

## Treatment of osteoarthritis of the knee with bracing: a scoping review

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### Abstract

Knee osteoarthritis is a leading cause of disability around the world. Knee bracing provides a conservative management option for symptom relief. A variety of different bracing types, manufacturers and products are currently available on the market. The goal of this study is to examine the current state of the literature regarding the treatment of knee osteoarthritis with unloader bracing, specifically examining the representation of specific brace types, manufacturers and models within the literature.

A scoping review technique was used because of its ability to evaluate research activity within an area of study and identify gaps within the literature. A thorough search of the MEDLINE database was conducted for articles where a knee brace model was identified, and we identified characteristics of the studies to evaluate important information about the body of literature related to knee bracing for the treatment of osteoarthritis.

Fifty eligible studies were identified. The majority of studies have been published in the United States, and a large increase in the number of publications in this field was seen between 2010-2014. The most prominent study type was prospective comparative studies (44%), however there is a lack of randomized controlled trials (6%) within the literature. The most prominent hinge type within the lit-

erature is the dual hinge push brace, followed by the single hinge pull.

While a large increase in the number of studies evaluating the treatment of knee osteoarthritis with bracing has occurred in the past 5 years, there is a lack of high quality studies evaluating the efficacy of the technique, as well as a lack of studies comparing bracing types and models.

### Introduction

As one of the leading causes of disability, knee osteoarthritis (OA) results in a substantial decrease in quality of life from people suffering from the disease, as well as a large economic burden on society.<sup>1,2</sup> There are numerous treatment methods available for knee OA including conservative treatment for milder OA and operative management for severe OA. Current clinical guidelines recommend the use of conservative treatment options to alleviate OA related symptoms in order to postpone total knee arthroplasty.<sup>3</sup>

Knee bracing offers a conservative, non-invasive treatment option to alleviate the symptoms of knee OA by decreasing biomechanical loads on the knee.<sup>4,5</sup> Numerous different braces have been developed, evaluated, and manufactured.<sup>6</sup> These braces are designed to decrease loads within the knee, and accomplish so by using various hinge types (single hinge or dual hinge) as well as decreasing the load in either the medial or lateral compartments of the knee by applying a valgus or varus external force to the knee, respectively. The application of this force can be applied either by the brace pushing (push brace) or pulling (pull brace) on the knee in order to apply the required force to decrease the load on the target compartment of the knee joint.

Several systematic review have been published evaluating the efficacy of knee bracing in the treatment of knee OA, and a recent literature review summarized the literature regarding specific brace models.<sup>6-8</sup> Although these reviews evaluate and summarize the efficacy of bracing, an examination of trends within the literature regarding brace types and manufacturers has not been conducted. Therefore, the goal of this scoping review is to summarize the state of literature on the use of knee braces for the treatment of knee OA. The objectives of this review are: i) to summarize the body of literature and examine trends in the treatment of knee OA with bracing and ii) to determine the representation of different knee bracing manufacturers, models and hinge types within the current literature.

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### Materials and Methods

#### Scoping review methodology overview

A scoping review is a literature review method allowing researchers to summarize a range of evidence in order to describe the breadth and depth of a field.<sup>8</sup> Unlike systematic reviews which address the current literature on a narrow focus, a scoping review addresses broader research questions where an abundance of interventions or study designs may be relevant.<sup>9</sup> The literature involving the treatment on knee OA with bracing covers a wide variety of bracing types and study designs. With little known about the types of literature, or the representation of specific products within the current literature, performing a scoping review to map the extent, range, and nature of available research was the most appropriate synthesis methodology.

## Literature search

A literature search was conducted on knee bracing for the treatment of OA. Using a combination of keywords and medical subject heading (mesh) terms related to knee OA and bracing, we performed a detailed search of MEDLINE (Table 1). The search was performed in July, 2014. The search was limited to articles published up to July, 2014 and to studies published in English. After the search, a supplemental search was performed in order to look for any additional articles related to the topic by examining articles referenced within the articles retrieved from the initial literature search.

## Study selection

Titles and abstracts from the literature search were compiled and reviewed for eligibility. Studies were included if they focused on the treatment of knee OA using bracing. Studies included were meta-analyses, systematic reviews, randomized controlled trials, surveys, prospective and retrospective comparative studies, case series and conference abstracts. We excluded basic science and biomechanical research and studies where the brace brand was not specified (Figure 1). Studies that were not published in English and studies that could not be retrieved were also excluded.

