

Review Paper

The Role of Non-rigid Pelvic Belts in Managing Pregnancy-related Pelvic Girdle Pain and Low Back Pain: A Systematic Review



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ABSTRACT

Objectives: Pelvic belts are prescribed for back and pelvic pain during pregnancy and postpartum. This study reviews level II literature (randomized clinical trials and clinical trials) considering the effect of pelvic belt application on pain and functional disability in pregnant women with pelvic girdle pain or low back pain.

Methods: Two reviewers independently performed a computerized literature search from PubMed/MEDLINE (NLM), Scopus, Web of Science, PEDro and Google Scholar databases. The included studies were agreed upon by the two reviewers, and a third reviewer mediated any disagreements. Data extraction was conducted by the two reviewers and cross-checked by a third reviewer. The quality of each included trial was assessed independently by the two reviewers and scored using the PeDro scale. Any discrepancies in selecting the studies and scoring them were resolved by a third collaborator.

Results: A total of 9 studies met the inclusion criteria and were selected for the systematic review. Four fair- and one low-quality study reported more significant pain reduction by the flexible pelvic belt than the usual healthcare or physical therapy. In two fair- and one low-quality study, higher functional improvement was reported by belt than healthcare or physical therapy. Meanwhile, one high- and one fair-quality study showed no added functional ability in the flexible belt for health care or exercise.

Discussion: The current review suggests using the flexible belt as a practical treatment approach in alleviating pain in pregnant women with pelvic girdle pain or low back pain (LBP) during pregnancy. However, the added efficacy in functional disabilities is controversial.

Keywords:

Pregnancy, Pelvic girdle pain, Low back pain, Maternity support, Pelvic belt

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Highlights

- The flexible belt is recommended to alleviate pain in pregnant women with pelvic girdle pain (PGP).
- The efficacy of a pelvic belt on the function of pregnant women is uncertain.
- The rigid and flexible belts result in similar functional improvement in PGP.

Plain Language Summary

Pregnant women usually experience pelvic pain during pregnancy. This discomfort is often felt at the end of pregnancy and especially during the third trimester. The reason for pelvic pain during pregnancy is that at this time, the mother's body is preparing for childbirth. During pregnancy, the mother's body releases hormones that allow the connective tissues to loosen and soften. As a result, the joints and ligaments between the pelvic bones also begin to loosen. Increasing the flexibility of these bones is essential at this time, as it allows the baby to move around in the mother's body during delivery. Also, part of the pain and discomfort felt by the mother is caused by lower back pain and changes in the position of the body. To reduce and relieve this pain during pregnancy, therapists' suggestions are massage programs and wearing special pelvic belts. According to the studies, there is evidence to support wearing pelvic belts. Pregnant women should consult with their healthcare provider before using a pelvic belt to ensure that it is safe and appropriate for their individual needs and conditions. With the proper use and guidance, pelvic belts can be a safe and effective tool for managing pelvic pain during pregnancy and improving the quality of life for pregnant women.

Introduction

Pelvic girdle pain (PGP) and low back pain (LBP) related to pregnancy are women's concerns and common social challenges. According to the literature, about 30% to 78% of women suffer from an amount of PGP (deep, diffusing, irradiating, or radiating pain around the sacroiliac joint or symphysis pubis) or LBP during pregnancy or after three months post-partum [1-5]. This has been reported at a severe level in one-third of women [6]. PGP might affect sitting, walking, and standing ability leading to disability in daily activity, and is estimated as the reason for 37% of sick leaves during pregnancy [6-10]. The symptoms can be disabling, not necessarily removed after childbirth, and often later. Despite the negative effect on the quality of life, the reason for pain in pregnancy has been recognized weakly [11]. This reasonably common disorder involves hormonal fluctuations, genes and biomechanical reasons [12]. A history of LBP, pelvic injury, young age, and multiplication are raised as pregnancy-related LBP and PGP risk factors [13, 14].

According to a theoretical model of pelvic function, in the self-locking mechanism, shear force in the sacroiliac joint is prevented through augmenting friction by using two factors as follows: The particular anatomical alignment, which increases friction coefficient (form-clo-

sure), and the tension of muscles and ligaments, which cross sacroiliac joint (SIJ) and provide higher stiffness (force-closure) [15, 16]. It has been recommended that during pregnancy, hormonal (rise of fertility hormones or hormones related to parturition), mechanical factors (lengthening of pelvic joints ligaments and fascia) and changes in motor control, cause pelvic instability and consequently lead to PGP [8, 17-20]. For this reason, most treatments for PGP are based on intervention approaches that improve muscle functions and pelvic stiffness [21]. Literature has proven that multimodal interventions, including physiotherapy, pelvic belt, and supplementary interventions (ergonomic education, massage therapy, acupuncture, and yoga), are effective in LBP and PGP relief [3, 22-30]. A Cochrane review indicated the superiority of using a belt or acupuncture, physical therapy, and exercise over only taking care. However, the best treatment options are not consensually declared [25].

