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Systematic review

Risk factors for pelvic girdle pain postpartum and pregnancy related low back pain postpartum; a systematic review and meta-analysis

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ABSTRACT

Background: Although pelvic girdle pain postpartum and pregnancy related low back pain postpartum (combined and named PGPP in this study) have a natural favourable course, there is a subgroup of women who have persistent complaints.
The objective of this study was to identify personal-, (pre)pregnancy-, obstetric-, and child related risk factors on PGPP by means of a systematic literature review and meta-analysis.
Methods: Literature searches of PubMed, EMBASE, CINAHL and Cochrane up to October 2018 were conducted. Prospective cohort studies in English or Dutch describing three or more risk factors for PGPP were included. We assessed articles for inclusion and risk of bias. Studies with high risk of bias were excluded from data extraction. Data was extracted and checked for accuracy confirming to the CHARMS-checklist. Homogeneous variables were pooled.
Results: Twelve full text studies were assessed. Seven studies were excluded due to high risk of bias. Data was extracted from five studies. Multivariate analysis was not possible due to heterogeneity in included risk factors as well as outcome measures on risk factor per study. Pooled univariate significant risk factors on PGPP were: a history of low back pain, pre-pregnancy body mass index >25, pelvic girdle pain in pregnancy, depression in pregnancy, and a heavy workload in pregnancy. No significant obstetric and child related risk factors were reported.
Conclusions: Risk factors on PGPP have been identified. Since multivariate analysis was not possible the outcome should be treated with care, because interaction between risk factors could not be analysed.

1. Introduction

Pelvic girdle pain (PGP) is one of the most common musculoskeletal disorders in women during pregnancy which affects almost half of the pregnant women (Wu et al., 2004; Robinson et al., 2006). The majority of women recover spontaneously within three months after delivery (Wu et al., 2004; Gutke et al., 2018; Robinson et al., 2006). However, a substantial number of women (30%) still report PGP after this period (Van Beukering, 2002). It is hard to find consensus in literature when describing PGP. Wu et al., 2004 describe PGP and pregnancy related low back pain (PLBP) combining the two and naming them lumbopelvic pain (Wu et al., 2004). Other studies define PGP as being pain in locations like lower back, buttocks, groin, pubic symphysis, unilateral or bilateral sacroiliac joint (Robinson et al., 2006; Stomp-van den Berg et al., 2012; Brynhildsen et al., 1998). Also when describing pelvic girdle pain postpartum different definitions are used. Some studies include low back pain, others not (Elden et al., 2016; Bergstrom et al., 2017; Brynhildsen et al., 1998; Sjohdahl et al., 2013). Because of this lack of consensus, we decided to describe PGP and PLBP as PGP in this study. In this study we will describe PGP postpartum and PLBP postpartum as PGPP. PGPP is a

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Table 1
Searchstring.

Concept I Prognostic factors	"Prognosis"[Mesh:NoExp] OR"Prognostic factor*"[tiab] OR"Prognostic model*"[tiab] OR Prognostic*[tiab] OR Riskfactor*[tiab] OR "Risk factor"[tiab] OR "Risk assess*"[tiab] OR Predictor*[tiab] OR "Predictive factor*"[tiab] OR "Prediction model"[tiab] OR "Etiological factor*"[tiab] OR Etiol* [truncated] OR "Parity effect*"[tiab]
Concept II Pregnancy	"Pregnancy"[Mesh:NoExp] OR"Pregnant"[Mesh:NoExp] OR Gestational[tiab] OR Gestation* [tiab] OR Perinatal[tiab] OR Natal[tiab] OR Parous [tiab] OR "Maternal age"[tiab] OR (Age AND pregnant*) [tiab] OR Twin pregnan* [tiab] OR (Obesity AND pregnan*) [tiab] OR (Diabetes AND pregnant*) [tiab] OR (overweight AND obesity)
Concept III Delivery	"delivery, obstetric"[Mesh:NoExp] OR "obstetric labor complications OR "obstetric labor complications[MESH:NoExp] OR "vacuum, extraction, obstetrical"[MESH:NoExp] OR "obstetrical forceps"[MESH:NoExp] OR "extraction obstetrical"[MESH:NoExp] OR "pelvic floor rupture"[tiab] OR Episiotomy[tiab] OR "Child birth"[tiab] OR "Birth weight"[tiab] OR "perineal laceration*"[tiab] OR "perineal trauma"[tiab] OR "vacuum extraction"[tiab] OR "vaginal delivery"[tiab] OR "vaginal birth"[tiab] OR laceration*[tiab] OR (stages AND delivery)[tiab] OR (stages AND obstetric) [tiab] OR (rupture AND delivery)[tiab] OR (Rupture AND obstetric)[tiab]
Concept IV Pelvic girdle pain	pelvic girdle pain*[tiab] OR pelvic girdle relaxation*[tiab] OR ("Pregnancy"[Mesh] AND low back pain*[tiab]) OR (Pregnancy*[tiab] AND low back pain*[tiab]) OR ("Pregnancy"[Mesh] AND pelvic pain*[tiab]) OR (Pregnancy*[tiab] AND pelvic pain*[tiab]) OR ("Pregnancy"[Mesh] AND lumbopelvic pain*[tiab]) OR (Pregnanc*[tiab] AND lumbopelvic pain*[tiab]) OR pelvic instability*[tiab] OR pelvic insufficienc*[tiab] OR Pelvic relaxation*[tiab] OR posterior pelvic pain*[tiab] OR peripartum pelvic pain*[tiab] OR postpartum pelvic pain*[tiab] OR symphysis pain*[tiab] OR pubic symphysis pain* [tiab] OR Symphysiolysis[tiab] OR sacral pain*[tiab]))

serious problem. It affects quality of life (QOL) in women as it often negatively influences their daily activities involving standing, sitting, lifting weight and walking (Wuytack et al., 2015; Elden et al., 2016; Van Beukering, 2002; Houtman et al., 2007).

