



Review

A historical perspective on pregnancy-related low back and/or pelvic girdle pain

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Abstract

The growing interest in pregnancy-related low back and/or pelvic girdle pain has invoked research projects to this subject. Although it seems a modern syndrome, historical articles show that pregnancy-related pelvic girdle pain (PPGP) was already known centuries ago. The purpose of the present article is to provide a summary review of performed studies on pregnancy-related pelvic girdle pain. Remarkably, these studies show large differences in results with regard to, for example, incidence rates and relevant etiologic factors of pregnancy-related pelvic girdle pain. These differences can be explained by the use of different definitions and descriptions of pregnancy-related pelvic girdle pain between studies. In conclusion, it is necessary to search for an evidence-based overall definition of pregnancy-related pelvic girdle pain in order to provide more knowledge about incidence rates, etiologic factors and other related subjects.

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Keywords: Review; Historical perspective; Pregnancy-related pelvic girdle pain; Risk factors

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1. Introduction

During the last years, interest in the development of pregnancy-related pelvic girdle pain (PPGP) and/or low back pain has been growing steadily. Especially in

Scandinavian countries, an increasing number of women have been diagnosed with pregnancy-related pelvic girdle pain. In studies conducted in these countries, incidence rates of PPGP vary greatly; Danish research reports incidence rates of 7.6–18.5 per 1000 pregnant women [1], while in Norway incidences of 15–160 per 1000 pregnant women are reported [2]. What causes this 10-fold difference remains unclear. It cannot be explained by differences between

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countries because the incidences of pregnancy-related pelvic girdle pain also vary within a country (in Norway, for example). Possible explanations could be differences in classification, diagnostic procedures or terminology.

Besides in the Scandinavian countries, pregnancy-related low back pain or pelvic girdle pain has only been studied in the US [3], the Netherlands [4], Israel [5], South Africa [6], Australia [7] and Nigeria [8]. An explanation for the lack of studies in other countries is that pregnancy-related pelvic girdle pain will probably not be recognized as a syndrome but as a normal side effect of pregnancy.

PPGP may be defined as pain in the pelvic region (with or without irradiation) that starts during pregnancy or within the first three weeks after delivery and for which no clear mechanisms are available to explain the symptoms [4]. Nevertheless, in the literature, terminologies like low back pain, pelvic girdle relaxation, sacro-iliac joint dysfunction, pelvic insufficiency, sacro-iliac joint pain and peri-partum pelvic girdle pain are used in abundance to describe the apparent same symptoms in pregnant women [9].

Sydsjö et al. reported that the number of Swedish women on sick leave because of back pain during pregnancy tripled between 1978 and 1986 [10]. He concluded that the state of back pain during pregnancy had been transformed from a situation of natural discomfort into a defined pathophysiological condition [10].

The growing interest in pelvic girdle pain during and after pregnancy has invoked research projects and media attention to this subject. As a result, women with (previously) poorly understood pelvic girdle pain during pregnancy felt recognition for their situation and women began to search for help if the symptoms occurred and/or persisted.

Although pregnancy-related pelvic girdle pain seems to be a modern problem (a belief strengthened in popular opinion, where one frequently hears the comment “in the old days pelvic girdle pain didn’t exist”), in this paper, the historical perspective on PPGP will be given. We used Medline (1966–2004), Web of Science (1988–2004) and Nederlandse Centrale Catalogus to find relevant English and Dutch literature. In case a relevant article was not written in English or Dutch, a translation (if possible) was made. A large number of search terms were used, including the numerous terminologies of PPGP. The reference lists of all identified articles were examined to find additional relevant articles. The articles, which have been found, range from 1861 to 2004. We tried to cover all current knowledge about PPGP, except treatment of PPGP. Clinical trials about treatment of PPGP were not included in this review.

This paper starts with a brief description of the knowledge of pregnancy-related pelvic girdle pain before the 20th century. Secondly, research during the 20th and 21st century, which was usually done to gain more knowledge about the biomechanical changes during pregnancy, is described. Third, the difficulties, considerations and motivations of researchers during the recent years are described, followed by a conclusion.