Pelvic belts are used to treat pelvic pain during pregnancy and postpartum. The logic for using belts is stabilizing and compressing SIJ surfaces and providing pelvic girdle stability through increasing force-closure (applying external force) [31, 32]. By this mechanism, pelvic belts might provide enough support for symphysis pubis and SIJ pain-relieving and are proposed as a primary treatment [33, 34]. Existing studies regarding the effects of wearing soft belts on pain relief have some

limitations that make it difficult to decide whether to use soft belts for clinical applications. First of all, the exact effects of wearing a pelvic belt on pain reduction are controversial. Ostgaard et al. indicated that 83% of PGP or LBP women reported posterior pelvic pain reduction while wearing a pelvic belt [33]. However, other studies did not report any pain-relieving after pelvic belt use [35]. Secondly, the pure effect of pelvic belts is difficult to specify, as they are used in combination with other treatments such as exercise and acupuncture. Thirdly, different belts are used [29, 31, 35, 36] and the best type regarding symptom relief and patient tolerance has not been specified yet.

Furthermore, a pelvic belt is used in clinical applications and other treatments, such as exercise and acupuncture. Therefore, their pure effect is not specified. Moreover, different belts are used [29, 31, 35, 36] and the best type regarding symptom relief and patient tolerance has not been specified yet. Some researchers investigated the effect of different positions (high position in anterior superior iliac spine level and low position in greater trochanter level and pubis joint) [31, 37] and flexibility (rigid and flexible) of the belt [37, 38] and different amounts of compressive force (50 and 100 N) [39] using biomechanical models. Two systematic reviews in 2019 indicated the positive effect of using dynamic elastomeric fabric orthosis or maternity support garments on pain and function during the pre-natal period [40, 41]. However, adherence to the principle of comprehensiveness (encompassing gray literature) and adherence to the principle of quality is missed in older systematic reviews. Moreover, the previous reviews considered different evidence levels. Therefore, to the best of our knowledge, a lack of consistent and citable evidence is considered regarding the exact effect of pelvic belts on pregnancy-related PGP and LBP. Accordingly, the current study reviews level II literature (randomized control trials or control trials) considering pelvic belt efficacy on pain, improves function in pregnant women with PGP and LBP, and provides a practical and clinical recommendation regarding the ability of pelvic belt prescription in pregnant women, and suggests when to use a pelvic belt during pregnancy.

Materials and Methods

This study was developed based on the preferred reporting items for systematic reviews and meta-analyses principles.

Search strategy

Two reviewers independently performed a computerized literature search from PubMed/MEDLINE (NLM), Scopus, Web of Science, PEDro and Google Scholar. The key terms used in PubMed/MEDLINE, Web of Science and Scopus included the following items: ([Pelvic AND pain*] OR [pelvic girdle AND pain*] OR [pelvic AND girdle pain*] OR [symphysis pubis AND dysfunction*] OR [pubis dysfunction* AND symphysis]) AND ([pregnant* AND woman*] OR [pregnant*] OR [gestation*]) AND ([brace*] OR [belt*] OR [semirigid AND belt*] OR [nonrigid AND belt*] OR [maternity AND garment*] OR [pelvic AND belt*] OR [soft AND belt*] OR [support AND garment*] OR [pelvic support AND belts*] NOT [seat AND belt*]).

Study selection

Eligibility criteria

Table 1 provides details on study eligibility criteria using the population, intervention, comparison, outcome, and study design framework.

Selection procedure

The review included studies in which pregnant women with PGP used a pelvic belt or pelvic supports to relieve pain. Experimental studies, including randomized controlled trials, non-randomized controlled trials (allocation performed with the date of birth, alteration or record numbers) or randomized comparative trials, were considered for this review. The review only included the studies published within 21 years (April 2000 to April 2021), published in peer-reviewed journals, full-text articles, and written in English. Two independent researchers (SB/FG) evaluated the identified studies for eligibility by screening the title and abstract, and then the full texts, grading each study as eligible/not eligible/might be eligible at each stage. Included studies were agreed upon by the two reviewers (SB/FG) and in case of disagreement, a third reviewer (MPA) mediated. The details, including sample size, intervention type, duration, and outcome measures, were extracted from the articles. The full texts of selected studies were obtained, and then two reviewers appraised the studies independently and scored them based on 11 points on the PeDro scale. A third collaborator resolved any disagreements in selecting the studies and scoring them. The complete process of study selection is summarized in the preferred reporting items for systematic reviews and meta-analyses principles flow diagram (Figure 1).

