labourers; employees of kitchen unit production; home care attendants; distribution centre employees; medical practices; airline employee's outpatients from Physiotherapy	18-65 years	Males and females
Linton et al., 2000 (26) Sweden and The Netherlands	To determine the interventions, and the evidence for their utility, used to prevent back and neck pain problems.	9 RCTs and 18 non-RCTs <i>Total = 27</i>	Not assessed	6546	Health care workers; fleet service clerks; cargo department staff; warehouse workers; autoworkers; Insurers; postal workers; hospital secretaries; off work for LBP; primary care pts for LBP; city employees with LBP; light industrial company staff; employees of a producer of kitchen units; light sedentary workers at a printing company; home care service workers; tobacco company workers	Varied age groups. Not stated by all RCT's included in review.	Males and females
Systematic reviews investigating treatment interventions of LBP							
van Duijvenbode et al., 2008 (21) The Netherlands	Evaluate the prevention and treatment of non-specific LBP using lumbar supports	8 RCTs (treatment) <i>Total = 15</i>	Unspecified	1221	Unspecified occupations. Chronic LBP, non-specific LBP and sciatica	18-65 years	Males and females
Jellema et al., 2001 (23) Sweden	To evaluate the efficacy of lumbar supports for management and prevention of NSLBP	6 RCTs (treatment) <i>Total = 13</i>	Cochrane Collaboration Back Review group (range): 2 to 7/10	1219	Unspecified occupations. NSLBP	18-65	Males and females
Healy et al., 2018 (27) USA	To review the evidence from RCTs assessing effectiveness and cost-effectiveness of prosthetic and orthotic interventions	<i>Total = 8 (related to lower back pain)</i>	Unspecified	553	Unspecified occupations	All ages	Unspecified
Pengel et al., 2002 (29) Australia	To assess the effect of conservative interventions for patients with subacute LBP	<i>Total: 13</i>	Cochrane Collaboration Back Review group: Internal validity (range): 0-3/9 Total range: 6-12/19	2560 (excl. sample size of one study)	Unspecified occupations. Subacute non-specific LBP	18-55 years	Males and female

SR = Systematic review; LBP = Low back pain; NSLBP = Non-specific low back pain; RCT = Randomized controlled trial; CCT = Controlled clinical trials

Table 2a: Description of outcomes used by selected systematic reviews investigating prevention interventions

Author	Outcome measures	Outcome measurement tool
Maher, 2000 (22)	Frequency, severity and prevalence of LBP episodes Work absence frequency	Pain: McGill Pain questionnaire, Function: ODI
van Poppel et al., 1997 (28)	Self-reported data on the incidence of back pain, number of days with back pain, number of painful months, and number of episodes with back pain; Incidence of work absence injury rate; Tired backs scores; Trunk ROM Muscle force (whilst wearing lumbar support)	Muscle force: EMG and IAP Subjective: MAWL; perceived exertion, discomfort, or intensity of the task
Linton et al., 2000 (26)	Pain: Perception of pain, pressure pain threshold Function: handicap; Work related back injuries; workers compensation rates; work absence; recurrence; days with LBP; recurrence Physical: Isometric strength; endurance of back muscles; fatigue;	Pain: VAS, Composite back pain score; Composite fatigue score
Dawson et al., 2007 (15)	Pain: Incidence of back pain; pain drawing; frequency and intensity of pain; Function: Interference with activities; work absence	
van Poppel et al., 2004 (24)	Back pain incidence; number of incidents; work absence; perceived physical exertion	
Steffens et al., 2016 (25)	LBP episodes; work absence	Occupational Function: Dutch musculoskeletal questionnaire
Bigos et al., 2009 (30)	Work injury claim; work absence; costs; Recall of frequency, duration, severity; functional disability and back treatment or limitations	
van Duijvenbode et al., 2008 (21)	Incidence of low-back pain, duration of low-back pain; Absenteeism	Function: RM-DQ; ODI
Jellema et al., 2001 (23)	Incidence of LBP, duration of LBP and back-pain-specific functional status; Work absence	Function: RM-DQ; ODI

LBP = Low back pain; ODI = Oswestry Disability Index; ROM = Range of movement; RM-DQ = Roland-Morris LBP Disability Questionnaire; EMG = electromyograph; IAP = Intra-abdominal pressure; MAWL = Maximum acceptable weight of lift; VAS = Visual Analogue Scale

Table 2b: Description of outcomes used by the selected systematic reviews investigating treatment interventions

Author	Outcome measures	Outcome measurement tool
van Duijvenbode et al., 2008 (21)	Pain, overall improvement (% improvement, NRS) Return to work (% of the population, number of days of absenteeism) Back-specific functional status	Pain: VAS, NRS; Function: RM-DQ, ODI
Jellema et al., 2001 (23)	Pain, overall improvement (% improvement, NRS) Return to work (% of the population, number of days of absenteeism) Back pain specific functional status	Pain: VAS, NRS Function: RM-DQ; ODI
Healy et al., 2018 (27)	Pain and functional scores	Hospital Anxiety and Depression Questionnaire; Pain: Tampa Scale of Kinesiophobia Questionnaire Function: Patient Specific Functional Scale; RM-DQ and EIFEL; Oswestry disability index
Pengel et al., 2002 (29)	Pain, disability, or return to work	Pain: VAS Function: RM-DQ

NRS = Numeric Rating Scale; ODI = Oswestry Disability Index; RM-DQ = Roland-Morris LBP Disability Questionnaire; EIFEL = French version of RM-DQ; EMG = electromyograph; IAP = Intra-abdominal pressure; MAWL = Maximum acceptable weight of lift; VAS = Visual Analogue Scale