2. The history of pelvic girdle pain

Historical evidence shows that pelvic girdle pain in pregnancy was already known and recognized many centuries ago. Symphysis pubis dysfunction (SPD) was mentioned by Hippocrates (c. 400 B.C.) in his theory of “disjunctio pelvica” [11,12]. According to Hippocrates, the widening of the symphysis pubis only occurred during the first parturition, and then remained permanent and sufficient for later childbirths [12]. This theory led to contributions by numerous authors including Vesalius, Severin Pineau, Ambroise Paré, Albinus of Leyden, William Hunter, Velpeau, Jacquemier, Baudelocque, Lenoir, Luschka and many others. Their views differed markedly: some believed that pelvic joint relaxation was a normal and constant phenomenon, while others considered it exceptional and pathological [11,13].

In the 17th century, the processes that led to the weakening of the symphysis and the sacro-iliac joints during pregnancy were of great interest. At that time, they were thought to be an important and necessary prerequisite in widening the birth canal [14].

The mechanism by which relaxation of the joints is brought about was a point of discussion [11]. Some researchers wrote that the joints became swollen to the extent of a third or even one-half greater than their normal volume [11,15]. Luschka (1854) briefly discussed the differences in the structure of the symphysis pubis in pregnant women and non-pregnant women. He tried to explain the increased “pathological” width and mobility of the symphysis in pregnant women. Luschka believed that the symphysis pubis was an incomplete joint with opposed faces, covered with cartilage and provided with synovial membranes. In pregnancy, this half joint became distended by secretion of synovial fluids [11,12,15]. These fluids increased the mobility of the symphysis pubis and the articular cavity increased in size [11,12]. Other researchers thought that the substance inside the symphysis pubis acted like a sponge, which forced the bones apart by absorbing fluids during pregnancy. Others again imagined it as swelling cartilage, wedging the bones apart [15].

Apart from its mechanism, between 1800 and 1900, authors began to pay more attention to pain symptoms during or after pregnancy. In 1870, Snelling described the pelvic syndrome as follows:

“The affection appears to consist of a relaxation of the pelvic articulations, becoming apparent suddenly after parturition, or gradually during pregnancy; and permitting a degree of mobility of the pelvic bones which effectually hinders locomotion, and gives rise to the most peculiar, distressing and alarming sensations” [15,16].

Furthermore, Snelling stated that this relaxation does not constitute a pathological condition on its own, but probably forms a part of the general preparation for the delivery. The occurrence of the separation, therefore, was considered to be

a consequence of the pressure of the fetal head on the bones [15]. In the same way, an unusual size of the child, abnormal size of the head of the child, a retroverted uterus, great physical and/or muscular weakness and difficult labor were regarded as causes for the painful “sensations” [13,15].

3. Pelvic girdle pain in the 20th century

In the beginning of the 20th century, most authors accepted the view that the pelvic joints softened and became more relaxed during pregnancy, but no accurate studies had been performed on the frequency and degree of separation [11]. In 1912, Loeschke et al. microscopically observed an increase in tissue fluids and a pronounced hyperemia and hypertrophy of the ligaments [17]. In 1926, the hormone relaxin was found to relax the pubic ligaments of guinea pigs and mice [17–19]. The finding of relaxin led to the hypothesis that pelvic joints undergo characteristic changes, which are normal during pregnancy. On the other hand, these processes may occasionally cross the border of normality and become pathological, bringing with them a predisposition to pain [14].

Brehm and Weirauch, in 1928, attempted to establish normal and abnormal degrees of pubic separation. They stated that patients with a separation of 9–20 mm had slight symptoms and those with more than 20 mm had marked symptoms [11].