Table 1. Study eligibility criteria using population intervention comparison outcome

Population	Pregnant Women With Pelvic Girdle Pain
Intervention	Pelvic support belt (soft/rigid)/dynamic elastomeric fabric orthoses
Comparison	Exercises and information
Outcome	Pain and disability
Study design	Randomized controlled trial non-randomized controlled trial or randomized comparative trial

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Data extraction

The researchers extracted the data, which was then rechecked by a third reviewer. As data were missing or ambiguous, trial authors were contacted for additional data.

The following information was extracted: Trial authors, countries, study design, the week of pregnancy, sample size, interventions, type of belt, study setting, outcome measures, follow-up period, and main results. Data related to crucial outcome measures, including pain and disability, were extracted.

Quality assessment in individual trials

The two reviewers (SB/FG) underwent training and conducted a pilot quality assessment. They evaluated the quality of each included trial independently, using the **PeDro** quality assessment tool informed by empirical evidence to assess internal validity. The third reviewer (MPA) commented on the following discussion for any disagreement. Each quality component was reported as low, fair, or high quality in tabular form.

Table 2. The PEDro scale for all eligible studies

No.	Author	Year	Total PEDro Scale	PEDro Grade	1	2	3	4	5	6	7	8	9	10	11
1	Carr et al. [44]	2003	4/10	Fair	Yes	No	No	Yes	No	No	No	Yes	No	Yes	Yes
2	Depledge et al. [35]	2005	8/10	High	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
3	Kalus et al. [29]	2007	7/10	High	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes
4	Kordi et al. [42]	2013	5/10	Fair	Yes	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes
5	Flack et al. [38]	2015	6/10	High	Yes	Yes	Yes	Yes	No	No	No	Yes	No	Yes	Yes
6	Bertuit et al. [37]	2017	5/10	Fair	Yes	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes
7	Cameron et al. [43]	2018	9/10	High	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
8	Szkwara et al. [36]	2019	3/10	Low	Yes	No	No	Yes	No	No	No	No	No	Yes	Yes
9	Marzouk et al. [34]	2020	5/10	Fair	Yes	No	Yes	Yes	No	No	No	Yes	No	Yes	Yes

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Results

A total of 1188 studies were identified during the search across different databases. Additionally, a hand search of references provided in studies yielded one more study. After removing duplicates of different databases and records marked as ineligible by automation tools, 544 articles remained. Upon initial review, the titles and abstracts of the articles were reviewed and 64 articles were selected for more surveys. In the next step, the full text of the articles was carefully reviewed, and 55 articles were excluded based on pre-determined criteria. Nine articles met the inclusion criteria and were selected for the systematic review (Figure 1).

Quality of included studies

The quality was considered for all studies. One study was rated as low quality, four were rated as fair quality, and four were rated as high quality. Table 2 shows the quality of the included studies.