Table 3a: Description of interventions and comparisons reported by the selected systematic reviews investigating prevention of LBP

Author	Intervention	Comparison
Maher, 2000 (22)	<ol style="list-style-type: none"> 1. Brace 2. Brace with adjustable strap and Velcro fastener 3. Brace with adjustable elastic side pulls, Velcro fasteners and flexible stays 4. Brace with custom lumbar insert plus 1hr training on BP prevention and body mechanics plus brace 	<ol style="list-style-type: none"> 1. Control 2. Training on spine anatomy and body mechanics; both (1) & (2); control 3. Lifting instruction and brace; lifting instruction; control 4. Training on BP prevention and body mechanics; Control
van Poppel et al., 1997 (28)	<ol style="list-style-type: none"> 1. Training on BP prevention and body mechanics and LS 2. LS 3. LS 4. LS, BS and instructions on warm up exercises 5. LS 	<ol style="list-style-type: none"> 1. Control 2. Control 3. Training session on spine anatomy and body mechanics; training session and LS; control 4. BS and instructions on warm up exercises 5. BS and instructions on warm up exercises
Linton et al., 2000 (26)	<ol style="list-style-type: none"> 1. Back belts at work 2. Back belt 3. LS during working hours 4. LSO during working hours plus training on BP prevention and body mechanics 5. Back belt 6. Back belt plus BS and instructions on warming up exercises 	<ol style="list-style-type: none"> 1. Control 2. Back belt plus training session on spine anatomy and body mechanics; Control 3. LS plus education/lifting instructions; Education/lifting instructions; Control 4. Training on BP prevention and body mechanics; Control 5. Control 6. Control: BS and instructions on warming up exercises (n=19).
Dawson et al., 2007 (15)	<ol style="list-style-type: none"> 1. Training in back belts, wearing back belts when lifting, manual handling training; 	<ol style="list-style-type: none"> 1. Manual handling training only.
van Poppel et al., 2004 (24)	<ol style="list-style-type: none"> 1. Training on BP prevention and body mechanics, and LS 2. LS 3. LS 4. LS 5. LS, BS and instructions on warm up exercises 6. LS 7. LS 8. LS; control 9. Required LS use 	<ol style="list-style-type: none"> 1. Training on BP prevention; Control 2. Control 3. Session on spine anatomy and body mechanics; training session and L; Control 4. Education; LS and education; Control 5. BS and instructions on Warm exercise 6. Lifting techniques; LS and lifting techniques; Control 7. Training on anatomy and body mechanics; training session and LS; Control 8. Control 9. Voluntary LS use
Steffens et al., 2016 (25)	<ol style="list-style-type: none"> 1. Training on correct use of back belts; 2. Stretch nylon back belts; 3. LS with adjustable elastic side pulls with Velcro fasteners and flexible stays; 	<ol style="list-style-type: none"> 1. Training in biomechanics and correct lifting techniques. (volunteers requested to wear back belts when lifting and on duty). 2. Information on LBP; control. 3. Lifting instructions.

BS- Back School; BP- Back pain; NI- No intervention; LS- Lumbar support (Back Orthoses); LSO = Lumbo-sacral orthosis

Table 3a: Description of interventions and comparisons reported by the selected systematic reviews investigating prevention of LBP (continued)

Author	Intervention	Comparison
Bigos et al., 2009 (30)	<ol style="list-style-type: none"> 1. Required to wear a back belt when lifting at work, and trained in lifting and back belt use 2. LS at work & lifting technique education 3. LSO to be worn during work and attended training on BP prevention and body mechanics 4. LSs: Adopted workplace policy that required use of back belts at work 	<ol style="list-style-type: none"> 1. Education alone: ergonomic lifting techniques and strategies for coping with BP; control 2. Education training on lifting techniques; LSs alone; Control 3. Education in BP prevention and body mechanics on the job; Control 4. Adopted workplace policy where use of back belts at work was voluntary
van Duijvenbode et al., 2008 (21)	<ol style="list-style-type: none"> 1. Back belt 2. Synthetic LS 3. LS 4. Weightlifting belt; LS 5. LS 6. LSO at work plus BS 	<ol style="list-style-type: none"> 1. Control 2. Safety meeting with education; Control 3. Belt and education; Training class 4. Usual care 5. Education; LS and education; Control 6. BS; Control
Jellema et al., 2001 (23)	<ol style="list-style-type: none"> 1. Back belt 2. Synthetic LS 3. Weightlifting belt 4. LS 5. Thick, woven, deformable nylon weightlifting belt plus BS and warm-up; education 6. Spandex belt with shoulder straps 7. LSO at work plus BS on body mechanics 	<ol style="list-style-type: none"> 1. Control 2. Control 3. Belt plus training class; Training class; Control 4. LS use at work plus education; Education; Control 5. BS and instruction on warm-up exercises 6. Control 7. BS; Control

BS = Back School; BP = Back pain; Control = No intervention; LS = Lumbar support (Back Orthoses); LSO = Lumbo-sacral orthosis

Table 3b: Intervention description of the selected systematic reviews investigating treatment of LBP