## Data abstraction

Important characteristics from each included study were abstracted to understand the characteristics of the literature. These variables included the year of publication, the geographic region where the study was conducted, study design, study perspective, outcomes assessed, and the model and manufacturer of the brace examined.

## Data analysis

Descriptive statistics were used to summarize all data. Counts, proportions and percentages were used to describe all data. Knee brace manufacturers and models within the literature were represented by the number of articles that each manufacturer/model was examined in. A manufacturer can only be referenced once in each article, however within a given article a manufacturer may have several models referenced.

Studies were classified by level of evidence. Level I evidence is high quality randomized controlled trials and systematic reviews of randomized controlled trials. Level II evidence includes lower quality randomized controlled trials, prospective comparative studies, and systematic reviews of level II evidence. Level III evidence consists of retrospective comparative studies and level IV evidence includes case studies. Level V evidence consists of opinion pieces.<sup>10,11</sup>

## Results

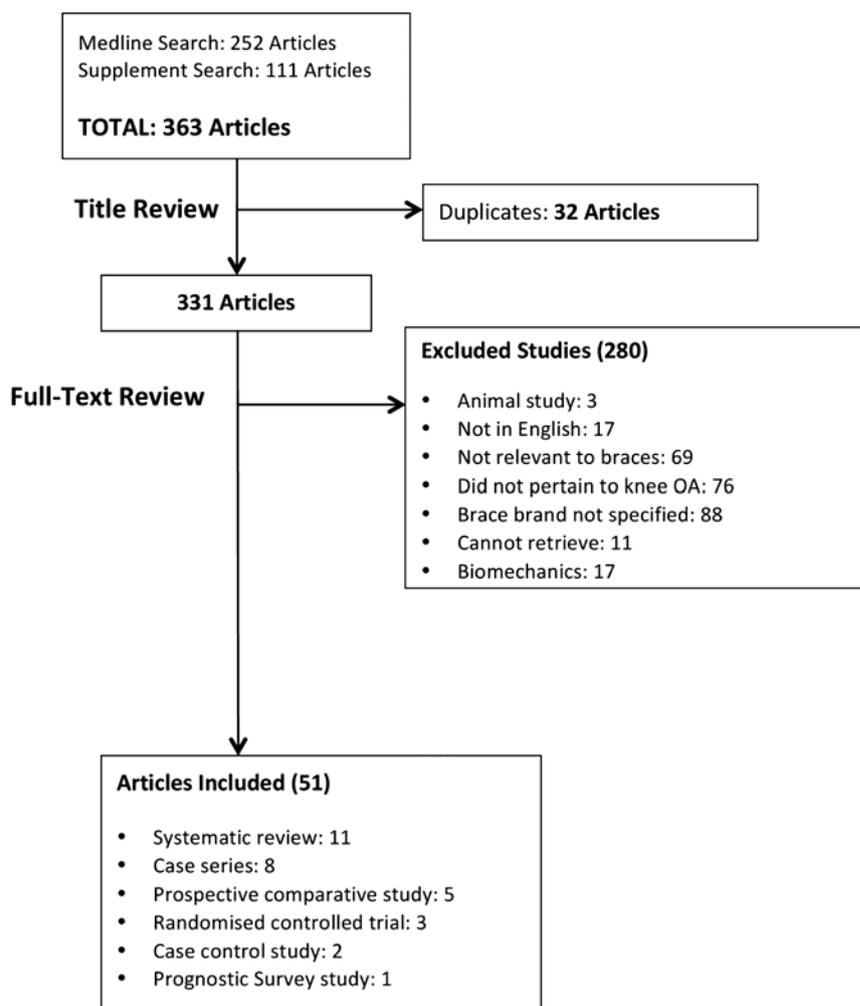
### Citation retrieval

The search strategy and supplemental search identified a total of 363 articles, of

which 32 studies were duplicates, which left 331 articles for consideration for inclusion in this review. We excluded 281 studies due to: being animal studies (3), not written in English (17), were not relevant to bracing (69), did not focus on knee OA (76), the brace

**Table 1. Search strategy.**

	Searches	Results
1	Braces/or unloader knee brace.mp.	4434
2	Knee brace.mp.	241
3	Knee osteoarthritis.mp. or osteoarthritis, knee/	12,050
4	Osteoarthritis.mp. or osteoarthritis/	56,155
5	(Osteoarthritis or osteoarthritic).mp. or osteoarthritis/	57,016
6	(Brace* or bracing).mp.	8606
7	1 or 2 or 6	8606
8	3 or 4 or 5	57,016
9	7 and 8	252



**Figure 1. Literature search results.**

brand was not specified (88), the article could not be located (11), and biomechanical studies (17). Therefore, 50 studies involving the use of bracing for the treatment of knee OA were included in this scoping review (Figure 1).