Heyman and Lundqvist found, in 1932, that the symphysis increases in width in all gravidae. According to them, this process starts early in pregnancy and continues until the third to fourth month before partus, but no further widening occurs during parturition [12,17]. The width of the symphysis returns to normal shortly after birth [12,14]. These findings were confirmed in several studies and also the increase in width of the sacro-iliac joints became of interest [11,17,20].

Abramson et al. began to question the relationship between the relaxation and the painful symptoms. In their research, several women, in whom no more than the average amount of relaxation was present, complained of symptoms, while other women, in whom marked separation occurred, made no complaint [11]. Vaudescal et al. (1934) stated that pain in the symphysis was due to an abnormal decalcification process [14]. They considered “pelvic insufficiency” to be a kind of preliminary stage of osteomalacia for which disturbances in the calcium metabolism during pregnancy might be responsible [17].

In the 20th century, the first estimates are given of the frequency of pelvic girdle pain during pregnancy. In Norway, Skajaa found that “painful relaxation of the symphysis and sacro-iliac joints” occurred in 31 out of 185 patients (16.8%) at the end of pregnancy [21]. In 1939, Young et al. studied 3030 American women during pregnancy and 114 women (3.7%) had symptoms of “pelvic insufficiency” that indicated treatment. Genell et al. (1948)

selected 92 (0.8%) cases out of 11,250 women who gave birth at a clinic in Malmö (Sweden) [14,17]. These frequencies depend on the criteria for the diagnosis. Genell used a list of several subjective and objective symptoms to diagnose “pelvic insufficiency”. The subjective symptoms were fatigue without obvious cause, aches and pains (sciatica), difficulty in walking or taking full steps, difficulty in turning over in bed, difficulty in rising from a chair and mild or moderate disturbance in gait. More objective symptoms were waddling, a positive Trendelenburg test, symptoms of back insufficiency, X-ray symptoms (diastases in the symphysis) and clinical symptoms from the symphysis and clinical symptoms from the sacro-iliac joints [17].

In 1962, Walde described differences between pelvic girdle pain and back pain. Pelvic girdle pain was connected with the weakening processes in the symphysis and the sacro-iliac joints during pregnancy while back pain behaved as a lumbo-sacral pain without any other clinical characteristic than the relationship to pregnancy [14]. Pain complaints after pregnancy were believed to be caused by degenerative disc lesions, which were related to pregnancy and childbirth.

Pain assessment and measurement became of interest around 1975 with the development of pain questionnaires and pain drawings [22,23]. This led to a turning point in pregnancy-related pelvic girdle pain and low back pain research. Up till then, pain used to be of secondary importance in pelvic or back insufficiency research and aspects involving laxity were the main focus. In the late 1970s, this focus shifted towards the pain complaints [24]. Furthermore, the general assumption that relaxation of the joints was the cause of pain became questionable.

4. Pelvic girdle pain in the last decades

Since 1987, the interest in PPGP has grown enormously. The awareness of the possible impact of PPGP on the quality of life, and the costs for society, had increased medical attention over the last decades [25]. As a result, several research projects were conducted to describe and/or explain this phenomenon. Table 1 shows a number of these research projects that have been conducted in the last 15 years.

Only a few prospective studies were performed. Berg et al. studied the development of low back pain during pregnancy [26]. Of 862 women who answered the questionnaires, about half developed some degree of low back pain during pregnancy. Unfortunately, only women with severe low back pain (79 cases) were included for follow-up after delivery, so no comparison could be made between severe cases and healthy women or women with less severe low back pain after delivery. Studies of Larsen et al. [27] and Albert et al. [28] show similar designs. Larsen et al. [27] followed 1600 pregnant women during pregnancy. The incidence of PPGP during pregnancy was 14%. Women who developed PPGP during pregnancy were included for

Table 1
Study characteristics of research on pregnancy-related low back pain and/or pelvic girdle pain performed between 1977 and 2003