PGPP also may withhold women from re-entering their work, the societal costs may be considerable (Van Beukering, 2002; Guideline Company doctors, 2018). Sick leave due to PGPP is quite common (Van Beukering, 2002; Guideline Company doctors, 2018). In the Netherlands, in one out of fifty working women who are on sick leave the cause is pregnancy-related, and in over 25% of young women receiving a disability pension, this situation was preceded by pregnancy and delivery (Van Beukering, 2002; Guideline Company doctors, 2018; https://www.ocwincijfers., 2017). The new guideline for company doctors, published in 2018, makes early screening of work-related risk factors one of their spearheads (Guideline Company doctors, 2018). Evidence based care by care providers, like giving women ergonomic advice, information and evaluation of work conditions as well as daily activities might increase their QOL and capability to handle their job, thus providing care providers with an important role (Houtman et al., 2007; Guideline Company doctors, 2018).

To prevent loss in QOL in women with PGPP and to reduce medical and societal costs identification of women who are at risk of developing PGPP is worthwhile.

In literature several risk factors are described, but until now risk factors on characteristics of the women (e.g. BMI and age), pre-pregnancy symptoms (e.g. LBP), pregnancy symptoms (e.g. PGP), delivery related factors (e.g. episiotomy) as well as child-related factors (e.g. head circumference) have never been pooled in a meta-analysis (Wu et al., 2004; Wuytack et al., 2015; Elden et al., 2016; Stomp-van den Berg et al., 2012). This makes it difficult for care providers to identify the women at risk. A recent systematic review was conducted by Wuytack et al., 2018). The population were women who had PGP during pregnancy and they excluded studies that examined a new onset of PGPP (Wuytack et al., 2018).

The aim of our study is to systematically review the literature on risk factors leading to PGPP, including all women who develop PGPP and to perform a meta-analysis. The identified risk factors can then be used by care providers and clinicians to identify the women at risk for PGPP.

2. Materials and methods

2.1. Protocol

This systematic review followed the guidelines as described by the PRISMA statement (Moher et al., 2009) and is registered under number Prospero: CRD42019131758.

2.2. Eligibility criteria

Eligible for inclusion were prospective cohort studies on personal-, pre-pregnancy-, pregnancy-, obstetric- and child-related risk factors on the outcome measurement PGPP. Systematic Reviews, RCT's and case studies were excluded as well as prospective cohort studies only describing one or two risk factors. Other exclusion criteria were LBP or PGP related to neurological disorders and systemic diseases.

2.3. Search

Between December 2016 and October 2018, MEDLINE, CINAHL, Ebsco/Embase and Cochrane were searched for relevant studies. The search strategy was defined by authors MN and AP who explored and combined all relevant terms following the PIO (Population, Intervention and Outcome) strategy: P = women, I = pregnancy and delivery O = risk factors on PGPP (See search string Table 1).

2.4. Study selection

Selection of studies was based on the eligibility criteria. The population were women with PGPP. The presence of PGPP is defined through questionnaires, pain drawings and/or clinical and diagnostic tests. Several steps were followed: first a screening of studies was performed based on title by authors MW, MH, MWP, MS and AP. Second all abstracts were screened based on criteria for eligibility. The kappa scores for agreement for inclusion between authors ranged from 0.69 to 0.88.

After this selection, MW and MH performed a third screening on full texts. In case no consensus was reached, a third reviewer, AP decided.

2.5. Data collection and data extraction

From all included studies, data was extracted by MW, MH and AP, using the checklist for critical appraisal and data extraction for systematic reviews of prediction modelling studies (CHARMS) data-extraction form (Moons et al., 2014). Data was extracted regarding design and methodology (i.e. cohort, inclusion, and blinding, timing, follow up) population (i.e. recruitment, inclusion exclusion criteria) and risk factors (i.e. dependent and independent variables).

2.6. Risk of bias

All included studies were checked by MW, MH and AO for possible methodological flaws and incorrect reporting using the Quality in Prognostic Studies tool (QUIPS) (Hayden et al., 2013). In case no consensus was reached, a fourth reviewer, AP decided. With the QUIPS, a score was given to each risk of bias factor on a 3-point ordinal scale (ranging from low, moderate to high risk) on study population, attrition,

prognostic factor measurement, outcome measurement, study confounding and statistical analysis and reporting. If the risk of bias was scored high on one of these items, the overall score of the study was defined as high risk of bias. Only studies reporting moderate or low risk of bias were eligible for statistical pooling.

2.7. Summary measures

Primary outcomes were reported frequencies on risk factors for PGPP, outcome of univariate analysis (odds ratios (ORs)) and multivariate analysis.

2.8. Synthesis of results

Statistical pooling (based on reported frequencies and ORs) was considered in case inclusion criteria of study population and selection of measurement instruments were comparable as well as methodological heterogeneity was found to be low. A p-value of 0.05 was assumed to be statistically significant. Calculations and additional analyses were performed using SPSS 24 (IBM Corp, Armonk, NY) and RevMan5 (Cochrane collaboration). RevMan5 was used for the univariate pooling of reported prevalence rates. ORs were calculated using Generic Invariance Function and plotted in forest plots. In case of reported ORs and 95% confidence intervals, the log of the OR as well as the log of the Upper Confidence Boundary (UCB) and Lower Confidence Boundary (LCB) were calculated. Using the following formula, the standard error was calculated: (UCB - LCB)/(2 * 1.96). In case of homogeneity of study population, risk factors, outcome measures, and follow up term multivariate analysis would be carried out.

