**Exercise for the prevention of low back and pelvic girdle pain in pregnancy: A meta-analysis of randomized controlled trials**

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**Conflict of interest**

The authors declare that they have no conflicts of interest.

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| **Databases** |
| PubMed, Embase, Cochrane Library, Google Scholar, ResearchGate and ClinicalTrials.gov |
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| **What does this review add** |
| Exercise has a small protective effect against low back pain during pregnancy. |

**Introduction**

Lumbopelvic pain, defined as pain in the low back (lumbar region) and/or pelvic girdle (symphysis pubis, sacroiliac joint and gluteal region) (Wu et al., 2004), is the most common musculoskeletal complaint in pregnancy (Vermani et al., 2010). More than half of pregnant women experience low back pain (Gjestland et al., 2013; Kovacs et al., 2012), and 10% to 65% pelvic girdle pain (Gjestland et al., 2013; Kovacs et al., 2012; Owe et al., 2016; Vleeming et al., 2008). Moreover, the pain is frequently rated as moderate to severe (Wu et al., 2004). The prevalence of lumbopelvic pain in the postpartum period is only about half that during pregnancy (Wu et al., 2004).

To date, little is known about the primary prevention of low back and pelvic girdle pain in pregnancy (Vermani et al., 2010). Light to moderate exercise during pregnancy is safe for the mother and fetus (Hinman et al., 2015) and has beneficial effects (Hinman et al., 2015; Nascimento et al., 2012). It prevents excessive maternal and fetal weight gain, prevents and controls gestational diabetes and improves cardiorespiratory fitness (Hinman et al., 2015; Nascimento et al., 2012). Exercise may also be effective in the secondary prevention of low back pain in pregnancy, reducing its intensity, and associated disability and sick leave (Kinser et al., 2017; Liddle and Pennick, 2015). A recent systematic review and meta-analysis (Liddle and Pennick, 2015) combined trials on the primary prevention of low back or pelvic girdle pain with those on its secondary prevention. It is unclear, however, whether benefits extend to primary prevention, and to pelvic girdle as well as low back pain. The aim of the current systematic review and meta-analysis of randomized controlled trials was to determine the effect of exercise on primary prevention of low back and pelvic girdle pain in pregnancy.

**Methods**

*Search strategy*

The PRISMA statement (Moher et al., 2009) was used when developing the review protocol and meta-analysis. Comprehensive literature searches were conducted in the PubMed, Embase, and Cochrane Library databases from their inception through May 2017, using predefined combinations of MeSH terms (PubMed, the Cochrane Library), Emtree terms (Embase) and text words (supplementary table S1). In addition, we searched Google Scholar, ResearchGate and ClinicalTrials.gov as complementary sources. We used a sensitive search strategy and did not limit the search to studies in pregnant women. There was also no restriction on language. Additionally, the reference lists of included articles and of previous reviews on the topic were hand-searched for further reports that might be relevant.

*Inclusion and exclusion criteria*

The titles, abstracts and full texts of potentially relevant reports were screened to identify studies that had investigated the effect of exercise in primary prevention of low back or pelvic girdle pain in pregnant women. Randomized controlled trials (RCT) were eligible for inclusion in the review if they compared an exercise intervention with usual daily activities and at least some of the participants were free from low back pain and/or pelvic girdle pain at baseline. However, studies in which all women already had low back pain and/or pelvic girdle pain at baseline were excluded, as were those that concerned spinal pain more broadly (neck, mid-back and/or low back), or did not present results for low back pain and/or pelvic girdle pain specifically, and also those that did not report quantitative data. We contacted the authors of four studies for further information (Foxcroft et al., 2011; Garshasbi and Faghih Zadeh, 2005; Haakstad and Bo, 2015; Ladefoged et al., 2012), and two provided us with additional results (Foxcroft et al., 2011; Haakstad and Bo, 2015). For the other two studies (Garshasbi and Faghih Zadeh, 2005; Ladefoged et al., 2012), we contacted the corresponding authors several times, and also their coauthors, but without success.