Author	Intervention	Comparison
van Duijvenbode et al., 2008 (21)	<ol style="list-style-type: none"> 1. Fabric made LS 2. Training and LS 3. Corset, any type 4. Back support elasticized with an attached silicone rubber pad of special shape 5. Flexible corset; Semi-rigid corset 6. Corset and rigid LS; Corset 7. Lumbo-sacral canvas corset with metal stays in the back 	<ol style="list-style-type: none"> 1. No LS 2. Training; Control 3. Manipulation; Physiotherapy; Analgesic tablets 4. Standard therapy: advice on rest and lifestyle 5. lingerie 6. Pneumatic LS 7. Spinal manipulation; Soft tissue massage; Transcutaneous muscle stimulus
Healy et al., 2018 (27)	<p>Group A: provision of a prosthetic or orthotic Group B: prosthetic or orthotic</p>	<p>Group A: no prosthetic or orthotic Group B: comparator</p>
Pengel et al., 2002 (29)	Corset	Spinal manipulation
Jellema et al., 2001 (23)	<ol style="list-style-type: none"> 1. Fabric made LS 2. Any type of Corset 3. Lumbosacral canvas corset with metal stays in the back 4. Back support, elasticated with an attached silicone rubber pad of special shape 5. Corset and lumbar rigid support 6. Pneumatic LS 	<ol style="list-style-type: none"> 1. No LS 2. Manipulation; Physiotherapy; Analgesic tablets 3. Spinal manipulation; Soft tissue massage; Transcutaneous muscle stimulation 4. Standard therapy: advice on rest and lifestyle 5. Corset 6. Control

BS = Back School; BP = Back pain; Control = No intervention; LS = Lumbar support (Back Orthoses);

Table 4: Results of Critical Appraisal Checklist for a Systematic Review (Methodological Quality using CASP, University of Glasgow)

	Check List Points Study No	Van Duijvenbode et al., 2008 (21)	Van Poppel et al., 1997 (28)	Healy et al., 2018 (27)	Maher, 2000 (22)	Jellema et al., 2001 (23)	Pengel et al., 2002 (29)	Linton et al., 2000 (26)	Dawson et al., 2007 (15)	Van Poppel et al., 2004 (24)	Steffens et al., 2016 (25)	Bigos et al., 2009 (30)
1	Population	✓	✓	✗	✓	✗	✗	✓	✓	✓	✓	✓
	Intervention	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Outcomes	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓
2	Appropriate question	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗
	Appropriate study design	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓
3	Relevant bibliographic database	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓
	Follow up from reference list	✓	✓	✓	✗	✓	✓	✓	✓	✗	✓	✓
	Contact with experts	✓	✓	✗	✓	✓	✓	✗	✓	✓	✓	✓
	Published & unpublished studies	✗	✓	✓	✗	✗	✓	✓	✓	✓	✓	✓
	Non- English studies	✓	✗	✗	✗	✓	✗	✓	✗	✓	✓	✗

“✓” = Add a Point, “✗” = No Point

Table 4: Results of Critical Appraisal Checklist for a Systematic Review (Methodological Quality using CASP, University of Glasgow) (continued)

	Check List Points Study No	Van Duijvenbode et al., 2008 (21)	Van Poppel et al., 1997 (28)	Healy et al., 2018 (27)	Maher, 2000 (22)	Jellema et al., 2001 (23)	Pengel et al., 2002 (29)	Linton et al., 2000 (26)	Dawson et al., 2007 (15)	Van Poppel et al., 2004 (24)	Steffens et al., 2016 (25)	Bigos et al., 2009 (30)
4	Rigour of the Studies (Quality of included studies)	✓	✓	*	✓	✓	*	*	✓	✓	✓	✓
5	Result were similar from study to study	*	*	✓	*	*	*	*	✓	*	✓	*
	Result of studies are clearly displayed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Results of different studies are similar	✓	✓	✓	✓	*	*	*	✓	✓	*	✓
	Reason for any variations are discussed	✓	*	✓	*	*	✓	✓	*	*	✓	✓
6	Clear "Bottom Line" Results	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Numerical Results	*	*	*	*	*	*	✓	*	*	✓	✓
	How results are expressed	✓	✓	✓	✓	✓	✓	✓	✓	✓	*	✓

"✓" = Add a Point, "*" = No Point

Table 4: Results of Critical Appraisal Checklist for a Systematic Review (Methodological Quality using CASP, University of Glasgow) (continued)

	Check List Points Study No	Van Duijvenbode et al., 2008 (21)	Van Poppel et al., 1997 (28)	Healy et al., 2018 (27)	Maher, 2000 (22)	Jellema et al., 2001 (23)	Pengel et al., 2002 (29)	Linton et al., 2000 (26)	Dawson et al., 2007 (15)	Van Poppel et al., 2004 (24)	Steffens et al., 2016 (25)	Bigos et al., 2009 (30)
8	Can results of population be applied locally	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Big difference between the reviews and the local setting	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
9	Were all important outcomes considered	✓	✗	✗	✗	✗	✓	✓	✓	✗	✓	✗
10	Are the benefits worth the harms and costs?	✓	✓	✓	✓	✓	✓	✗	✓	✓	✗	✗
Result	TOTAL POINTS (23)	19	17	16	13	14	14	17	19	17	19	18

“✓” = Add a Point, “✗” = No Point

2.3.4 Categorized results – supporting, negating, neutral evidence

The results of the studies were extracted and classified it into the three groups previously mentioned; Positive, Negative and Neutral. Majority of the studies (54.5%) showed negative results, 27.3% showed neutral and 18.1% showed positive (Figure 2).

A great proportion of participants (82%) showed negative results with the use of back orthoses, 14.6% saw neutral results and only 3.3% saw positive results (Figure 3).