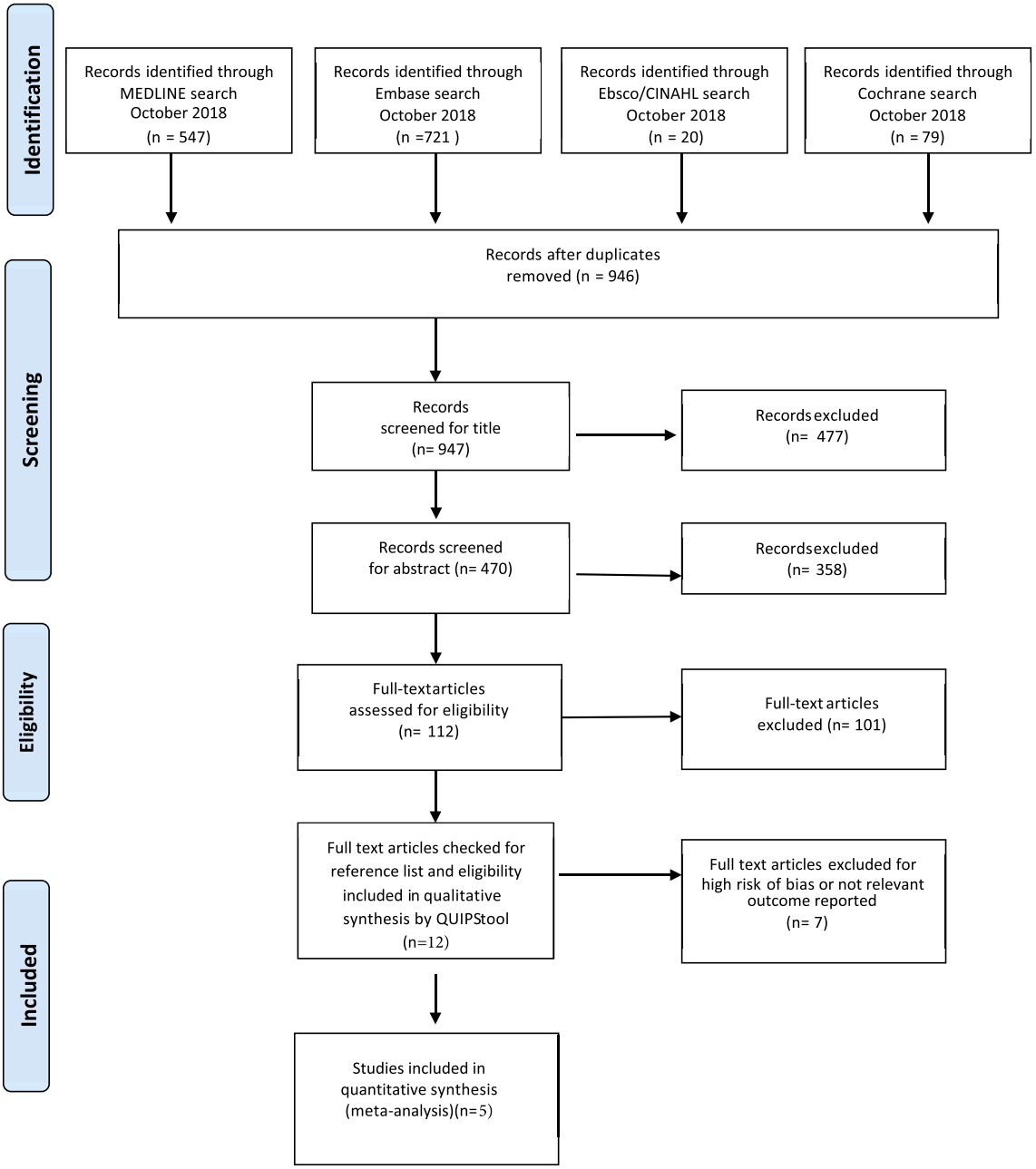

Fig. 1. PRISMA flowchart of the inclusion of studies.

3. Results

3.1. Search results

The search identified 946 studies, after duplicates were removed. After the full text screening, twelve studies were included. A flowchart of inclusion of studies is provided in Fig. 1.

3.2. Risk of bias

In total seven studies scored high on risk of bias using the QUIPS scores. Most reported reasons for a high risk of bias were related to study confounding, especially no appropriate accounting for important confounders in the analysis. The most important cofounders that were not described and analysed clearly were treatment and intervention. In some studies, valid and reliable measurement of outcome was lacking or prognostic factors were not clearly defined. Study participation and study attrition were mostly well described, although loss in follow up was poorly reported. One study scored a low risk of bias (Mogren, 2006). Four studies scored a moderate risk of bias (Stomp-van den Berg et al., 2012; Gausel et al., 2016; Robinson et al., 2010; Bjelland et al., 2013a). Studies with low and moderate risk of bias were eligible for data extraction (See Table 2) (see Table 3).