First author [reference], country	Design	Study population	Population size	Description of pain complaints	Diagnostic method(s)	Period of pain measurement	Moment of measurement	Prevalence of pregnancy-related LBP/PPGP
Mantle [24], England	CS	Patients who delivered in the labour ward of the London hospital	180	<i>Backache</i> within the 'troublesome' to 'severe' range	<i>Questionnaire:</i> self-reported pain	During pregnancy	Within 24 h of delivery	48%
Nwuga [8], Nigeria	CS	Patients who delivered in the labour ward of the Akure State Hospital	99	<i>Back pain</i> within the 'very mild' to 'severe' range	<i>Questionnaire:</i> self-reported pain	During pregnancy	Within 24 h of delivery	89.8%
MacLennan [7], South Australia	CC	Pregnant patients attending Queen Victoria Hospital	35 cases; 368 controls	<i>Severe pelvic joint pain:</i> sufficiently incapacitating to necessitate prolonged bed rest and positive lateral flexion tests	Lateral flexion tests with the patient standing on one leg and then the other	Latter stages of pregnancy	–	–
Bullock [51], Queensland	–	Women attending the antenatal clinic of a large Brisbane women's hospital	34	ND	Interviews	Between 12th week of pregnancy and childbirth	First measurement between 14 and 22 weeks; re-measurement 8 and 16 weeks after first assessment	88.2%
Fast [3], US	CS	Patients of the maternity ward of an active general hospital	200	<i>Pain</i> located in the low back, sometimes radiated to the lower extremities and/or legs	Interviews	During pregnancy	24–36 h after labor	56%
Berg [26], Sweden	PC	Pregnant women attending antenatal clinics between 1983 and 1984 in the community of Linköping	862 79 severely affected women	<i>Low back pain:</i> ND <i>Severe back pain:</i> ND <i>Sacro-iliac dysfunction:</i> positive Patrick's test, Derbolowski's test and or sacro-iliac joint fixation test <i>Symphysiolyse:</i> pain and/or tenderness over the symphysis	<i>Questionnaire:</i> self-reported LBP <i>Severely affected women:</i> orthoneurologic examination; postural asymmetry of the pelvis; Sacroiliac joint fixation test; Patrick's test; Derbolowski's test; ventral and dorsal gapping test	During pregnancy <i>Severely affected women:</i> followed to 12 months after delivery	20th, 30th and 35th week of pregnancy <i>Severely affected women:</i> 6–12 months after delivery	49% back pain during pregnancy 9.2% severe pain.

Svensson [46], Sweden	CS	Selection of women who had been pregnant out of a random sample of 1760 women	1218	<i>Transient LBP:</i> LBP only present during pregnancy <i>Continuing LBP:</i> LBP continued after delivery	<i>Questionnaire:</i> self-reported LBP	During and after previous pregnancies	Retrospective	24%
Ostgaard [29,52,30], Sweden	PC	Pregnant women attending one of the maternity care units in Gothenburg during a 1-year period	855	<i>High back pain:</i> pain above the lumbar region <i>Low back pain:</i> pain in the lumbar region with or without radiation into one or both legs <i>Sacroiliac pain:</i> pain over the sacroiliac joint area(s), sometimes with radiation to the thigh(s) Pain in symphysis pubis was found in all three groups	<i>Questionnaire:</i> self-reported LBP, pain drawing, VA-scale	Between 12th week of pregnancy and 1 year after delivery	Week 12, 16, 20, 24, 26, 28, 30, 32, 34, 36 of pregnancy and 1 year after delivery	49% back pain during pregnancy (point prevalence of 25% throughout pregnancy) 67% back pain directly after delivery 37% some back pain 18 months post partum
Ostgaard [47], Sweden	CC	Pregnant women attending one of the maternity-care units in Gothenburg during a 1-year period	420 cases 375 controls	ND	<i>Questionnaire:</i> self-reported LBP, pain drawing, VA-scale	Between 12th week of pregnancy and childbirth	Week 12, 16, 20, 24, 26, 28, 30, 32, 34, 36 of pregnancy	–
Saugstad [45,50], Norway	CS	Members of the National Association for the Crippled (women suffering severe incapacitating PPPJI for years)	153	ND	Questionnaire	During and after previous pregnancies	Retrospective	–
Orvieto [5], Israel	CS	Women who were consecutively referred for an antenatal ultrasonographic examination for various reasons	449	All conditions of pain, ache, stiffness, or fatigue localized in the lower back	<i>Questionnaire:</i> self-reported LBP	Between 15th and 41 weeks of pregnancy	Between 15th and 41 weeks of pregnancy	54.8%
Endresen [37], Norway	CS	Norwegian women who gave birth in the maternity ward during fall of 1989	5400	ND	<i>Questionnaire:</i> self-reported PPP/LBP	During pregnancy	Shortly after delivery	58%
Kristiansson [40,43] Sweden	PC	Women attending during early pregnancy in the year 1991 the antenatal clinics in two districts of the city of Sundsvall	200	<i>Back-pain:</i> those who reported sacral, lumbosacral, lumbar, and cervicothoracic pain.	Questionnaire: Pain sketches, visual analog scales, 12 disability ratings	Between 12th weeks of pregnancy and 12 weeks after delivery	Week 12, 24, 36 of pregnancy and 12 weeks after delivery	76.4% (61% reported onset during pregnancy)