The results are further described in Table 5 (a and b).

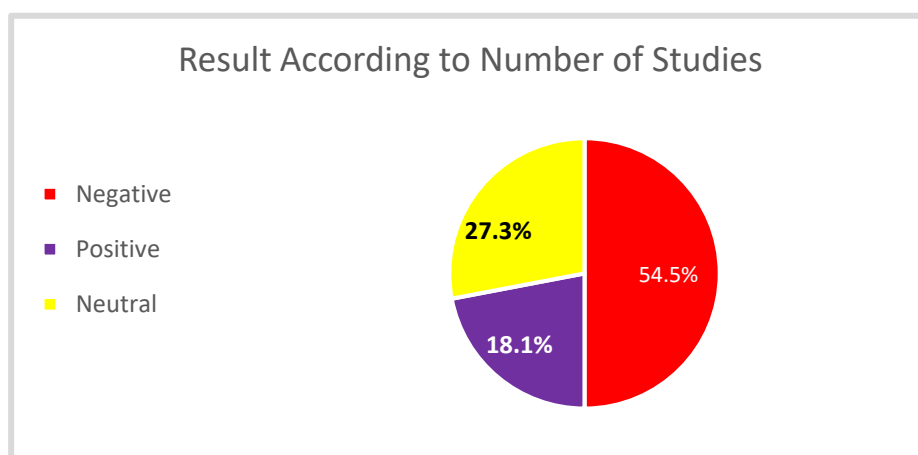


Figure 2 Results as a percentage of the number of studies included

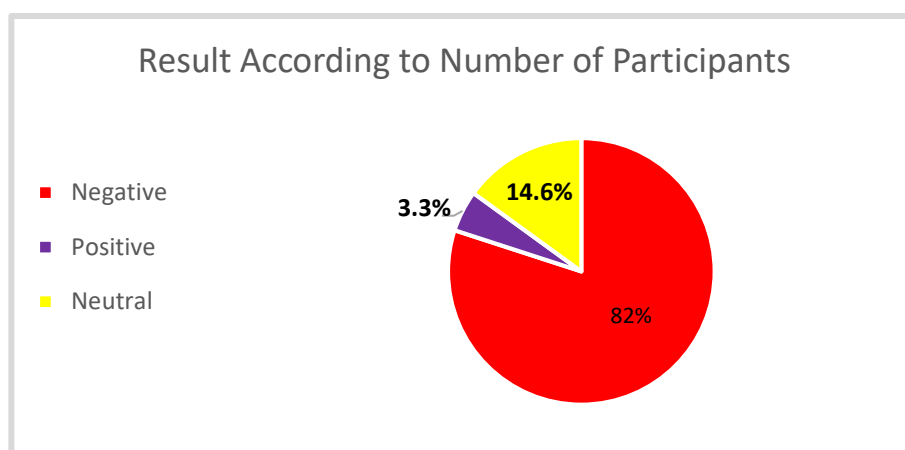


Figure 3: Results as a percentage of the number of participants

Table 5a: Results of the selected systematic reviews investigating prevention interventions for LBP

Author	Effect of back orthoses	Effect size	Conclusion
Maher, 2000 (22)	Prevalence, severity, cost and work absence: Level 1 Negative	Heterogeneous data	Braces are ineffective in reduction of severity and prevalence of LBP as well as work absence due to LBP (strong)
van Poppel et al., 1997 (28)	Level 4, Neutral	<i>Trunk ROM:</i> Flexion –extension: 0.70 (95% CI: 0.39–1.01); Lat. bending: 1.13 (95% CI: 0.17–2.08) Rotation was not statistically significant (0.69; 95% CI: 20.40–1.78). <i>Muscle force (with lumbar support): Electromyogram</i> (0.09; 95% CI 20.41– 0.59) <i>IAP</i> (0.26; 95% CI: 20.07–0.59). <i>Subjective OM:</i> 20.002; (95% CI: 20.41–0.41).	There is no conclusive evidence for or against the effectiveness of lumbar supports in the prevention of back pain in industry.
Linton et al., 2000 (26)	Level 1, Negative	<i>Unspecified</i>	Lumbar supports are ineffective for prevention neck and back pain (strong).
Dawson et al., 2007 (15)	Level 3, Positive	<i>Heterogeneous data</i>	Lumbar support is effective in LBP prevention (limited).

Level 1 = strong evidence provided by generally consistent findings from multiple RCTs; Level 2 = moderate evidence provided by one RCT or largely consistent findings from many CCTs; Level 2 = limited evidence provided by one CCT; Level 4 = no evidence/ inconsistent evidence; LBP = Low back pain; Positive = supports the use of intervention; Negative = against the use of intervention; Neutral = inconclusive results.