3.3. Data extraction and analysis

In total five studies were included for data extraction using the CHARMS data extraction form. Prevalence of PGPP was measured at different time points in our studies and ranged from twelve weeks postpartum till six months postpartum. In four studies the target population was primipara and multipara selected for inclusion at antenatal clinics either or not located in hospitals (Mogren, 2006; Gausel et al., 2016; Robinson et al., 2010; Bjelland et al., 2013a). In one study the target population was pregnant female employees from fifteen Dutch companies (Stomp-van den Berg et al., 2012). In two studies the study population was drawn from a previous study in women with LBP or PGP during pregnancy. These women were invited to participate in the study 3–6 months postpartum (Mogren, 2006; Gausel et al., 2016). Three studies examined women during pregnancy and twelve weeks to six months postpartum (Stomp-van den Berg et al., 2012; Robinson et al., 2010; Bjelland et al., 2013a). To define the outcome PGPP four studies described pain with the use of a visual analogue scale (VAS) or numeric pain rating scale (NPRS) and used a pain drawing or questions about the pain location (in lower back, groin, buttocks, pubic symphysis, sacroiliac joints) (Stomp-van den Berg et al., 2012; Mogren, 2006; Gausel et al., 2016; Robinson et al., 2010).One study defined PGP only through the question "do you have pain in the pelvic girdle; if you have pain where is the pain located"? PGP was defined as combined pain in the anterior pelvis and on both sides in the posterior pelvis. PGPP was defined when pain was present in these three locations (Bjelland et al., 2013a). Clinical examination was conducted in two studies either postpartum or in pregnancy (Stomp-van den Berg et al., 2012; Robinson et al., 2010). Three studies also examined the outcome disability, all using different questionnaires; Roland-Morris Disability-24 questionnaire (RDQ), Oswestry Disability Index (ODI) and Disability Rating Index (DRI) (Stomp-van den Berg et al., 2012; Gausel et al., 2016; Robinson et al., 2010). Only two studies included obstetric-, and child related risk factors in their search (Stomp-van den Berg et al., 2012; Mogren, 2006).

3.4. Risk factors

Thirty potential risk factors were found across the five included studies. Multivariate analysis was not possible due to heterogeneity in included risk factors as well as outcome measures on risk factor per study. Only significant ORs from univariate data pooling will be reported in forest plots (Figs. 2.1–2.5).

Univariate pooling resulted in the identification of six risk factors on PGPP, of which five reached significance (Table 4).). Data analysis demonstrated a low heterogeneity in all pooled studies except for the factor PGP during pregnancy. The heterogeneity of this factor was I^2 =85%, due to the fact that the study population in the study of Bjelland et al. (2013) was very large (n = 41,421) compared to the study population in the other studies, namely Gausel et al., 2016 (n = 309) and Robinson et al., 2010 (n = 179). Post analysis of this risk factor without the contribution of Bjelland et al. (2013) still resulted in a positive OR of 2,28 95% CI[1,59–3,28].

3.4.1. Significant personal and pre-pregnancy risk factors

Two univariate pooled risk factors could be identified for PGPP: a history of LBP and a BMI >25 (Figs. 2.1–2.2).

A history of LBP was described in three studies (Stomp-van den Berg et al., 2012; Gausel et al., 2016; Robinson et al., 2010). In two of the studies multivariate analysis also defined a history of LBP to be a significant risk factor on PGPP (Stomp-van den Berg et al., 2012; Gausel et al., 2016). A BMI>25 prior to pregnancy was described in two studies. In both studies, after multivariate analysis a pre-pregnancy BMI>25 was associated with PGPP though not significantly (Gausel et al., 2016; Robinson et al., 2010).

Table 2
Risk of bias of the full text studies n = 12.

Prospective study	Study participation	Study attrition	Prognostic factor measurement	Outcome measurement	Study confounding	Statistical analysis and reporting	Overall score
Albert 2001	moderate	moderate[b]	high[c]	high	high	moderate	HIGH
Brynhildsen et al., 1998	low[a]	moderate	moderate	moderate	high	low	HIGH
Gausel et al., 2016	low	moderate	moderate	low	low	low	MODERATE
Mogren, 2006	low	low	low	low	moderate	low	LOW
Robinson et al., 2010	low	moderate	moderate	low	low	low	MODERATE
Rost 2006	moderate	moderate	low	high	high	moderate	HIGH
Sjodahl 2013	moderate	moderate	high	low	high	low	HIGH
Stomp 2012	low	moderate	low	moderate	moderate	low	MODERATE
Van de Pol 2007	low	high	moderate	moderate	high	high	HIGH
Bjelland 2013[24]	moderate	low	moderate	moderate	moderate	low	MODERATE
Bjelland 2013[28]	moderate	moderate	high	moderate	moderate	moderate	HIGH
Elden et al., 2016	high	high	moderate	low	moderate	low	HIGH

[a] = low risk of bias (included).
[b] = moderate risk of bias (included).
[c] = high risk of bias.

Table 3
Characteristics of the included studies.