*Assessment of study quality*

The methodological quality of the included trials was assessed independently by two reviewers (RS and KFH) using the Cochrane Collaboration’s tool for assessing risk of bias in randomized trials (Higgins et al., 2011). Five sources of bias were assessed: selection bias, performance bias, detection bias, attrition bias and reporting bias. Disagreements between raters were resolved through discussion.

*Meta-analysis*

In our meta-analysis, we estimated relative risks (RRs) for seven outcomes: i) prevalent LBP; ii) a new episode of sick leave for LBP; iii) prevalent pelvic girdle pain; iv) prevalent lumbopelvic pain; v) a new episode of sick leave for lumbopelvic pain; vi) prevalence of lumbopelvic pain, or if no information was available about pelvic girdle pain, of low back pain; and vii) a new episode of sick leave for lumbopelvic pain, or if no information was available about pelvic girdle pain, for low back pain. In addition, we estimated the raw and standardized mean differences in the intensity of lumbopelvic pain, or if no information was available about pelvic girdle pain, of LBP. Standardized mean differences were calculated as the ratio of the raw difference between means to their pooled standard deviation. We calculated Hedges' g (Higgins and Green, 2009), which weights each group's standard deviation by its sample size.

To estimate a RR for lumbopelvic pain in a trial (Eggen et al., 2012) that reported separate estimates for low back pain and pelvic girdle pain, we combined results by a fixed-effect meta-analysis to give an overall pooled estimate for low back or pelvic girdle pain. Moreover, we corrected the variance of the pooled estimate by a method that has been suggested for combining multiple outcomes within a study (Borenstein et al., 2009 ; Shiri et al., 2016). For this calculation we used the natural logarithms of RRs and their confidence intervals. In the same study,pain intensities in the intervention and control groups were presented as means with 95% confidence intervals. We calculated standard deviations for each group by multiplying the standard error of the mean by the square root of the sample size.

For one trial (Sklempe Kokic et al., 2017) with a moderately sized sample (20 participants in intervention group and 22 in the control group) that reported the median, and low and high end of the range of lumbopelvic pain intensity, we calculated mean and standard deviation using formula suggested by Hozo et al. (Hozo et al., 2005).

A random-effects meta-analysis was used to combine the estimates from different studies (Higgins and Green, 2009). The presence of heterogeneity across the studies was assessed by the I2 statistic (Higgins and Thompson, 2002). A funnel plot was used to explore publication bias, Egger’s regression test to examine funnel plot asymmetry, and the trim and fill method to estimate the number of studies missing through publication bias (Duval and Tweedie, 2000; Rothstein et al., 2005). The statistical significance of publication bias was based on a *P* value <0.10 (Borenstein et al., 2009 ). Stata, version 13 (Stata Corp, College Station, TX) was used for the meta-analysis.

**Results**

*Study search.* The first author screened 9004 publications in PubMed, 10,752 in Embase, 2663 in the Cochrane Library and 1000 in Google Scholar (Figure 1). Two reviewers (RS and KFH) independently screened 82 potentially relevant trials. From these, we excluded 44 that concerned secondary prevention of low back or pelvic girdle pain, or in which the control group received another type of exercise, 23 that were in non-pregnant women, three that were non-randomized clinical trials (Beyaz et al., 2011; Dumas et al., 1995; Sedaghati et al., 2007), and one with insufficient data. Thus, finally, 11 eligible individually-randomized controlled trials (N = 2347 pregnant women) qualified for the meta-analyses (Table 1 and Supplementary Table S2). Four of these trials were conducted in Norway, and one in each of Australia, Brazil, Croatia, Denmark, Iran, Sweden, and Thailand.

*Study characteristics.* Sample sizes ranged from 42 to 762 pregnant women and follow-up time ranged from 2 to 8 months. Seven RCTs appropriately allocated participants to treatment arms, but four did not specify the method of randomization (Supplementary Table S2). Seven concealed allocation sequence and four did not report the method of concealment. None of the trials blinded the participants, personnel, or outcome assessors. Loss to follow-up ranged from 4.0% to 21.5%.