Table 5a: Results of the selected systematic reviews investigating prevention interventions for LBP (continued)

Author	Effect of back orthoses	Effect size	Conclusion
van Poppel et al., 2004 (10)	Level 4, Neutral	Lumbar support: unspecified	No evidence for the effect of lumbar supports in the prevention of low back pain.
van Duijvenbode I., 2008 (21)	Incidence of LBP: Level 2, Negative	Heterogeneous data	There was moderate evidence that lumbar supports are not more effective than no intervention or training in preventing LBP. Conflicting evidence whether lumbar supports are effective supplements to other preventive interventions.
Bigos et al., 2009 (30)	% of sample with BP: Level 1, Neg	Lumbar support on % of sample with BP: 0.004	Level of evidence not clearly stated.
Jellema et al., 2001 (23)	Incidence, severity of LBP and injury: Level 2, Negative Level 3, Positive	Heterogeneous data	There was moderate evidence that lumbar supports are not effective for primary prevention. There is limited evidence that lumbar support with back school is more effective than back school alone

Level 1 = strong evidence provided by generally consistent findings from multiple RCTs; Level 2 = moderate evidence provided by one RCT or largely consistent findings from many CCTs; Level 2 = limited evidence provided by one CCT; Level 4 = no evidence/ inconsistent evidence; LBP = Low back pain; Positive = supports the use of intervention; Negative = against the use of intervention; Neutral = inconclusive results

Table 5a: Results of the selected systematic reviews investigating prevention interventions for LBP (continued)

Author	Effect of back orthoses	Effect size	Conclusion
Steffens et al., 2016 (25)	<p><i>(Short term) LBP episode:</i> Level 4, Positive</p> <p><i>Long term) LBP episode</i> Level 3, Negative</p>	<p><i>Back belts vs control on LBP episode:</i> short term: 1.01 (0.71-1.44) long term: 0.85 (0.64-1.14) <i>Pooled effect of RR:</i> I² = 40.6%</p>	<p>Low-quality evidence of no short-term effect of back belts over controls Level of evidence was not clearly stated.</p>

Level 1 = strong evidence provided by generally consistent findings from multiple RCTs; Level 2 = moderate evidence provided by one RCT or largely consistent findings from many CCTs; Level 3 = limited evidence provided by one CCT; Level 4 = no evidence/ inconsistent evidence; LBP = Low back pain; Positive = supports the use of intervention; Negative = against the use of intervention; Neutral = inconclusive results. RR = relative risk; BP = back pain

Table 5b: Results of the selected systematic reviews investigating the effects of lumbar support as treatment on LBP

Author	Results	Effect size (95% CI)	Conclusion
van Duijvenbode et al., 2008 (21)	<i>Incidence of LBP:</i> Level 3, Negative (short term) Level 4	unspecified - Heterogeneous data	There is limited evidence that lumbar supports are not more effective than no intervention for short-term pain reduction and improved functional status for patients with chronic LBP.
Jellema et al., 2001 (23)	<i>Pain index:</i> Level 3, Positive <i>Vs. other types of treatment</i> Level 2 Neg	unspecified - Heterogeneous data	There is limited evidence that lumbar supports provide some reduction in pain in patients with LBP. There is moderate evidence that a lumbar support is not more effective in pain relief than other types of treatment. There is limited evidence that a rigid back insert lumbar is more effective than a lumbar support with no rigid insert.
Healy et al., 2008 (27)	Level of evidence / GRADE not used. See effect size	<i>GROUP A - ODI:</i> <i>foot orthosis:</i> -0.65 (-1.57 to 0.27) <i>Extensible LSO:</i> -0.37 (-2.51 to 0.77) <i>In extendable LSO</i> -0.37 (-1.51 to 0.77) <i>Pain:</i> <i>LSO:</i> -0.53 (-1.51 to 0.45)	The use of foot orthoses: significance was calculated for a reduction in pain with use of the orthoses. Positive results for custom made foot orthoses compared to placebo orthoses were evident.
Pengel et al., 2002 (29)	GRADE not used. See effect size	<i>TENS vs Corset:</i> <i>Pain:</i> -0.2 (-0.8; 0.4) <i>Disability:</i> -0.6 (-1.4; 0.3) <i>Massage vs Corset disability:</i> 0.9 (1-1.6)	Use of a corset, compared with massage, reduced disability immediately after treatment when compared with massage.

Level 1 = strong evidence provided by generally consistent findings from multiple RCTs; Level 2 = moderate evidence provided by one RCT or largely consistent findings from many CCTs; Level 2 = limited evidence provided by one CCT; Level 4 = no evidence/ inconsistent evidence; LBP = Low back pain; Positive = supports the use of intervention; Negative = against the use of intervention; Neutral = inconclusive results. RR = relative risk; BP = back pain; LSO = lumbo-sacral orthoses; ODI = Oswestry Disability Index; TENS = Transcutaneous electrical nerve stimulation

2.4 DISCUSSION

The current study presents the methods and results of an overview of systematic reviews aimed at providing an evidence-based overview of the effect of back orthoses as either a management strategy or prophylactic treatment on pain, and related disability in adults with non-specific, mechanical LBP in the short-, mid- and long-term. Although back orthosis is helpful to: 1) provide good support for the back and abdominal area (10,11); 2) avoid any kind of hyper-movement for the area protected; 3) support the normal erect position to promote a good posture and (12); 4) reduce energy cost during the active time; many studies also report that back orthoses is not recommended as it 1) reduces trunk motion in flexion-extension and lateral bending or rotation; 2) reduces the supported area proprioception; 3) affects other organs activity like lungs expansion or pressing the skin and 4) acts as a passive trunk stabilizer (11,12,25,26). However, the results of this study show that the majority of the included studies were against the use of back orthoses (21-23,25,26,30), while three studies showed neutral results (24,28,29) and two studies (15,27) showed a positive result. The main finding of this review regarding the effect of back orthoses as either a management strategy or prophylactic treatment on pain and related disability in adults with non-specific, mechanical LBP in the short-, mid- and long-term, was that the use of back orthoses is generally not suggested.