Study	n	Participants	Exclusion	T0	T1-T3	Outcome	n = PGPP post-partum	n = no PGPP post-partum	OR(95% CI) p < 0,05
Gausel et al., 2016	309	Primi and multipari with PGP during pregnancy	No PGP during pregnancy, declining examination postpartum and only LBP postpartum	1 day after delivery	3–6 months after delivery	Persistent PGPP	36	273	PGP and LBP in P 2.8 [1.2–6.4] Maternal age≥30 2.9 [1.3–6.8] ODI>20 3.3[1.1–9.7] ODI>40 5.1[1.7–15]
Mogren et al., 2006	464	Primi and multipari with PGP during pregnancy	No PGP during pregnancy, time to response on Q2>9 months	At delivery	6–9 months after delivery	Persistent PGPP	200	264	reported hypermobility 1.56[1.01–2.4] Adjusted for BMI, parity and maternal age: VAS>6–8 in P 3.79 [1.43–10], VAS>8–10 in P 6.71[2.3–19.54]
Robinson et al., 2010	283	Primi and multipari with PGP during pregnancy	No PGP during pregnancy	P 28 weeks	P 30 weeks 12 weeks after delivery	Persistent PGPP and disability>10 on DRI	179	104	pre-P BMI≥25 2.1 [1.0–4.05] pain provocation tests in P > 6 3.5[1.2–10.3] pain sites 3–4 in P 4.4 [1.3–14.6] ASLR>1 in P on DRI 7.61 [3.21–18.04]
Stomp-van den Berg et al., 2012	548	Pregnant employees working at least 12 h a week	Not returning to work after maternity leave, miscarriage before 27 weeks receiving or submitting for disability benefit	P Between 6 and 40 weeks	P30 weeks, 6 weeks after delivery, 12 weeks after delivery	Persistent PGPP at 12 weeks PP	234	314	Overall prediction model predictors during P: History LBP 2.39[1.54–3.72] work in uncomfortable positions 1.35[1.11–1.64] higher somatisation on 4DSQ 1.12 [1.07–1.18] hours of sleep≥ 9 1.71[1.14–2.56] more disability on RDQ 1.19 [1.05–1.35] higher mean pain 1.16[1.04–1.31] Predictors PP: having PGPP at 6 weeks 2.56[1.42–4.61] higher birth weight 1.001 [1.0–1.0] decreasing the risk of PGPP: number of days with complete bed rest 1–2 days 0.51[0.26–0.99] 3–4 days 0.25[0.13–0.52]
Bjelland et al., 2013	41.421	Primi and multipari with PGP during pregnancy	No PGP during pregnancy and no response to SCL-5	P 17 weeks	P 30 weeks, 6 months after delivery	Persistent PGPP on 3 locations, severe persistent PGPP on 3 locations functional disability (use of crutches y/n)	1448	39.973	Predictors for PGPP: emotional distress during P at one time points on SCL-5≥2.0 1.3[1.1–1.5] and on 2 time points 1.5[1.2–1.9] Pain in 3 locations during P 4.2[3.7–4.8] and severe pain in 3 locations 16.3 [14–18.9] history of LBP 1.5[1.4–1.7] BMI≥30 1.8 [1.5–2] co morbidity of 1 disease 1.3[1.1–1.6] 2–3 diseases 1.8[1.5–2.1] ≥4 diseases 2.4[1.9–3] age at menarche ≤10 1.3[1–1.8] and 111.2[1–1.4] occasional smoker 1.3 [1–1.6] Predictors for severe PGPP emotional distress during P at one time points on SCL-5≥2.0 2.0 [1.4–2.9] and on 2 time points 1.9[1.1–3.1] Pain in 3 locations during P 3.5 [2.4–5.1] and severe pain in 3 locations 24.0[16.8–34.3] co morbidity of 2–3 diseases 1.6[1.1–2.5] ≥4 diseases 2.3[1.3–3.9]] BMI≥30 1.6 [1.1–2.4] age at menarche ≤10 3.1[1.8–5.3] and 11

(*continued on next page*)

Table 3 (*continued*)

Study	n	Participants	Exclusion	T0	T1-T3	Outcome	n = PGPP post-partum	n = no PGPP post-partum	OR(95% CI) p < 0,05
									1.7[1.2–2.6] and 12 1.4 [1.0–2.0] history of LBP 1.4 [1.0–1.9]

n = number of, T0 = first measurement, T1-T3 = follow up measurements, OR= Odds Ratio, PGP = pelvic girdle pain, PGPP = pelvic girdle pain postpartum, LBP = low back pain, BMI = body mass index, ODI=Oswestry disability index, VAS=Visual Analog Scale, P = pregnancy, PP = postpartum, DRI = Disability Rate Index RDQ = Roland-Morris Disability Questionnaire, 4DSQ = Four Dimensional Symptom Questionnaire, SCL-5 = Hopkins Symptom Checklist 25.