### Study design and characteristics

The majority of studies were conducted in the United States (58%), with fewer studies conducted in Canada (8%) and the United Kingdom (8%) (Figure 2A). While the earliest article involving bracing for the treatment of knee OA where a brand was specified was published in 1986, half (50%) of all publications have been published between 2010 and 2014 (Figure 2B). The most prevalent type of study were prospective comparative studies (44%), followed by prospective case series (20%) and narrative reviews (12%) (Figure 2C). These studies were predominantly level II (44%) evidence and level IV (28%) evidence. Very few level I studies were identified (6%) (Figure 2D). The majority of the published articles demonstrated a positive effect of bracing (92%), with 3 articles (6.0%) showing no effect of bracing, and only one study (2.0%) claiming a negative effect of bracing.

### Comparison of bracing manufacturers and models

When comparing all brace manufacturers, Össur™ (Reykjavík, Iceland) had the most models evaluated in the published literature (8), followed by DonJoy (DJO, Vista, CA, USA; 7 models), Breg Inc.™ (Carlsbad, CA, USA; 5 models), and Bledsoe™ (Carlsbad, CA, USA; 4 models) (Table 2).

Similarly, the most commonly evaluated brace manufacturer was Össur (27 articles), followed by DonJoy (17 articles), and Breg (11 articles) (Table 2). Across the 14 manufacturers, 36 models were examined in the literature, of which the models evaluated most frequently were the OAdjuster (DonJoy; 13 articles), the Generation II (Össur; 10 articles), Unloader (Össur; 9 articles), OAsys (Össur; 8 articles), Unloader ADJ (Össur; 8 articles), and OA Defiance (DonJoy; 7 articles) (Table 2). Between the years of 2010-2014, Össur braces were most commonly evaluated in the literature (11 articles), followed by DonJoy (10 articles) and Breg (6 articles) (Figure 3).

Two manufacturers had level I studies in the literature; Össur (2 studies) and Cropper Medical Inc. (Ashland, OR, USA; 1 study) (Table 3). Össur had the most level II studies (8 studies) followed by DonJoy (7 studies). The brace models that were evaluated in level I studies were the Generation II (Össur), the OAsys (Össur) and the Bioskin Q (Cropper Medical) (Figure 4). The brace most referenced in level II studies was the OAdjuster (DonJoy; 6 studies), followed by the Unloader (Össur; 3 studies). The manufacturer with the