Eleven systematic reviews were found appropriate for inclusion in this review. The reviews were conducted in various countries over a span of a several years with a total number of 116 443 participants. This is a good sample size from which to draw conclusions. Most of the included reviews critically appraised the primary studies they included. Some used PEDro, some used the Cochrane Risk of Bias tool. According to the CASP assessment of the studies, the highest evidence came from two studies (25,30) which had the highest number of participants. Both studies were against the use of back orthoses. Overall each of the included studies were either considered to have moderate or high evidence of either being negative, positive or neutral in their decision around the use of back orthoses for reducing pain and functional disability in people with non-specific, mechanical LBP.

Three studies however did not report on the critical appraisal of the primary studies they included. This finding is out of the ordinary for systematic reviews, as typically the included studies should be critically appraised. If the methodological quality of studies is not assessed, the results of such a review cannot be believed to be accurate (20). It is therefore recommended that future systematic reviews report on the critical appraisal of the studies they include.

Typically, the included studies reported on the inclusion of a variety of population/occupation types i.e. healthcare workers, industry workers, airport workers, postal workers etc. – occupations that require heavy lifting and manual labor. This group of workers are the ones who often develop LBP (4,10) and is therefore the group of workers that would generally use back orthoses if they believed it would work. All the included studies evaluated participants from developed countries, where many manual laborers are employed. Typically, in these work settings, and dependent on the country, workers are not monitored in terms of ergonomics, or posture, and work stations are not evaluated in terms of being conducive to work at without causing further harm or preventing harm at all (34). Stricter policies should therefore be in place to prevent LBP from occurring or to manage existing LBP. More emphasis should be placed on back education and care in these settings. Furthermore, since a large proportion of the economy of a country is sourced from these occupations (35), more specific focus on this population is important in future in terms of preventing LBP.

Studies against the use of back orthoses had strong evidence for the hypothesis that back orthoses reduced trunk motion for flexion–extension and lateral bending (21,22,25,30) and did not appear to prevent LBP, or related disability. Other studies (27–29,31) found conclusive evidence for the role of back orthoses in primary prevention of back pain. However, one study which support the use of back orthoses clarify that there will not be any negative effect to use orthoses for a short period of time (29). There is conflicting evidence regarding the effect of back orthoses for reducing pain and disability as a management for non-specific, mechanical LBP. This finding is in line with the previous findings around this topic and revision of the current recommendations cannot be made. The bottom line is that in practice, however, patients still have the option to decide what works for them. This is because in evidence-based practice, the available evidence, the clinician's skills and the patient's

beliefs need to be considered (20). Patients can therefore decide that if they feel 'safer' with the use of a back orthosis, and they find that the back orthosis decreases their pain and disability, then clinicians should provide them with a back orthosis, despite the conflicting evidence. The clinician should however inform the patient of the evidence and the negative effects of wearing a back orthosis for long periods of time, and the patient can therefore make an informed decision.

The majority of the included studies compared the use of back orthoses to education (21,25,26,28–31). Education should however form part of any management or prevention strategy and should include education for every aspect of a participant's life, not just at work (36). Wearing a back orthosis, and not being educated about how exactly to lift heavy items is of no use, as the back orthoses cannot substitute bad ergonomic habits. It is therefore recommended, that even if the patient believes that they require a back orthosis or if the clinician insists on providing a back orthosis despite the evidence, education should always form part of the management session (36). Whether it is to prevent further pain and disability, or to manage the current episodes.

Some studies compared the use of back orthoses to spinal manipulation (21,29). Spinal manipulation is a manual treatment intervention used to adjust the spine to improve function and reduce symptoms and is typically used by physiotherapists to treat LBP (37). Although both treatments can be viewed as passive treatments, spinal manipulations typically only last for a few minutes, whereas the use of the back orthoses will be for a longer duration. They therefore fulfil different roles for different reasons at different times. Therefore, depending on what the patient believes in and if they would still want to wear a back orthosis during the day, as it makes them feel 'safe', in practice the use of either treatment strategy should be considered as they have different roles to play within the management of a patient with non-specific, mechanical LBP either in the short-, mid- or long-term. The clinician should consult with the patient, explain the conflicting evidence and have the patient make an informed decision regarding whether they want to use the back orthosis or not.

Some of the studies compared various types of back orthoses to each other and to other common interventions. Some studies even elaborated on the different materials for back orthoses used (21–23, 25). These comparisons are important to consider since different people prefer different

materials. Further research is however required perhaps on what people prefer, and not the effect of the orthoses, since the use of orthoses is personal choice in most cases.

What has not however been factored in this overview is the cost of back orthoses compared to other common interventions. However, it is important to consider the aspect of cost in future research. Cost in many countries drives the level of care received and for this reason, cost should also be considered. The once-off cost of a back orthosis versus the ongoing cost of multiple treatments should be considered within various populations. Not considering cost was therefore a limitation of this study.

Another limitation was the inclusion of studies only published in English. This was due to restraints faced by the researcher in terms of costs for translation. Future research should however expand the search by including other languages.

2.5 CONCLUSION

The main finding of this review regarding the effect of back orthoses as either a management strategy or prophylactic treatment on pain and related disability in adults with non-specific, mechanical LBP in the short-, mid- and long-term, was that the use of back orthoses is generally not recommended. However, patients still have the option to decide what works for them and if they would prefer using back orthoses in everyday life. The treating clinician should however inform the patient of the conflicting evidence and the possible negative effects of wearing a back orthosis for long periods of time, so that the patient can make an informed decision. Further research is however required on what the cost implications are of using back orthoses compared to other common interventions, and if there is a specific material preferred.