The exercise interventions in the trials included water gymnastics (Kihlstrand et al., 1999), sitting pelvic tilt exercise (Suputtitada et al., 2002), an energy expenditure exercise (Foxcroft et al., 2011), strengthening exercises for abdominal, hamstrings and spinal muscles (Garshasbi and Faghih Zadeh, 2005), low impact gymnastics and strengthening exercises (Ladefoged et al., 2012) or a combination of at least three of aerobic, strengthening, stretching and relaxation, flexibility and endurance, resistance exercises, pelvic floor muscle training, or balance exercises (Eggen et al., 2012; Haakstad and Bo, 2015; Miquelutti et al., 2013; Mørkved et al., 2007; Sklempe Kokic et al., 2017; Stafne et al., 2012) (Table 1 and Supplementary Table S2). The duration of the intervention ranged from 8 to 24 weeks. It was 8 weeks in one trial (Suputtitada et al., 2002), 12 weeks in six trails (Garshasbi and Faghih Zadeh, 2005; Haakstad and Bo, 2015; Miquelutti et al., 2013; Mørkved et al., 2007; Sklempe Kokic et al., 2017; Stafne et al., 2012) and 16 weeks or longer in four trials (Eggen et al., 2012; Foxcroft et al., 2011; Kihlstrand et al., 1999; Ladefoged et al., 2012). In 10 trials exercises began in the 2nd trimester and in one trial (Suputtitada et al., 2002) in the 3rd trimester.

All the RCTs recruited participants with or without low back pain or pelvic girdle pain (Table 1). Three trials estimated the effect of exercise on low back pain only (Garshasbi and Faghih Zadeh, 2005; Kihlstrand et al., 1999; Ladefoged et al., 2012), four on lumbopelvic pain as a single entity (Mørkved et al., 2007; Sklempe Kokic et al., 2017; Stafne et al., 2012; Suputtitada et al., 2002), and four trials (Eggen et al., 2012; Foxcroft et al., 2011; Haakstad and Bo, 2015; Miquelutti et al., 2013) looked separately at low back pain and pelvic girdle pain (Table 1).

Ten RCTs used self-report to estimate the prevalence of low back and/or pelvic girdle pain and one trial (Foxcroft et al., 2011) used the Roland-Morris Disability Questionnaire. Pain intensity was assessed using a visual analogue scale in three RCTs (Miquelutti et al., 2013; Stafne et al., 2012; Suputtitada et al., 2002), numeric rating scale in two RCTs (Eggen et al., 2012; Sklempe Kokic et al., 2017) and the Quebec back pain disability scale in one trial (Garshasbi and Faghih Zadeh, 2005). Three trials (Foxcroft et al., 2011; Garshasbi and Faghih Zadeh, 2005; Kihlstrand et al., 1999) assessed the outcome in the 2nd–3rd trimesters of pregnancy and eight in the 3rd trimester of pregnancy (Table 1). However, one trial (Haakstad and Bo, 2015) reported an intention-to-treat analysis for low back pain or pelvic girdle pain in the 3rd trimester combined with 6-8 weeks postpartum. Four trials assessed sick leave due to lumbopelvic pain or low back pain during the follow-up period.

*Exercise and low back pain.* In a meta-analysis of seven RCTs (N=1175 women), exercise reduced the risk of low back pain in pregnancy by 9% (pooled RR = 0.91, 95% CI 0.83-0.99, I2 =0%, Figure 2).

*Exercise and pelvic girdle pain.* Only four RCTs assessed the effect of exercise during pregnancy on pelvic girdle pain. These trials found no protective effect of exercise against pelvic girdle pain (RR = 0.99, CI 0.81-1.21, I2 =0%, 4 studies, N=565, Figure 2).

*Exercise and lumbopelvic pain.* Exercise during pregnancy had no statistically significant protective effect against lumbopelvic pain (pooled RR = 0.96, 95% CI 0.90-1.02, I2 =1%, 8 RCTs, N=1737, Figure 2). The pooled RR of either lumbopelvic pain (8 RCTs) or (in the absence of information about pelvic girdle pain) low back pain (3 RCTs) was 0.94 (CI 0.89-0.99, I2 =7%, 11 RCTs, N=2347).