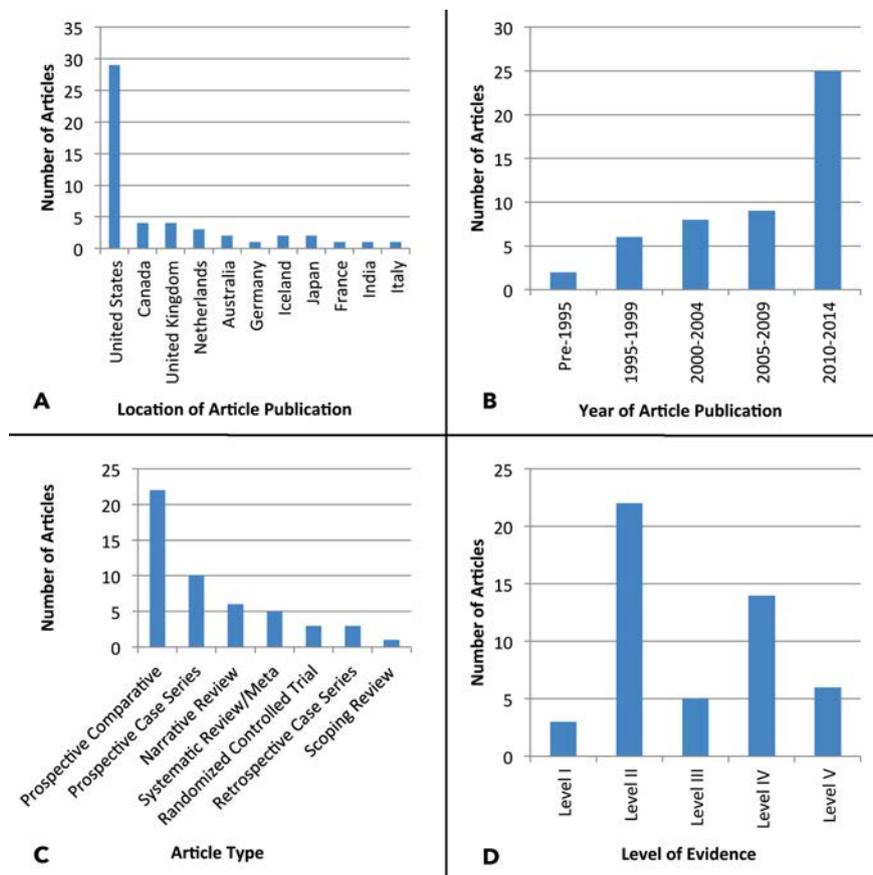


Figure 2. Study characteristics: A) location of studies; B) year of publication; C) study design; D) level of evidence (N=50).

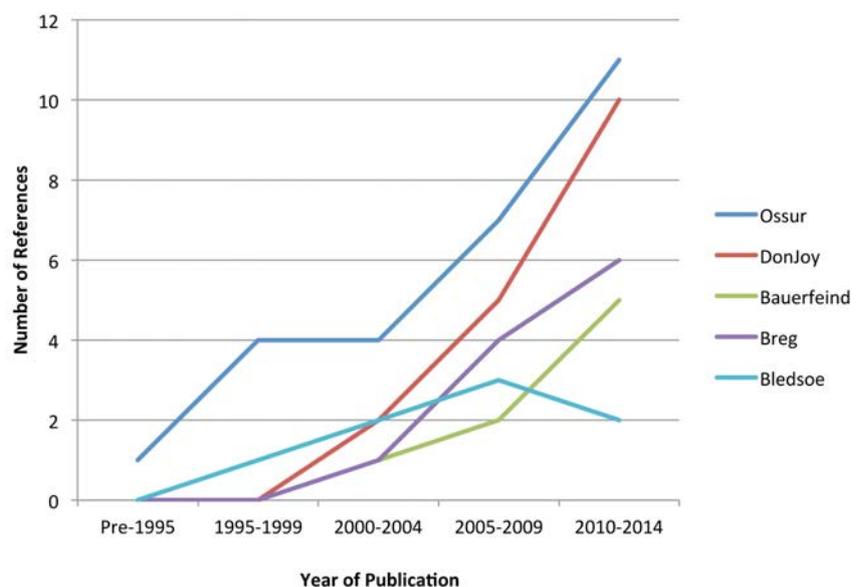


Figure 3. Number of references for the 5 most referenced bracing manufacturers over time.

**Table 2. Knee brace manufacturers and models.**

Manufacturer	Articles referenced*	Model	Articles referenced*
Össur (Reykjavík, Island)	27	Generation II	10
		Unloader	9
		OAsys	8
		Unloader ADJ	8
		Unloader One	5
		Unloader Select	5
		Unloader Spirit	4
		Unloader Express	1
DonJoy (Vista, CA, USA)	17	OAdjuster	13
		OA Defiance	7
		Monarch	3
		On-Track	2
		Montana	1
		OA Lite	1
		OA Nano	1
Breg (Carlsbad, CA, USA)	11	Counter Force	5
		Tradition X2K	3
		Fusion OA	2
		Patellar Tracking Orthosis	2
		Tradition	1
Bauerfeind (Zeulenroda, Germany)	8	MOS Genu	6
		Softec OA	5
Bledsoe (Carlsbad, CA, USA)	8	Thruster 2	5
		Thruster	4
		Legacy Thruster	1
		DUO	1
Otto Bock (Duderstadt, Germany)	4	Genu Arthro	4
Big Sky Medical (Missoula, MT, USA)	3	Custom Unloader	3
VQ OrthoCare (Irvine, CA, USA)	2	Free Stride	1
		OActive	1
Cropper Medical (Ashland, OR, USA)	1	Bioskin Q	1
Camp Healthcare (Jackson, MI, USA)	1	Bilateral B1	1
Ongoing Care Solutions (Pinellas Park, FL, USA)	1	Orthopro OA	1
Proteor (Dijon Cedex, France)	1	ODRA	1
St. Clare Engineering Ltd (Eastleigh, UK)	1	TVS	1

\* The number of articles for each manufacturer does not equal the total of all articles for models of that manufacturer as multiple models could be mentioned within the same article.