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CHAPTER 3

3.1 SUMMARY

The current study aimed to provide an evidence-based overview of the effect of back orthoses as either a management strategy or prophylactic treatment on pain, and related disability in adults with non-specific, mechanical LBP in the short-, mid- and long term.

According to the literature, back orthosis is helpful to: 1) provide good support for the back and abdominal area; 2) avoid any kind of over movement for the area protected; 3) support the normal erect position to promote a good posture and; 4) reduce energy cost during the active time. As a prophylactic treatment, the use of orthoses therefore helps prevent injuries when lifting heavy objects and if the person already has LBP, the use of orthoses may help to reduce the pain, make it possible for the person to carry on with normal duties and prevent further injury.

Many studies however also report that back orthoses are not recommended as it 1) reduces trunk motion in flexion-extension and lateral bending or rotation; 2) reduces the supported area proprioception; 3) affects other organs activity like lungs expansion or pressing the skin and; 4) acts as a passive trunk stabilizer. These studies have shown that back orthoses restrict spinal motion and result in back and abdominal muscle weakness by providing passive stiffness to trunk, reducing the activity of antagonist muscles, elevating blood and intra-abdominal pressure, increasing spinal rigidity by limiting end range movement, increasing heart rate and causing gastrointestinal tract (GIT) disorders. Conflicting evidence therefore exists for the use of back orthoses for non-specific, mechanical LBP. Despite the conflicting evidence, in practice, patients continue to use back orthoses as prophylactic treatment and a source of comfort and some clinicians continue to advise patients to wear back orthoses as conservative treatment.

A search of electronic databases including PubMed, Medline, Cochrane, Science Direct and Elsevier was conducted. Systematic reviews investigating the effect of back orthoses on pain and related

disabilities among adults complaining of non-specific, mechanical LBP were sought and reviewed. Fourteen systematic reviews were found appropriate for inclusion in this review. The reviews were conducted in various countries over a span of several years but **included 114 different RCT**, non-RCT and OCT with approximately 116 443 participants. The majority (50%) of the included studies were against the use of back orthoses while 3 studies showed neutral result and 4 studies showed a positive result.

The main finding of this review regarding the effect of back orthoses as either a management strategy or prophylactic treatment on pain and related disability in adults with non-specific, mechanical LBP in the short-, mid- and long term, was that the use of back orthoses is generally not recommended.

Clinical implications of study findings

Despite the conflicting evidence and the general guideline consensus that back orthoses should not be recommended, patients still have the option to decide what works for them and if they would prefer using back orthoses in everyday life. Based on the principles outlined for evidence-based practice, in addition to considering the available evidence and the clinician's skills, the patient's belief and values must also be considered. In the end, if the patient believes that the back orthoses prevent LBP or manages their pain and disability related to their LBP, then the patient cannot be denied the opportunity to use the back orthoses. The treating clinician should however inform the patient of the conflicting evidence and the possible negative effects of wearing a back orthosis for long periods of time, and the patient should therefore make an informed decision.

Recommendations for future research

Further research is however required on what the cost implications are of using back orthoses compared to other common interventions, and if there is a specific material preferred.

Limitations of the study

The following limitations existed in the study:

- Only studies published in English were included.
- GRADE was not used in this study
- Cost was not investigated.
- Included studies which included adults only
- Included only a systematic review study designs

|

APPENDICES

APPENDIX 1: LEVEL OF EVIDENCE HIERARCHY

Intervention	Level
A systematic review of level II studies	I
A randomised control trial	II
A pseudo-randomised controlled trial (i.e. alternate allocation or some other method)	III – 1
<p>A comparative study with concurrent controls:</p> <ul style="list-style-type: none"> * Non-randomised, experimental trial * Cohort study * Case-control study * Interrupted time series with a control group 	III – 2

<p>A comparative study without concurrent controls:</p> <ul style="list-style-type: none"> * Historical control study * Two or more single arm study * Interrupted time series without a parallel control group 	<p>III-3</p>
<p>Case series with either post-test or pre-test/post-test outcomes</p>	<p>IV</p>

APPENDIX 2: CRITICAL APPRAISAL CHECKLIST FOR A SYSTEMATIC REVIEW**DOES THIS REVIEW ADDRESS A CLEAR QUESTION?**

	Yes	Can't tell	No
<p>1. Did the review address a clearly focussed issue?</p> <p>Was there enough information on:</p> <ul style="list-style-type: none"> • The population studied • The intervention given • The outcomes considered 			
<p>2. Did the authors look for the appropriate sort of papers?</p> <p>The 'best sort of studies' would</p> <ul style="list-style-type: none"> • Address the review's question • Have an appropriate study design 			

ARE THE RESULTS OF THIS REVIEW VALID?

	Yes	Can't tell	No
<p>3. Do you think the important, relevant studies were included?</p> <p>Look for</p> <ul style="list-style-type: none"> • Which bibliographic databases were used • Follow up from reference lists • Personal contact with experts • Search for unpublished as well as published studies • Search for non-English language studies 			
<p>4. Did the review's authors do enough to assess the quality of the included studies?</p> <p>The authors need to consider the rigour of the studies they have identified. Lack of rigour may affect the studies results.</p>			
<p>5. If the results of the review have been combined, was it reasonable to do so?</p> <p>Consider whether</p> <ul style="list-style-type: none"> • The results were similar from study to study • The results of all the included studies are clearly displayed • The results of the different studies are similar 			

<ul style="list-style-type: none"> The reasons for any variations are discussed 			
--	--	--	--