*Exercise and sick leave due to low back pain or lumbopelvic pain.* Exercise during pregnancy prevented new episodes of sick leave due to low back pain (pooled RR = 0.67, CI 0.40-1.12, I2 =0%, 2 RCTs, N=349, Figure 2) during follow-up, and also new episodes of sick leave due to lumbopelvic pain (pooled RR = 0.79, CI 0.64-0.99, I2 =0%, 3 RCTs, N=1168). Furthermore, exercise during pregnancy prevented new episodes of sick leave due to either lumbopelvic pain (3 RCTs) or low back pain (1 RCT) by 23% (pooled RR = 0.767, CI 0.625-0.942, I2 =0%, 4 RCTs, N=1412).

*Exercise and pain intensity.* Five RCTs (Eggen et al., 2012; Miquelutti et al., 2013; Sklempe Kokic et al., 2017; Stafne et al., 2012; Suputtitada et al., 2002) assessed the intensity of lumbopelvic pain and two trials (Garshasbi and Faghih Zadeh, 2005; Miquelutti et al., 2013) the intensity of low back pain in intervention and control groups. Lumbopelvic pain intensity on a 100 mm visual analogue scale was lower in intervention than control groups (pooled mean difference for total sample [participants with or without pain] -13.3, 95% CI -35.4, 8.9, N = 1244). For intensity of low back pain, the mean difference was -1.6 (CI -5.9, 2.8, N = 373). Although the raw difference was not statistically significant for lumbopelvic pain, the standardized mean difference achieved significance (Hedges' g = -0.94, CI -1.67, -0.21, Supplementary Figure S1). However, the pooled mean difference in lumbopelvic pain intensity reduced to -1.0 (CI -4.2, 2.2, N = 1177) and the standardized mean difference to -0.04 (CI -0.20, 0.12) after exclusion of one small trial (Suputtitada et al., 2002) with a large difference in pain intensity between intervention and control groups.

*Heterogeneity and publication bias.* For all meta-analyses, the observed heterogeneity was low. A test for funnel plot asymmetry was non-significant for seven trials on low back pain (*P*-value for Egger test = 0.46, Supplementary Figure S2). Moreover, the trim and fill method imputed only one missing study attributed to publication bias (Supplementary Figure S3) and the pooled estimate did not change after adjustment for possible publication bias.

Egger test for funnel plot asymmetry was non-significant for four trials on pelvic girdle pain (*P* = 0.35) and eight trials on lumbopelvic pain (*P* = 0.11). However, the trim and fill method imputed only one missing study on pelvic girdle pain and two missing studies on lumbopelvic pain due to publication bias. After adjustment for possible publication bias, the pooled RR increased to 1.01 (CI 0.84-1.22) for pelvic girdle pain, but the effect estimate for lumbopelvic pain did not change (RR = 0.96, CI 0.89-1.03).

The *P*-value from the Egger test was 0.25 for three trials on sick leave due to lumbopelvic pain. The trim and fill method imputed no missing study on the right side of the funnel plot for either sick leave due to low back pain or sick leave due to lumbopelvic pain, while on the left side of the funnel plot it imputed one missing study on sick leave because of low back pain and two missing studies on sick leave because of lumbopelvic pain. After adjustment for small study effect, the pooled RR for sick leave due to low back pain reduced to 0.60 (95% CI 0.37-0.96) and that for sick leave due to lumbopelvic pain to 0.77 (CI 0.63-0.93, Supplementary Figure S4).**Discussion**

This meta-analysis of 11 randomized controlled trials (2347 participants) suggests that exercise has a small protective effect against low back pain in pregnancy, but not against pelvic girdle pain. Moreover, exercise appeared to prevent new episodes of sick leave due to lumbopelvic pain (4 randomized controlled trials including 1412 participants).

To reduce the possibility that relevant studies were missed, we employed a broad search strategy and did not apply a filter relating to study design, which might have excluded some older clinical trials inappropriately. Despite this, we found only a few small RCTs that had assessed the effect of exercise on pelvic girdle pain or on sick leave due to low back pain, which limited statistical power to estimate effects on those outcomes. A further limitation was the heterogeneity of the interventions employed, in their nature, timing, frequency and duration, and in the time periods over which outcomes were assessed. However, if there were major benefits from exercise, they should have been apparent despite the heterogeneity.