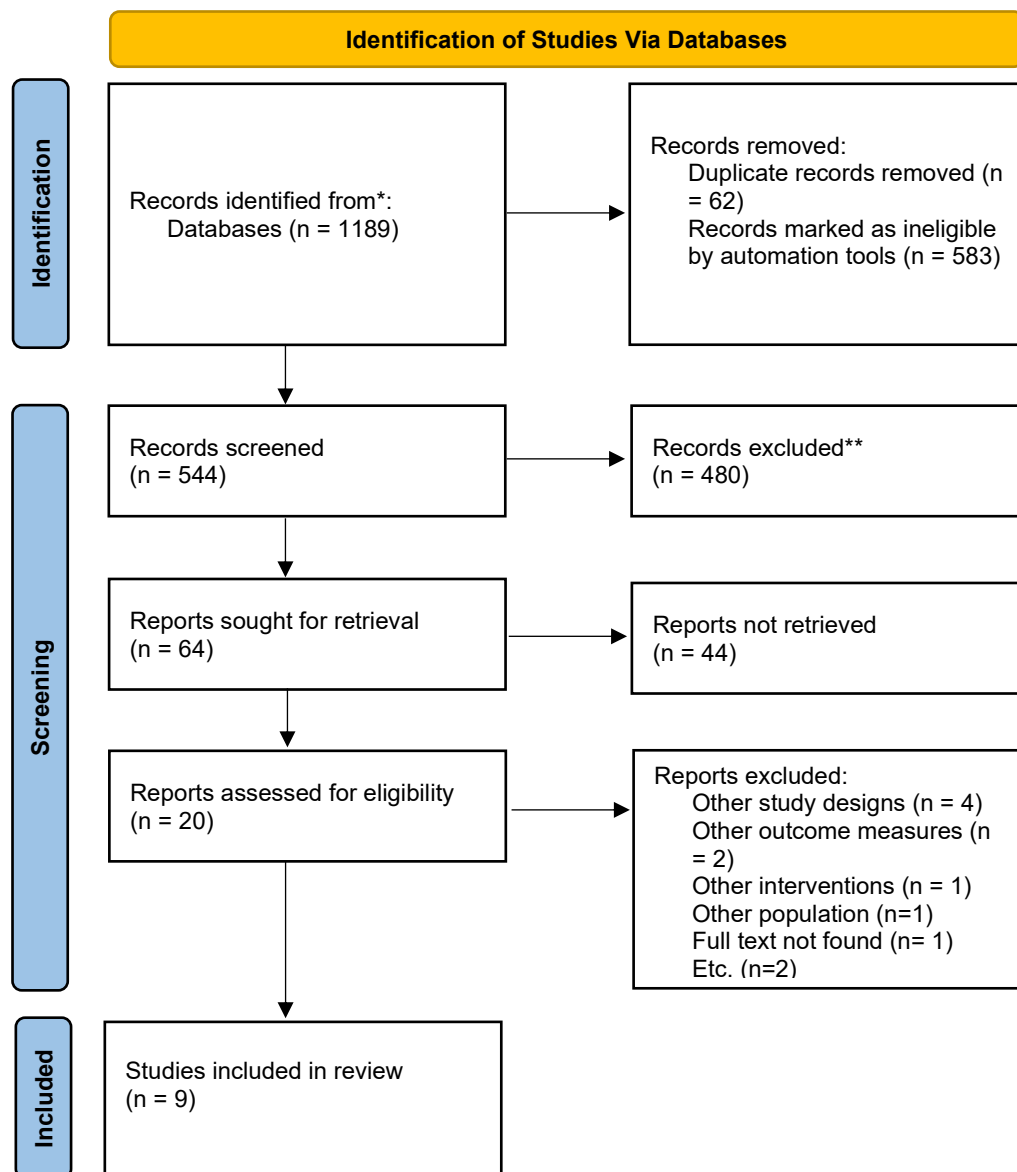


Figure 1. The PRISMA flowchart summarizing the steps of database search, screening, and selection of studies

Review of participant characteristics

Table 3 shows eligible trial population characteristics. According to the included studies, PGP is described as pain in the symphysis pubis or SIJ in pregnant women [34-38, 42, 43]. Two studies from New Zealand considered symphysis pubis [35, 38]. One study from Belgium [37] and one from the United Kingdom [43] considered SIJ or symphysis pubis. One study from Iran considered SIJ [42]. One study from Egypt and one from Australia considered lumbar spine or posterior pelvic pain [34, 36], one from the USA considered LBP [44] and one study from Australia considered two types of bra [29]. All of the studies considered pregnant women

and the mean age ranged between 26.72 and 30. Two studies did not report the mean age of the included participants [29, 36]. The study by Flack et al. justified the compared groups for patient-specific functional scale pre-intervention [38]. At the start of the intervention, the gestational age was between the 23rd and 32nd weeks of maternity. Szkwara et al. started the intervention at the earliest time (23th-25th week) [36] and Depledge et al. and Flack et al. started the intervention at a mean age of 31st gestational week [35, 38].