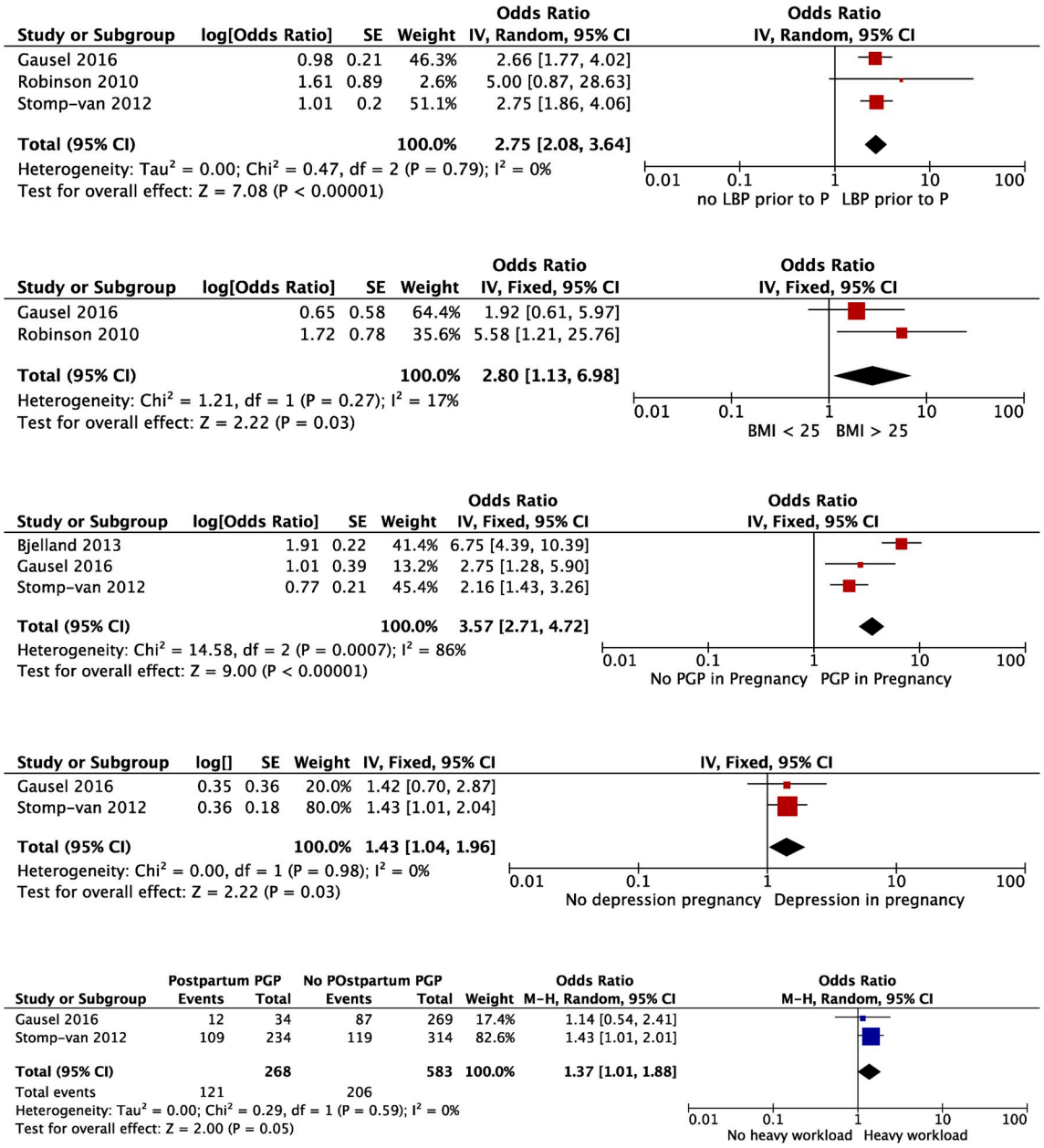

Fig. 2. Riskfactors on persistent Pelvic Girdle Pain Post partum displayed in a forest plot
2.1 History of low back pain
2.2 Body mass index more than 25 pre-pregnancy
2.3 Pelvic girdle pain in pregnancy
2.4 Depression in pregnancy
2.5 Heavy workload in pregnancy.

Table 4
Risk factors for PGPP from pooled univariate analysis.

Risk factor		Studies	Number of participants	OR	95% CI
Pelvic Girdle Pain in pregnancy	Gausel et al., 2016 Robinson et al., 2010 Bjelland et al., 2013	41,909	3.57*	2.71–4.72	
Pre-pregnancy Body Mass Index >25	Gausel et al., 2016 Robinson et al., 2010	486	2.80*	1.13–6.98	
History of Low Back Pain	Gausel et al., 2016 Robinson et al., 2010 Stomp et al., 2012	1033	2.75*	2.08–3.64	
Depression in pregnancy	Gausel et al., 2016 Stomp et al., 2012	857	1.43*	1.04–1.96	
Heavy workload in pregnancy	Gausel et al., 2016 Stomp et al., 2012	851	1.37*	1.01–1.88	
High educational level	Mogren et al., 2006 Stomp et al., 2012	1002	0.42	0.06–2.97	

* = $p < 0.05$.

3.4.2. Significant pregnancy related risk factors

Three pregnancy related risk factors could be identified by means of univariate pooling: PGP in pregnancy and depression in pregnancy as well as a heavy workload during pregnancy (Figs. 2.3–2.5).

After multivariate analysis one study found PGP in pregnancy to be a significant risk factor, and another described a heavy workload as to be significant (Stomp-van den Berg et al., 2012; Gausel et al., 2016). In the study of Bjelland et al., 2013 we were able to distract data on the risk factor PGP during pregnancy. Unfortunately, there was only data presented on women who experienced PGP but recovered postpartum concerning the risk factor PGP. Therefore, we were not able to extract data on other risk factors described (Bjelland et al., 2013a). The last risk factor we were able to pool in our search was the level of education (Stomp-van den Berg et al., 2012; Mogren, 2006). In none of the included studies the level of education was a significant risk factor, nor when pooling.

3.4.3. Risk factors on obstetric factors and child-related factors

These risk factors were examined in two studies. Mode of delivery (e.g. vaginal, vacuum, forceps, elective or emergency CS, extra stimulation in delivery, extra pressure in delivery) was included (Stomp-van den Berg et al., 2012; Mogren, 2006), as was duration of delivery>18 h (Stomp-van den Berg et al., 2012). No obstetric risk factors could be pooled, and none of the obstetric risk factors reached significance in multivariate analysis in solitary studies. The only child-related factor examined was birth weight (Stomp-van den Berg et al., 2012; Mogren, 2006). In one study the odd for PGP was 1001 higher for each gram increase in birth weight (Stomp-van den Berg et al., 2012). In neither of the studies birth weight was of influence on PGPP.

Twenty-four risk factors are described in only one of the included studies (Table 5). After multivariate analysis Stomp et al., 2012 built two overall prediction models, one pregnancy related and one pregnancy and postpartum related model. Next to the pooled significant risk factors described, somatisation in pregnancy and more than 9 h of sleep or rest in pregnancy were predictors for PGPP twelve weeks postpartum. At six weeks postpartum PGPP, somatisation and a higher pain-score were seen to be significant (Stomp-van den Berg et al., 2012). In the multivariable model of Robinson et al., 2010) the number of positive pain sites and pain provocation tests in pregnancy were significantly associated with PGPP twelve weeks postpartum. After multiple logistic

Table 5
Risk factors on PGPP reported in one included study.