All but one of the trials that we included in our review recruited participants with or without low back and/or pelvic girdle pain at baseline, and as such, they assessed a combination of primary and secondary prevention. In each study, the baseline prevalence of low back and/or pelvic girdle pain was similar in the intervention and control groups. However, from the information available, it was not possible to distinguish effects on the incidence of new pain from those on the persistence of existing pain.

Our meta-analysis suggests that exercise during pregnancy reduces new sick leave for low back pain and pelvic girdle pain by more than 20%. However, because of low statistical power, the effect on sick leave for low back pain did not reach statistical significance. Only a small number of the trials included in the review had collected data on sick leave. Also, estimates of the effect on sick leave were based on all participants, although women would not have been at risk for an episode of sick leave if they were unemployed or on maternity leave.

A protective effect of exercise against LBP during pregnancy is plausible, given its effects on LBP in non-pregnant women (Shiri and Falah-Hassani, 2017; Shiri et al., 2016; Steffens et al., 2016), and also limited evidence of benefits in the treatment of LBP during pregnancy (Kinser et al., 2017; Liddle and Pennick, 2015). Furthermore, a prospective cohort study of 2753 pregnant women found that moderate or high level of physical activity was associated with a 10% reduction in new episodes of low back pain after adjustment for age, parity, education, smoking, pre-pregnancy body mass index, and low back pain before the current pregnancy (Gjestland et al., 2013). Exercise improves muscle strength and endurance, and seems to be more effective in the prevention of new episodes of low back pain when it is habitual (Nilsen et al., 2011). Because of greater adherence, physical exercise performed at a workplace or in a class may be more effective than home-based exercise (Jakobsen et al., 2015) in reducing new episodes of low back pain. To the extent that women randomized to exercise did not do so habitually, and adherence to exercise was not perfect, the effect of exercise on low back pain may have been underestimated.

In contrast, our meta-analysis suggested no effect of exercise on pelvic girdle pain during pregnancy, although an earlier prospective cohort study of 39,184 nulliparous women had found that pre-pregnancy exercise for 3-5 times/week reduces the risk of pelvic girdle pain during pregnancy by 14% (Owe et al., 2016). The discrepancy may have occurred because the interventions in the trials that were included in the current review did not start until the 2nd trimester. Exercise may have an effect on pelvic girdle pain during pregnancy if started before pregnancy or in the first trimester. Alternatively, it could be that the association in the observational study was a product of uncontrolled residual confounding.

In summary, exercise during pregnancy appears to reduce low back pain and associated sick leave, but there is no clear evidence for an effect on pelvic girdle pain. Even for low back pain, the protective effect is only modest, but given the other benefits of exercise, primary care practitioners and those providing care across the prenatal period can recommend exercise to pregnant women.

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**Disclosure of interests**

The authors declare that they have no conflicts of interest.

**Contribution to authorship**

RS developed the review protocol and conducted the literature searches. RS and KFH screened the eligible studies and rated the quality of included studies. RS extracted the data and performed the meta-analyses. RS and DC interpreted the results and wrote the paper.

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**Details of ethics approval**

Not applicable.

**Figure legend**

**Figure 1** A meta-analysis of 11 randomized controlled trials on the effects of exercise on low back pain, pelvic girdle pain, lumbopelvic pain, sick leave due to low back pain, and sick leave due to lumbopelvic pain. The size of the gray shaded area indicates the weight of each study. Horizontal lines show the 95% confidence intervals (CI). RR, risk ratio.