**Table 3. Number of brace models by hinge type and manufacturer.**

	Dual hinge push	Single hinge push	Single hinge pull	Patellofemoral	Dual hinge distraction	Total
Össur	1	0	7	0	0	8
DonJoy	4	2	0	1	0	7
Breg	4	0	0	1	0	5
Bledsoe	1	3	0	0	0	4
Bauerfeind	1	1	0	0	0	2
VQ OrthoCare	0	2	0	0	0	2
Otto Bock	0	1	0	0	0	1
Big Sky Medical	0	1	0	0	0	1
Cropper Medical	0	0	0	1	0	1
Camp Healthcare	1	0	0	0	0	1
Ongoing Care Solutions	1	0	0	0	0	1
Proteor	0	0	0	0	1	1
St. Clare Engineering Ltd.	0	0	1	0	0	1
Total	13	10	8	3	1	35

most studies with a positive outcome was Össur (25 studies), followed by DonJoy (17 studies) and Breg (11 articles) (Figure 5).

### Comparison of hinge types

Within the literature the majority of brace models fall under three types; dual hinge push (14 models), single hinge push (10 models) and single hinge pull (8 models) (Table 4). Of the 14 dual hinge push models, DonJoy and Breg contribute the most models with 4 each. Amongst single hinge push models 2 of the 10 models belong to Bledsoe braces, while Össur braces comprise 7 of the 8 single hinge pull models.

The most referenced bracing type is dual hinge push (52 references), of which 24 references (46.1%) belong to DonJoy braces. A complete summary of braces by manufacturer is provided in Appendix. Single hinge pull braces are the second most referenced brace type (43 references), with Össur braces comprising 42 (97.8%) of single hinge pull references. The third most referenced bracing type is single hinge push braces (26 references) of which 10 references (38.5%) belong to Bledsoe braces.

When classifying the studies by the level of evidence for each bracing type, we found that dual hinge push, single hinge pull and patello-femoral braces each had one level I study in the literature. The bracing types with the most level II evidence were dual hinge push braces (10 studies), single hinge push braces (9 studies) and single hinge pull braces (7 studies). A complete summary of study designs by bracing type is provided in Appendix.

## Discussion

The purpose of this review was to summarize the literature regarding knee bracing for the treatment of knee OA, and to examine the

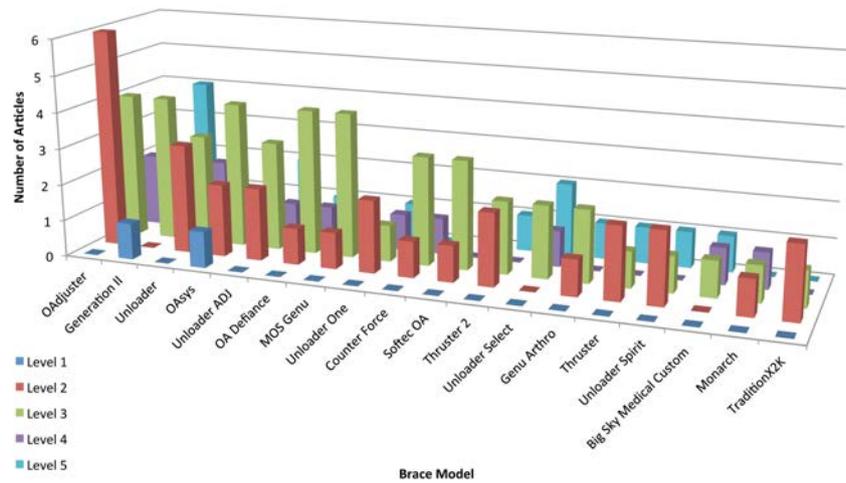


Figure 4. Level of evidence by bracing model for models with 3 or more articles.