Risk factor	Study	Number of participants	OR	95% CI
PGPP >6 weeks Y/N	Stomp et al., 2012	548	7.77*	5.25–11.20
Higher score on pain scale 0–10 6 weeks postpartum >2,1 (±2,7)	Stomp et al., 2012	548	1.36*	1.26–1.47
Number of positive pain provocation tests > 6 in pregnancy	Robinson et al., 2010	179	11.94*	1.04–11.96
Active Straight Leg Raise-score > 1 in pregnancy	Robinson et al., 2010	179	7.61*	3.21–18.04
Pain on Numeric Rating Scale > 6 in pregnancy	Robinson et al., 2010	179	1.19*	1.10–1.28
Roland Disability Questionnaire-score 6,2 (±5,9) in pregnancy	Stomp et al., 2012	548	1.09*	1.05–1.14
Roland Disability Questionnaire-score 1,5 (±3,4) postpartum	Stomp et al., 2012	548	1.62*	1.44–1.82
High score on Oswestry Disability Index > 20 postpartum	Gausel et al., 2016	307	2.25*	1.11–4.59
Short Form36 Limitation in Physical function ≥ 50 in pregnancy	Stomp et al., 2012	548	0.57*	0.40–0.81
Sleep > 9 h in pregnancy	Stomp et al., 2012	548	1.84	1.29–2.62
Maternal age >30	Gausel et al., 2016	287	2.93*	1.32–6.54
Somatisation on Four Dimensional Symptom Questionnaire >4,7 (±3,9) postpartum	Stomp et al., 2012	548	1.22*	1.15–1.30
Somatisation on Four Dimensional Symptom Questionnaire >7,2 (±4,7) in pregnancy	Stomp et al., 2012	548	1.15*	1.11–1.20
Income < 30.000 Euro	Stomp et al., 2012	548	1.72*	1.11–2.64
Hypermobility diagnosed and/or perceived	Mogren et al., 2006	458	1.55*	1.01–2.38
Job adjustments in pregnancy Y/N	Stomp et al., 2012	548	1.72*	1.21–2.44
Sick leave in pregnancy due to LBP or PGP Y/N	Stomp et al., 2012	548	2.27*	1.39–3.71
Job insecurity on Job Content Questionnaire 3–10 > 4 in pregnancy	Stomp et al., 2012	548	1.65*	1.05–3.59
Physical exertion on Job Content Questionnaire 3–12 > 6,64 (±2,07) in pregnancy	Stomp et al., 2012	548	1.11*	1.02–1.20
Uncomfortable work posture on Job Content Questionnaire 2–8>3,91 (±1,05) in pregnancy	Stomp et al., 2012	548	1.42*	1.19–1.69
3–4 days bedrest after delivery	Stomp et al., 2012	548	0.58*	0.35–0.97
Extra stimulation during delivery Y/N	Stomp et al., 2012	548	1.70*	1.10–2.61
Distress on Four Dimensional Symptom Questionnaire >5,2 (±5,1) postpartum	Stomp et al., 2012	548	1.06*	1.02–1.10
Social support spouse on Social Support List 1–5 >3,9 (±0,7) postpartum	Stomp et al., 2012	548	0.74*	0.57–0.96

LBP = Low Back Pain, PGP= Pelvic Girdle Pain, PGPP= Pelvic Girdle Pain Postpartum.
Nr = Number.
* = $p < 0.05$.

regression Gausel et al., 2016 described age≥30 years and a higher score on the Oswestry Disability Index to be independent risk factors for PGPP.

4. Discussion

Five significant pooled risk factors for PGPP can be demonstrated by univariate analysis in this systematic review: personal and pre-pregnancy characteristics are a history of LBP and a BMI >25; pregnancy related factors are PGP in pregnancy and depression in pregnancy as well as a heavy workload. No pooled factors are present on obstetric factors nor on child-related factors.

The history of LBP may include PGP and PGPP in or after a previous pregnancy (Stomp-van den Berg et al., 2012). A long term follow up study of eleven years found women that experience PGP or LBP before the first pregnancy to be at greater risk of developing long term PGPP (Elden et al., 2016).

Although the risk factor BMI>25 is not always significant in solitary studies, with pooling of data it is (Gausel et al., 2016; Robinson et al., 2010). Study reports (pre-)pregnancy BMI and BMI six months after delivery being highly inter-correlated and significantly increased in women with recurrent and continuous postpartum LBP (Mogren, 2006). In another recent SR obesity (BMI >30 at approximately seventeen weeks gestation) is reported to be a risk factor on persistent PGPP up till six months postpartum (Wuytack et al., 2018). A Danish study on pre-pregnancy BMI with a large cohort of almost 80,000 women and a follow up time of twelve years states that the risk of developing degenerative musculoskeletal conditions increases with 28% in women with a BMI ≥25 and with 26% in women with a BMI ≥30. Although the outcome measurement was not specific for PGPP, these results show a trend in the same direction (Bliddal et al., 2016). We suggest therefore that women with a pre-pregnancy BMI >25 should be monitored with care during pregnancy and postpartum.

PGP is often described a significant risk factor, however there is no consensus in outcome measurements defining PGP since some studies include LBP and some do not (Wu et al., 2004; Stomp-van den Berg et al., 2012; Gausel et al., 2016; Bjelland et al., 2013a). In the study of Bjelland et al. (2013) the question asked to determine PGP and PGPP is not supported by validated questionnaires and thus open for interpretation. We strongly recommend future studies to use similar outcome measurements to make multivariate analysis possible. Therefore, we recommend to develop a core outcome set so that researchers will use the same methods, the same questionnaires and the same clinical tests to define PGP.