Table 3. Descriptive characteristics of included studies

No.	Study	Design/Quality	Participant Characteristics	Intervention	Dosage of Intervention	Outcome Measures	Conclusion
1	Marzouk et al. 2020, [34]; Journal of Nursing and Health Science	Non-randomized controlled trial; unblinded; fair quality	126 pregnant women experiencing pregnancy-related low back pain; control group=42; mean age=27.9 years; belt group=42; mean age=28; exercise group=42; mean age=28.4 years; week of maternity=26-28	Control group: Usual pre-natal instructions; belt group: Lumbo-pelvic belt beside usual instruction; exercise group: 3-step pelvic strengthening exercise.	6 weeks as tolerated during day waking hours	Numerical rating scale- pain: Pain intensity; Modified Oswestry disability index: To assess how low back pain affects women's ability to do daily activities.	The wearing of a pelvic support belt and exercise effectively reduced pregnancy-related low back pain and modified Oswestry disability index scores compared to usual prenatal care. Also, using the belt was more effective than doing the exercises.
2	Szkvara et al. 2019, [36] (Australia); Peer J	A prospective quasi-experimental controlled study using parallel groups; low quality	55 childbearing women complaining of LBP and/or pelvic girdle pain; Mean age=not reported; Experimental group=38; control group=17; week of maternity=23-25	Experimental group: Compression shorts pregnancy shorts in addition to receiving the usual care; the control group received usual prenatal physiotherapy and broader health care.	Wear 10 h/day for 6 weeks	Numeric pain rating scale: Pain; Roland-Morris disability questionnaire: Function.	The comparison between the two groups showed that the numeric pain rating scale and Roland-Morris disability questionnaire in the belt group significantly decreased compared to those in the control group.
3	Cameron et al. 2018, [43] (UK); International Journal of Women's Health Care	Single-centered, double-blinded, randomized comparative trial; High quality	N=72 women; week of maternity=28-29; Control group: SEROLA (36), mean age=29 years; experimental group: Dynamic elastomeric fabric orthoses [36], mean age=30	Control group: Off-the-shelf rigid pelvic belt plus standardized advice; experimental group: The customized dynamic elastomeric fabric orthoses plus standardized advice. Experimental	18-weeks; hours of daily use were not reported.	Numeric pain rating scale: Pain during day and night; pelvic girdle questionnaire: Evaluates activity/ participation and body functions/symptoms.	The novel, customized dynamic elastomeric fabric orthoses could effectively reduce pelvic girdle pain in pregnant women rather than wearing off-the-shelf rigid pelvic belts.
4	Bertuit et al. 2017, [37] (Belgium); Journal of Clinical Nursing	Randomized controlled trial; fair quality	46 pregnant women with pelvic girdle pain; 25 in two groups Experimental group (n=17), mean age=29±5 years, mean height=161±4 cm; comparison group (n=8), mean age=29±5 years, height=163±6 cm, week of maternity: 26-28	Experimental group: Belt 1 (Ortel-P Thusne), this belt is narrow and flexible. The belt can be placed in a high position (at the anterior superior iliac spine) or low position (at the pubis); belt 2 (LombaMum Thusne) is wide and rigid with metal reinforcements in the lumbar area; comparison group did not wear a belt.	4 days a week and 2:30 h/day for 9 weeks	Visual analog scale: Pain; Quebec back pain disability scale: Qualitative functional capacity.	The use of pelvic belts reduced pelvic girdle pain, particularly in the sacroiliac joint. Also, daily activities, such as standing, walking and sitting were more manageable in the experimental group. The results suggest that different belts (narrow and flexible or wide and rigid) could have different effects on global, sacroiliac joints, and back pain during pregnancy.
5	Flack et al. 2015, [38] (New Zealand); Pregnancy and childbirth	A randomized controlled trial; high quality	20 pregnant women, mean age=29.4±6.5 years; experimental group (n=10), mean age=28.6±5.6 years; comparison group (n=10), mean age=30.2±7.6 years, week of maternity=29-32	Experimental group: Flexible neoprene support belt; comparison group: Thinner, more rigid belt made of nylon webbing with foam lining.	3-weeks, 5 h/day	Patient-specific functional scale: Functional status; visual analog scale: Pain; worst pain over the preceding 24 h and the preceding week; modified version of the Oswestry disability index: Disability.	The result indicated that pelvic support belts might potentially reduce pain and improve function in pregnant women with pubic symphyseal pain. The flexible belt may be more effective in pain reduction and more comfortable.

No.	Study	Design/ Quality	Participant Characteristics	Intervention	Dosage of Inter- vention	Outcome Mea- sures	Conclusion
6	Kordi et al. 2013, [42] (Iran); Journal of Back and Musculoskeletal Rehabilitation	Randomized controlled trial; fair quality	105 pregnant women with pelvic girdle pain; experimental group (n=34); comparison group: General information group: A (n=31) Comparison group: Exercise group: B (n=31); Mean age=26.72 years; week of maternity=25-26	Experimental group: Non-rigid lumbopelvic belt and the information; comparison group A: General information; comparison group B: Exercise group	6-weeks, during day	Visual analog scale: Pain; Oswestry disability index: Disability.	Using a lumbopelvic belt plus information about the ergonomic and anatomic condition of the spine is more effective in reducing pain and functional disability of patients with pelvic girdle pain than exercise plus information or information alone.
7	Kalus et al. 2007, [29] (Australia), BJOG: An International Journal of Obstetrics & Gynaecology	Randomized comparative trial; high quality	94 pregnant women with lumbar back pain or posterior pelvic pain; experimental group (n=46); control group: (n=48); week of maternity: 28-29	Experimental group: Belly bra a nylon/spandex undergarment worn like a vest. A wide elastic band sits below the abdomen, supporting the uterus and lifting the weight of the pelvis; control group: Tubigrip is worn in double layers and extends from the mid-thoracic spine to the sacral and pelvis.	3-weeks; hours of daily use were not reported.	Visual analog scale and the Likert scale scores: Pain; severity and physical activity	The belly bra and Tubigrip both reduced the severity of pregnancy-related low back pain. However, the Belly Bra was more effective than Tubigrip in alleviating the impact of pain on physical activities.
8	Depledge et al. 2005, [35] (New Zealand); Physical Therapy	Randomized controlled trial; high quality	59 pregnant women, Mean age=29.5 years; Experimental group (n=29); comparison group 1 (n=28); comparison group 2 (n=30); week of maternity=31	Experimental group: Non-rigid neoprene support belt (smiley belt) plus information and exercise; comparison group 1: Rigid pelvic belt plus, information, and exercise; comparison group 2: Exercise completed three times a day to enhance the stability of the pelvic bone; verbal and written education about symphysis pubis' anatomy and pathology dysfunction and their daily activity.	One week, 6 h/day	Numeric pain rating scale: Average and worst pain; patient-specific functional scale and modified Roland-Morris disability questionnaire: Performance.	Based on the results, pelvic support belts showed no more effective than exercise on pelvic girdle pain in pregnant women.
9	Carr, 2003, [44] (USA); Journal of Obstetric, Gynecologic, & Neonatal Nursing	A pilot study using a prospective, two-group design with repeated measures; fair quality	Experimental group=30; control group=10; mean age: Not reported; week of maternity=27	Experimental group: Maternity lumbosacral support binder; Comparison group: No belt. The comparison group received a support binder after the research follow-up.	Wear while awake for 2 weeks	Pain in pregnancy questionnaire: Back pain intensity, duration, and effect on daily activities.	Wearing a support binder reduces pelvic girdle pain scores significantly. Also, pregnant women showed good acceptance.