WHAT ARE THE RESULTS

<p>6. What is the overall result of the review?</p> <p>Consider</p> <p>If you are clear about the reviews 'bottom line' results What these are (numerically if appropriate)</p> <p>How were the results expressed (NNT, odds ratio, etc)</p>			
<p>7. How precise are the results?</p> <p>Are the results presented with confidence intervals?</p>			
<p>8. Can the results be applied to the local population?</p> <p>Consider whether</p> <ul style="list-style-type: none"> The patients covered by the review could be sufficiently different from your population to cause concern Your local setting is likely to differ much from that of the Review 	Yes	Can't tell	No
<p>WILL THE RESULTS HELP LOCALLY?</p>			
<p>9. Were all important outcomes considered?</p>			
<p>10. Are the benefits worth the harms and costs?</p> <p>Even if this is not addressed by the review, what do you think?</p>			

APPENDIX 3: BMC MUSCULOSKELETAL DISORDERS JOURNAL SUBMISSION GUIDELINES

Research articles

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Title page

Abstract

Keywords

Background

d Methods

Results _____ and

discussion

Conclusions

List of abbreviations used (if any)

Competing interests

Authors'

contributions

Authors' information

Acknowledgements

Endnotes

References

Illustrations and figures (if
any) Tables and captions

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The Accession Numbers of any nucleic acid sequences, protein sequences or atomic coordinates cited in the manuscript should be provided, in square brackets and include the corresponding database name; for example, [EMBL:AB026295, EMBL:AC137000, DDBJ:AE000812, GenBank:U49845, PDB:1BFM, Swiss-Prot:Q96KQ7, PIR:S66116].

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indicate the corresponding author

Please note:

the title should include the study design, for example "A versus B in the treatment of C: a randomized controlled trial X is a risk factor for Y: a case control study"

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In press article

Kharitonov SA, Barnes PJ: Clinical aspects of exhaled nitric oxide. *EurRespir J*, in press.

Published abstract

Zvaifler NJ, Burger JA, Marinova-Mutafchieva L, Taylor P, Maini RN: Mesenchymal cells, stromal derived factor-1 and rheumatoid arthritis [abstract]. *Arthritis Rheum* 1999, 42:s250.

Article within conference proceedings

Jones X: Zeolites and synthetic mechanisms. In *Proceedings of the First National Conference on Porous Sieves: 27-30 June 1996; Baltimore*. Edited by Smith Y. Stoneham: Butterworth-Heinemann;

1996:16-27.

Book chapter, or article within a book

Schnepf E: From prey via endosymbiont to plastids: comparative studies in dinoflagellates. In *Origins of Plastids. Volume 2*. 2nd edition. Edited by Lewin RA. New York: Chapman and Hall; 1993:53-76.

Whole issue of journal

Ponder B, Johnston S, Chodosh L (Eds): Innovative oncology. In *Breast Cancer Res* 1998, 10:1-72.

Whole conference proceedings

Smith Y (Ed): *Proceedings of the First National Conference on Porous Sieves: 27-30 June 1996; Baltimore*. Stoneham: Butterworth-Heinemann; 1996.

Complete book

Margulis L: *Origin of Eukaryotic Cells*. New Haven: Yale University Press; 1970.

Monograph or book in a series

Hunninghake GW, Gadek JE: The alveolar macrophage. In *Cultured Human Cells and Tissues*. Edited by Harris TJR. New York: Academic Press; 1995:54-56. [Stoner G (Series Editor): *Methods and Perspectives in Cell Biology*, vol 1.]

Book with institutional author

Advisory Committee on Genetic Modification: *Annual Report*. London; 1999.

PhD thesis

Kohavi R: Wrappers for performance enhancement and oblivious decision graphs. *PhD thesis*. Stanford University, Computer Science Department; 1995.

Link / URL

The Mouse Tumor Biology Database [<http://tumor.informatics.jax.org/mtbwi/index.do>]

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Corpas M: The Crowdfunding Genome Project: a personal genomics community with open source values [<http://blogs.biomedcentral.com/bmcblog/2012/07/16/the-crowdfunding-genome-project-a-personal-genomics-community-with-open-source-values/>]

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Tim Albert has produced for BioMed Central a list of tips for writing a scientific manuscript. [American Scientist](#) also provides a list of resources for ~~science~~ writing. For more detailed guidance on preparing a manuscript and writing in English, please visit the [BioMed Central author academy](#).

Abbreviations

Abbreviations should be used as sparingly as possible. They should be defined when first used and a list of abbreviations can be provided following the main manuscript text.

Typography

Please use double line spacing.

Type the text unjustified, without hyphenating words at line breaks.

Use hard returns only to end headings and paragraphs, not to rearrange lines.

Capitalize only the first word, and proper nouns, in the title.

All lines and pages should be numbered. Authors are asked to ensure that line numbering is included in the main text file of their manuscript at the time of submission to facilitate peer-review. Once a manuscript has been accepted, line numbering should be removed from the manuscript before publication. For authors submitting their manuscript in Microsoft Word please do not insert page breaks in your manuscript to ensure page numbering is consistent between your text file and the PDF generated from your submission and used in the review process.

Use the *BMC Musculoskeletal Disorders* reference format.

Footnotes are not allowed, but endnotes are permitted.

Please do not format the text in multiple columns.

Greek and other special characters may be included. If you are unable to reproduce a particular special character, please type out the name of the symbol in full. Please ensure that all special characters used are embedded in the text, otherwise they will be lost during conversion to PDF.

Units

SI units should be used throughout (liter and molar are permitted, however).