Table 1 (Continued)

First author [reference], country	Design	Study population	Population size	Description of pain complaints	Diagnostic method(s)	Period of pain measurement	Moment of measurement	Prevalence of pregnancy-related LBP/PPGP
Mens [4], the Netherlands	CS	Members of the Dutch “association for patients with pelvic complaints in relation to symphysiolysis”	394	<i>Peripartum pelvic pain:</i> if pain was felt in the symphysis region, the groin, the greater trochanter, the region of the SI-joints, or the lateral parts of the buttock	<i>Questionnaire:</i> pain sketches	During and after previous pregnancies	Retrospective	–
Hansen [19], Denmark	CC	Pregnant women admitted to the out-patient obstetric clinic with symptom-giving pelvic girdle relaxation	38 cases 14 controls	ND	<i>Symptom-giving PGR:</i> tenderness when palpating symphysis; pain at symphysis when standing on one leg; tenderness of ilio-psoas muscle (right or left); tenderness at palpation of the SI-joint (left or right); Patrick’s ‘fabere’ sign; tenderness of sacrotuberous ligaments at palpation	During and after pregnancy	In the 30th and 38th week of pregnancy as well as 2 and 6 month after delivery	–
Larsen [27], Denmark	CC	Women were recruited from the antenatal obstetric clinic at Herlev University Hospital	1600 227, Pelvic girdle relaxation	Pelvic girdle relaxation: arising during present pregnancy and occurring repeatedly in at least two of the following situations: (1) turning in bed; (2) walking; (3) lifting a light load; (4) getting up from a chair; (5) climbing chairs	Interviews during routine prenatal examinations; interview by rheumatologist; clinical and neurological examination	During and after pregnancy	Week 16, 20, 30, 33, 38,40 of pregnancy Month 2,6,12 after delivery (only cases)	14% (during pregnancy) 5% (2 months post partum) 4% (6 months post partum) 2% (12 months post partum)
Worlu [48], Lesotho	CS	A random sample of 4001 mothers, collected from the Maeru District of Lesotho	4001	ND	<i>Questionnaire:</i> self-reported LBP	After previous pregnancies	Time of data-collection	58.5% 10.1% severe LBP
Albert [28], Denmark	CC	Women registered to deliver at Odense University Hospital	1789 405, Pelvic joint pain	Pelvic joint pain divided into five subgroups: (1) pelvic girdle syndrome; (2) symphysiolysis; (3) one-sided sacroiliac syndrome; (4) double-sided sacroiliac syndrome; (5) miscellaneous	Questionnaire filled out by physiotherapist and physical examination (15 objective tests)	Between 33 weeks of pregnancy and 24 months after delivery	Week 33 of pregnancy Month 1,3,6, 12,18and 24 after delivery (only cases)	22.6% PGS: 6.6% Symph.: 2.1% O-S SI-synd.: 5.5% D-S SI-synd.: 6.7% Miscellaneous: 1.7%