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**Table 1:** Study characteristics

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| First author | Year | Country | Study population | Recruitment time (week of pregnancy) | Follow-up time (month) | Pain at baseline | Sample size | | |  | Intervention (exercise) | | | |  | Control group |  | Outcome | |
| Control | Intervention | Total |  | Type | Frequency | Duration (weeks) | Place |  |  | Outcome at follow-up\* | Timing (week of pregnancy) |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| *Randomized controlled trials* | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Sklempe Kokic | 2017 | Croatia | Healthy pregnant women or with mild gestational diabetes | 13-30 (mean 25) | 3 | Intervention 35%, control 23% | 22 | 20 | 42 |  | Aerobic, resistance, pelvic floor exercises, stretching and relaxation, and brisk walk | Twice a week plus daily walk | 7-23 (mean 12) | Exercise class |  | Usual activity |  | LPP, intensity of LPP | 36-39 |
| Haakstad | 2015 | Norway | Sedentary pregnant women | 12-24 | 8 | Intervention 29%, control 32% | 53 | 52 | 105 |  | Endurance, aerobic dance, strength, stretching and relaxation | An hour for at least twice a week | 12 | Exercise class |  | Usual activity |  | LBP, PGP, LPP, sick leave due to LPP | 36-38, and 6-8 weeks postpartum |
| Miquelutti | 2013 | Brazil | Healthy pregnant women | 18-24 | 4 | With or without, % not reported | 76 | 85 | 161 |  | Prenatal education and stretching exercises, pelvic floor muscle training, and aerobic exercises | Every day for at least 30 minutes | 12 | Exercise class plus home excises |  | Prenatal education and usual activity |  | LBP, PGP, LPP, intensity of LBP, PGP and LPP | 36-38 |
| Eggen | 2012 | Norway | Pregnant women | 16-20 | 4 | Intervention 48%, control 46% | 128 | 129 | 257 |  | Aerobic, strengthening, stretching, and relaxation | An hour once a week | 16-20 | Exercise class plus home excises |  | Usual activity |  | LBP, PGP, intensity of LPP | 24-36 |
| Ladefoged | 2012 | Denmark | Sedentary pregnant women | 12-18 | 5 | With or without, % not reported |  |  | 154 |  | Low impact gymnastics, strength exercises | An hour once a week | 20 | Exercise class |  | Usual activity |  | LBP | 38 |
| Stafne | 2012 | Norway | Pregnant women | 18-22 | 3 | Intervention 57%, control 61% | 365 | 397 | 762 |  | Aerobic, strengthening and balance exercises | An hour once a week | 12 | Exercise class plus home excises |  | Usual activity |  | LPP, intensity of LPP, sick leave due to LPP | 32-36 |
| Foxcroft | 2011 | Australia | Obese pregnant women | 12-14 | 6 | 6% had LBP | 20 | 22 | 42 |  | A single group education session, and individualized exercise program with an energy expenditure goal of 900 kcal/week | An energy expenditure goal of 900 kcal/week | 24 | Various sports and exercise activities |  | A single group education session, and usual activity |  | LBP, PGP, LPP | 20-36 |
| Mørkved | 2007 | Norway | Pregnant women | 18-20 | 7 | Intervention 43%, control 43% | 153 | 148 | 301 |  | Aerobic, strengthening, light stretching and relaxation | An hour once a week | 12 | Exercise class plus home excises |  | Usual activity |  | LPP, sick leave due to LPP | 36 |
| Garshasbi | 2005, 2010 | Iran | Pregnant women | 17-22 | 3 | With or without, % not reported | 105 | 107 | 212 |  | Abdominal, hamstrings and spinal muscles strengthening | An hour 3 times a week | 12 | Exercise class |  | Usual activity |  | LBP, intensity of LBP | 17-34 |
| Suputtitada | 2002 | Thailand | Healthy sedentary pregnant women | 26-30 | 2 | Intervention 97%, control 97% | 35 | 32 | 67 |  | Sitting pelvic tilt exercise | Twice a day for 5 days a week | 8 | Exercise class plus home excises |  | Usual activity |  | LPP, intensity of LPP | 34-38 |
| Kihlstrand | 1999 | Sweden | Pregnant women | 17-19 | 5 | Intervention 49%, control 48% | 120 | 124 | 244 |  | Water gymnastics | An hour once a week | 17-20 | At a swimming pool |  | Usual activity |  | LBP, sick leave due to LBP | 18-38 |

\*LBP, low back pain; LPP, lumbopelvic pain; PGP, pelvic girdle pain