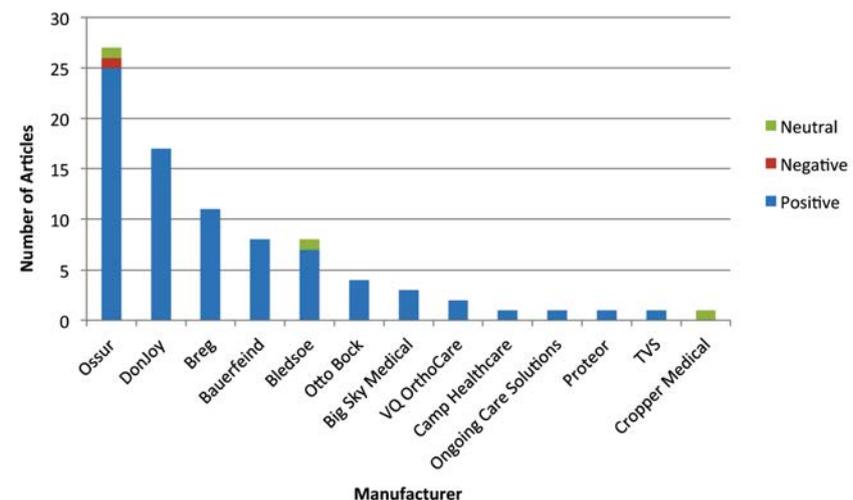


Figure 5. Study outcome by brace manufacturer (n=50).

Table 4. Number of articles by level of evidence by bracing manufacturer.

Manufacturer	Level I	Level II	Level III	Level IV	Level V
Össur	2	8	5	6	6
DonJoy	0	7	4	3	3
Breg	0	3	3	2	3
Bauerfeind	0	2	4	1	1
Bledsoe	0	4	2	0	2
Otto Bock	0	1	2	0	1
Big Sky Medical	0	0	1	1	1
VQ OrthoCare	0	2	0	0	0
Cropper Medical	1	0	0	0	0
Camp Healthcare	0	1	0	0	0
Ongoing Care Solutions	0	1	0	0	0
Proteor	0	0	0	1	0
TVS	0	0	0	1	0

representation of different OA knee brace manufacturers, models and hinge types within the scientific literature. To accomplish this, a scoping review was performed which, unlike a systematic review, does not evaluate the data within selected articles but rather evaluates articles to gain an understanding of the characteristics of the published literature.<sup>12</sup> This approach also allows for the examination of articles that are not randomized controlled trials, such as systematic reviews and meta analyses in order to evaluate the total body of literature associated with a selected topic.

The present scoping review identified 51 articles pertaining to the treatment of knee OA in which the model of knee brace examined is specified. The majority of articles examining bracing for the treatment of knee OA are published in the United States (58%) between the years 2010-2014 (50%). Prospective comparative studies were the most common type of study examining knee braces (44%), with very few randomized controlled trials being conducted (6%). Articles involving bracing for the treatment of knee OA generally displayed positive outcomes (92%) with only 4 articles indicating a neutral or negative outcome (8%).

When examining all knee brace manufacturers and models, Össur had the most models within the literature (22.9% of all models), with DonJoy (20% of all models) and Breg (14.3% of all models) following. Össur braces were examined in the most articles (54% of all articles), followed by DonJoy (34% of all articles) and Breg (22% of all articles). The most studied type of brace was the dual hinge push (40.9% of references), followed by single hinge pull braces (33.9% of references).

Strengths of the present study are the wide search strategy that was used to ensure an accurate overview of the literature available regarding the use of knee bracing as a treatment for OA of the knee, as well as the division of braces among manufacturers, models and hinge types in order to provide a more detailed scope of the literature. Limitations of the present study are that only one database was used to investigate the literature. Also, only select-

ing articles published in English may exclude applicable articles related to bracing for the treatment of knee OA. The final limitation of this study is that only articles in which a knee brace model was mentioned were included, which resulted in the exclusion of a large amount (88) of articles relevant to knee bracing for the treatment of knee OA.

Gaps within the current literature identified in this scoping review are a lack of high quality articles including randomized controlled trials evaluating the efficacy of knee bracing for the treatment of knee OA. Additionally, few articles comparing hinge type or specific models are present within the literature in order to show superiority to one type of brace over others. Increasing the number of high quality studies, as well as studies comparing brace types (single versus dual hinged; push braces versus pull braces) and models will provide better insight into the efficacy of specific brace types on the treatment of knee OA.

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## Conclusions

The use of knee braces for the treatment of knee OA has experienced an increase in the number of publications since 2010; however there is a lack of high quality evidence examining the efficacy of the treatment method. Few comparative studies examining differences between hinge types and brace models are also present within the literature. Future research should aim to evaluate the efficacy of bracing for the treatment of knee OA with high quality studies, as well as studies examining differences in performance between different bracing types.

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