Methodology considered and outcome measures

Nine papers that met the inclusion criteria were evaluated. Two studies were performed in a quasi-experimental design (controlled trials) [34, 36] and three studies were randomized comparative trials that compared the efficacy of two types of maternity support [29, 38, 43]. Four studies were performed in randomized control trials design [35, 37, 42, 44]. In four studies [35, 37, 38, 43], both types of non-rigid and rigid pelvic support were evaluated, and five studies evaluated the therapeutic effect of the non-rigid belt as an intervention [29, 34, 36, 42, 44]. As a result, the team decided to consider the results of the non-rigid pelvic support for systematic review.

The pain was measured using the visual analog scale [29, 37, 38, 42] or the numeric pain rating scale [34-36, 43], or the pain in pregnancy questionnaire [44]. Disability was measured using the Oswestry disability index [42], a modified version of the Oswestry disability index [34, 38], the patient-specific functional scale [35, 38], the Quebec back pain disability scale [37], the Roland Morris disability questionnaire [35, 36], the pelvic girdle questionnaire [43] or a Likert scale [29, 44]. Pain and disability were evaluated as the primary outcome measures.

Belt types considered in studies

The included studies considered different types of belts and supports, but this review focused on the efficacy of flexible types. Bertuit et al. used the narrow flexible belt Ortel-P Thuasne and also evaluated the efficacy of a wide rigid belt [37]. Cameron et al. Szkwara et al. considered the efficacy of elastomeric dynamic elastomeric fabric orthoses and compared it with a rigid belt (SERO-LA) [36, 43]. Depledge et al. and Flack et al. compared the efficacy of wide flexible and thin rigid belts [35, 38]. Marzouk et al., Kordi et al., and Carr et al. considered soft lumbopelvic belts [34, 42, 44] and Kalus et al. compared the two soft undergarments effectiveness named Tubigrip and BellyBra [29] (Figure 2).

Follow-up and adherence

The reviewed studies reported pain reduction after wearing a pelvic belt from one week [35] to 9 weeks [37] and 18 weeks [43]. One study evaluated belt efficacy for two weeks [44]. Two studies considered a three-week treatment duration [29, 38], and three studies followed patients for six weeks [34, 36, 42]. Due to the heterogeneity of the instruments used in pain intensity and function measurement, finding a correlation between the duration of belt use and pain reduction or functional improvement was impossible. Adherence to belt-

wearing was varied in the included studies; the least time duration of belt-wearing was 2.5 hours a day, four days a week [37]. A total of 5 to 6 h/day was reported in two studies [35, 38], 10 h was reported by one study [36], and three studies reported daily use [34, 42, 44]. Two studies did not report the hours of belt daily usage [29, 43].

Discussion

Comparing the effect of the flexible belt to healthcare or exercise on pain intensity

Pain intensity was measured using VAS in four studies and NPRS in five studies (Table 3). Nine clinical trials were considered: One low-quality, four fair-quality, and four high-quality clinical trials considered pain intensity. Eight studies (except one high-quality study) reported pain reduction after wearing the flexible pelvic garment [29, 34, 36-38, 42-44]. In five clinical trials (four fair- and one low-quality) the flexible pelvic belt was more effective in reducing pain than the control group, which received healthcare or physical therapy [34, 36, 37, 42, 44]. One high-quality randomized controlled trial [35] determined no added effect of the flexible belt on exercise and information after a one-week follow-up (Table 4). According to the clinical trials with differing levels of evidence, this review suggests using the flexible belt as a practical treatment approach to alleviating pain in pregnant women with PGP or LBP.