Women who experience depression during pregnancy tend to develop PGPP (Stomp-van den Berg et al., 2012; Gausel et al., 2016). However, different definitions are used. One study only describes depression during pregnancy, while another also takes somatisation, distress and fear into account (Stomp-van den Berg et al., 2012; Gausel et al., 2016). In addition to depression, emotional wellbeing is described in several studies (Elden et al., 2016; Bergstrom et al., 2017; Virgara et al., 2018). The presence of emotional distress during pregnancy is associated with PGPP six months postpartum in one study (Bjelland et al., 2013a). Because this study included only women with PGP during pregnancy, nothing could be said about the solitary risk factor of emotional distress. Furthermore, a study among pregnant women examined the three-way relationship between PGP, depression/anxiety and disability finding women with PGP and a concurrent risk of depression/anxiety to experience a significant higher level of disability even though the severity of pain did not differ from women with PGP alone (Virgara et al., 2018). One can hypothesise the impact of pain on the emotional wellbeing of women and vice versa. This in combination with reduced sleep, not being able to perform household tasks, a job or taking care of the baby due to PGPP may have great impact.

Several studies did research on the working environment of pregnant women (Stomp-van den Berg et al., 2012; Gausel et al., 2016). In our analysis a heavy workload is a significant risk factor for PGPP, also described in more detail as working in uncomfortable positions, irregular work and weekend shifts (Stomp-van den Berg et al., 2012). Study also reports that 46,5% of the women with PGP to have an adjusted job at thirty weeks of pregnancy (Stomp-van den Berg et al., 2012). A follow up study of twelve years found the combination of women with previous LBP and moderate or heavy occupations to increase the risk for current LBP, 25% of these women changes occupation because of LBP (Brynhildsen et al., 1998). The guideline for company doctors thoroughly describes work related risk factors and the interventions necessary during pregnancy. Clinicians should take note of the guideline to provide women with proper advice (Guideline Company doctors, 2018).

Although two studies described obstetric factors and child factors, only one described extra stimulated delivery to be a risk factor in univariate analysis (Stomp-van den Berg et al., 2012; Mogren, 2006). Bjelland et al., 2013 describe mode of delivery in women with moderate to severe PGP during pregnancy(28). Since this study only presented data on women with moderate to severe PGP, we did not select this study for analysis. After multivariate analysis an instrumental vaginal delivery (forceps or vacuum) and a planned caesarean section were associated with PGPP in three locations six months postpartum (Wuytack et al., 2018; Bjelland et al., 2013b). These findings are of interest to midwifes and gynaecologists.

5. Strengths and weaknesses

The strengths of this study are the use of only prospective studies and the width of our search including MEDLINE, Embase, Ebsco/CINAHL and Cochrane. A limitation is the heterogeneity in research making it impossible to do a multivariate pooling, which we hoped to accomplish. There is a huge variety in postpartum follow up terms and it was impossible to make a distinction in short term and long term follow up in our pooling, so we decided to merge all the follow up terms, although we know that the overall recovery of pregnancy and childbirth is at least nine months (NVFB, 2018). In almost all studies pain, during pregnancy as well as postpartum, is described. We were often not able to pool the results in our search due to heterogeneity in outcome measurements on pain. Physical examination is conducted in several studies, but different tests are used. The outcome measurements were different in several studies, some included LBP and some did not include LBP as outcome measurement. Again, a call for a core outcome set to define the outcome measurement PGP and PGPP. Only a few studies included obstetric and child related risks factors (Stomp-van den Berg et al., 2012; Mogren, 2006; Bjelland et al., 2013b), therefore we were not able to pool these risk factors.

Another limitation is the methodological quality of the included studies. In the QUIPS score few studies presented an overall low/moderate risk of bias. We could therefore only include five studies.

6. Recommendations to care providers and clinicians

Recommendations for care providers and clinicians aiming to reduce or prevent PGPP are to start monitoring pregnant women at the beginning of their pregnancy, or even when planning to get pregnant, giving them advice concerning a healthy BMI. We recommend to screen the women early on significant risk factors based on the findings of this study. If risk factors are present evidence-based care should start and care takers should be aware of the guideline for company doctors. Communication is the key within this care. A history of LBP or PGPP after a previous pregnancy may not be modifiable but early information about risks, self-management, adaptations at home and at work are proved to be effective care(Houtman et al., 2007; Guideline Pregnancy Relat, 2017). A recent SR and meta-analysis states that physical activity and exercise performed in various formats during pregnancy decreases the severity of LBP, PGP and PGPP but does not reduce the odds of developing PGPP (Davenport et al., 2019).

7. Recommendations for research

To achieve more insight in the risk factors of developing PGPP it is essential to perform studies with high methodological quality. Taking the QUIPS into account while setting up the methodology of the study might prevent low scores resulting in high risk of bias. It is of great importance for future studies to provide homogeneity in follow up terms, outcome measurements, questionnaires, tests used in physical examination and analysed risk factors. This will allow for pooling of data in meta-analysis. The development of a core outcome set could be very helpful.

In our search a limited number of studies included obstetric factors and child factors. We would recommend more research in those areas. Postpartum factors like days of rest after delivery, hours of rest/sleep a day are interesting new findings in one study in our search. We would like to recommend more research in this area.

8. Conclusion

Based on the SR and meta-analysis the following univariate pooled risk factors are significant for developing PGPP: a pre-pregnancy BMI>25, a history of LBP before pregnancy, PGP in pregnancy, depression in pregnancy and a heavy workload in pregnancy. No significant obstetric and child related risk factors are found in our search. Because multivariate analysis was not possible, the outcome of this study should be treated with care. Taking the risk factors into account preventative measures during pregnancy, or even before pregnancy, may have a positive effect on reducing or preventing PGPP.

Ethical approval

Not applicable.

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Declaration of competing interest

Non declared.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.msksp.2020.102154.

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