Comparing the effect of the flexible belt to healthcare or exercise on functional disability

Functional disability was evaluated using the Oswestry disability index or modified Oswestry disability index, Roland-Morris disability questionnaire, pelvic girdle questionnaire, Quebec back pain disability scale, and the Likert scale. The eligible studies indicated that the use of flexible belts improved function, with one low-, two fair-, and four high-quality studies reporting improvements in disability after using a flexible belt [29, 34-36, 38, 42, 43]. Among these studies, two fair- and one low-quality study reported higher efficacy of belts than healthcare or physical therapy [34, 36, 42]. While one fair-quality study found no functional improvement with or without the belt [37]. In contrast, one high-quality study that followed up after one week showed no added effect of the flexible belt on functional ability compared to health care or exercise after a one-week follow-up [35] (Table 4). Despite the favoring results of studies, the present review supposes that the literature lacks enough evidence to conclude about the added efficacy of pelvic belts to general healthcare or physical therapy in improving functional disability.



Figure 2. A summary of the used pelvic belts in eligible studies

a: 3M nexcare [34]; b: Elastomeric DEFO [36]; c1: Elastomeric DEFO [43]; c2: Rigid SEROLA [43]; d1: Narrow and flexible belt [37]; d2: Wide and rigid belt [37]; e1: Wide and flexible belt [38]; e2: Narrow and rigid belt [38]; f1: Tubigrip [29]; f2: BellyBra [29]; g1: Wide and flexible belt [35]; g2: Narrow and rigid belt [35]; h: Loving comfort back support [44].

Comparing the flexible and rigid belt

Four studies including one fair- and three high-quality, assessed the efficacy of flexible and rigid belts [35, 37, 38, 43]. Cameron et al. found a higher efficacy of flexible dynamic elastomeric fabric orthoses during the pre-natal period than rigid SEROLA, with clinically significant efficacy. However, within the post-natal period, despite no significant difference between groups, the rigid belt helped in meaningful pain reduction [43]. Flack et al. reported a positive effect of both rigid and flexible belts on pain intensity and functional scale after three weeks of use. Pain intensity was reduced more with the flexible belt than with the rigid belt, however, there was no difference in functional status and dis-

ability between the two belt types [38]. Bertuit et al. also compared the efficacy of narrow flexible and wide rigid belts and found that both types of belts were effective in reducing pain. The flexible belt significantly decreases global and SIJ pain intensity, while rigid belts alleviate spine pain by encompassing the spine with a wide belt.

Additionally, one study found neither efficacy nor difference between flexible and rigid belts in the functional score [37]. Depledge et al. also compared the efficacy of wide flexible and narrow rigid belts and found that the rigid belt significantly reduced average pain after a one-week follow-up, but the flexible had no effect. The researchers observed no difference between the two

groups in terms of the worst experienced pain or functional improvement [35] as demonstrated in Table 4.

The limited evidence available does not allow for conclusive comparisons between the efficacy of rigid and flexible belts. Furthermore, the included studies used belts of varying width and flexibility ranges, which makes it challenging to draw definitive conclusions. The studies that did show similar outcomes, but the efficacy in pain relief was controversial.

Different types of flexible belts efficacy

One high- and one low-quality study investigated the efficacy of elastomeric dynamic elastomeric fabric orthoses and reported satisfying results in pain reduction and function improvement after 18 and 6 weeks of use, respectively [36, 43]. Two high-quality studies have investigated the efficacy of a wide flexible belt [35, 38]. Flack et al. confirmed the efficacy of wide flexible belts on pain alleviation and functional improvement after three weeks of belt-wearing [38]. However, Depledge et al. did not confirm pain improvement after using a wide flexible belt for one week [35]. Three fair-quality studies have investigated the efficacy of lumbopelvic belts and confirmed their effectiveness in pain reduction and disability improvement [34, 42, 44]. One fair-quality study investigated the efficacy of a flexible narrow belt, which was effective in pain reduction but not disability [37]. One high-quality study compared the efficacy of two flexible garments (BellyBra and Tubigrip) and found that both types alleviated pain intensity. However, the BellyBra was more effective compared to the Tubigrip in functional improvement [29] (Table 4). Regarding the belt type, the sub-group analysis confirmed the efficacy of narrow flexible belts, elastomeric dynamic elastomeric fabric orthoses, and lumbopelvic belts after short or long-term wearing. However, more confirming studies are needed to establish the efficacy of wide flexible belts.

The potential mechanisms of pain and function improvement by belts

The proposed pain-alleviating mechanisms of the belt in literature can be summarized as follows. The first hypothesized mechanism is providing proprioceptive feedback. The pelvic belt's compression force helps stimulate proprioceptive receptors in the skin layers or pelvic joints [45]. These proprioceptive receptors are responsible for providing optimal postural control [45]. The stimulated receptors improve the proprioception of the pelvic joints and help in better motor control of pel-

vic and lumbar muscles, reducing compensatory patterns and, thereby reducing pain and improving function [45].

The second explanation is the biomechanical effect. Pelvic garments are supposed to improve the self-locking of the pelvis and reduce SIJ laxity by increasing the "force closure," which was discussed formerly. Enhancing force closure reduces shearing forces through the SP and SIJ and releases the strained ligaments that are the main reason for pelvic pain in pregnant women [15, 46].

The current review findings related to pain reduction due to belt wearing, extracted from randomized controlled trials and controlled trials studies, are valuable in clinical decision-making when choosing to add a belt in addition to only health instruction or physical therapy. However, the results are comparable to a systematic review from 2019 that was more specific, limiting eligible studies to higher evidence levels (II). Nevertheless, the current review finding is strong enough to judge the belt efficiency in pregnant women with pelvic or low back pain.

Conclusion

Based on the limited evidence, the current review suggests wearing a flexible belt during the 20th to 30th weeks of pregnancy. Nevertheless, the belt efficacy depends on adherence. Besides, more studies with a high level of evidence are recommended to confirm the belt efficacy with confidence.

Study limitations

This study faced some significant limitations. The pelvic belt interventions used in the included studies were different types of non-rigid pelvic belts. Additionally, the follow-up period and the adherence reported in the reviewed studies were variable, making it challenging to provide accurate conclusions in this matter. There was a lack of evidence considering the safety of pelvic belt intervention. Due to the heterogeneity of the eligible study, meta-analysis was not applicable. Moreover, the eligible high-quality randomized controlled trials were limited, which reduces the power of judgment about the efficacy of the pelvic belt. Despite these limitations, this work offers insight into the importance of the role of pain-relieving pelvic belts while managing PGP in pregnant women. Large prospective controlled studies could provide more definitive evidence.

Table 4. Numerical descriptive data and p value of comparative and pre-post changes of primary outcomes if included clinical trials

Outcome Year/Author	Experimental	Control	Disability Mean Difference Post-pre (P)	Pain Mean Difference Post-pre (P)	Disability Mean Difference Post-pre (P)	P (Pain [Between Group])	
1 Pain/function 2017. Bertuit et al. [37]	Flexible and rigid belt: 38	Flexible belt: 17	NPRS: SUI: 40-60=-20(P=0.02); Symphys: 10-20=-10(P=0.27); VAS global: 40-60=-20(P=0.004); Spine pain: 10-20=-10(P=0.10)	NPRS: SUI: 50-50=0(P=0.87); Symphys: 20-0=20(P=0.19); VAS global: 50-50=0(P=0.80); Spine pain: 10-20=-10(P=0.23)	MODI: 41-41=0(P=0.80)	MODI: 38-42=-4(P=0.48)	SUI: P=0.83; Symphys: P=0.70; VAS global: P=0.77; Spine pain: P=0.94
2 Pain/function 2013. Kordi et al. [42]	35	35	VAS: 11-64,4=-53,4(P not reported)	VAS: 45.2-51=-5.8(P not reported)	ODI: 20.1-40,6=-20,5(P not reported)	ODI: 25.7-32,3=-6,6(P not reported)	P<0.001
3 Pain/function 2005. Depledge et al. [35]	Non-rigid belt: 29 Rigid belt: 28	30	NPRS: 37,43=6(P not reported)	NPRS: 33-47,8=-14,8(P not reported)	RMDQ: 11.9-15,2=-3,3 (P not reported)	RMDQ: 11.3-14,5=-3,2 (P not reported)	P = 0.04
4 Pain/disability/ 2015. Flack et al. [38]	Soft: 10	Rigid: 10	VAS: 24 h: 37.9-55.5=-17,6(P not reported); previous week: 53-68,7=-15,7(P not reported)	VAS: 24 h: 58.9-58,2=0,7(P not reported); previous week: 64-71,6=-7,6 (P not reported)	MODQ: 4.2-6,5=-2,3(P not reported)	MODQ: 4.7-7,1=-2,4 (P not reported)	P=0.454
5 Pain/disability 2020. Marzouk et al. [34]	42	42	NPRS: 24 h: 2.4-6,2=-3,8 (P<0.001); previous week: 1.4-6,0=-4,6 (P<0.001)	NPRS: 24 h: 6.4-6,0=-0,4(P=0.07); previous week: 6.2-5,8=-0,4(P=0.19)	MODI: 22.3-39,0=-16,7 (P<0.001)	MODI: 41.9-39,2=2,7 (P=0.59)	P<0.001

Ethical Considerations

Compliance with ethical guidelines

The protocol of this review was registered on the [International Prospective Register of Systematic Reviews \(PROSPERO\)](#) (Code: CRD42019121687).

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Authors' contributions

Conceptualization, methodology and writing the original draft: Faezeh Ghorbani, Shahrbanoo Bidari, Mohammadreza Pourahmadi; Supervision: Mohammadreza Pourahmadi; Funding administration, data collection, data analysis and investigation: All authors; Review and editing: Mohammadreza Pourahmadi, Arman Jalaledini, Kourosh Barati.

Conflict of interest

The authors declared no conflict of interest.

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