Damen [49], Netherlands	CS	Women were recruited from the obstetric outpatient clinic of the University Hospital Rotterdam.	163	<i>Pregnancy-related pelvic pain</i> : includes pain from the posterior pelvis and/or from the pubic symphysis	Questionnaire, pain drawing, the PPPP-test and the ASLR- test, visual analog scales, Quebec back pain disability scale	At 36 weeks of pregnancy	Week 36 of pregnancy	44.8% moderate or severe PRPP
Stapleton [53], South Australia	CS	Women reporting to having at least one pregnancy beyond 20 weeks, selected out of the South Australian Health Omnibus Population	1120	Low back pain that was disabling, severe or moderately severe	<i>Interview</i> : self reported LBP	During previous pregnancies and after pregnancies	Retrospective	35.5% LBP during pregnancy 3.1% disabling LBP during pregnancy 24% recurring LBP
To [54], China	PC	Low-risk obstetric patients were recruited from the antenatal ward	326	<i>Back pain</i> : positive pain symptoms at any stage in pregnancy	<i>Questionnaires</i> : pain distribution chart; visual analog scale	During pregnancy until 24 months after delivery	Early postnatal period (within 3 days after delivery) and 24 months after delivery	76% LBP during pregnancy 21.1% persistent pain at 24 months after delivery
Wang [55], USA (Connecticut)	CS	Pregnant women attending various antenatal clinics in New Haven County, Connecticut and various prenatal educational programs	950	ND	<i>Questionnaires</i> : self-reported LBP	During pregnancy	At one moment (different between respondents) during pregnancy	68.5% LBP during pregnancy

CS: cross-sectional; PC: prospective cohort study; CC: case-control study; ND: no definition is given.

follow-up after delivery. Albert et al. [28] have studied 1789 women during pregnancy, of which 405 women developed PPGP (22.6%). These women (405 cases) were followed-up until 2 years after delivery.

Ostgaard et al. [29,30] studied the prevalence of low back pain during and after delivery. They included 855 pregnant women and 417 of these women (49%) complained of back pain at some time during pregnancy [29]. At approximately 1 year after delivery, all women were contacted again. At follow-up, 37% of the women still had some back pain. In this study, women were only contacted once after delivery. This measurement took place at one year after childbirth and women were asked to recall a one-year period. This could have lead to recall bias.

One of the most striking differences between the studies is the description of pain complaints. The authors were unable to clearly define PPGP, leading to a great variety in classification between the performed studies.

4.1. Defining pregnancy-related pelvic girdle pain

In previous research, the terms low back pain and pelvic girdle pain were used abundantly to describe pregnancy-related pain. Following Walde [14], Ostgaard et al. [9] described differences between low back pain and so called “posterior pelvic pain”. Based on their observations, they proposed that, while low back pain during pregnancy may not be different from low back pain in non-pregnant individuals, pelvic girdle pain may be specifically related to pregnancy and can be diagnosed based on the clinical presentation and the posterior pelvic pain provocation test [31,32]. The pain intensity during pregnancy should also be higher among women with posterior pelvic pain than among women with back pain [28]. According to Ostgaard, differences between back pain and posterior pelvic pain can be made by the criteria shown in Table 2. He developed the pelvic pain provocation test to differentiate between low back pain and posterior pelvic pain. The test was positive when the patient felt pain while her vertically positioned femur was gently pressed by the examiner who simultaneously stabilized the women’s pelvis. Only when all criteria are fulfilled, is a woman classified into the posterior pelvic pain group. Pain in the symphysis pubis was not considered important [9].

The reasons for distinguishing low back pain from posterior pelvic pain are unclear. According to Ostgaard [33], treatment will fail if no distinction is made; a conclusion based on earlier research of Dumas et al. [34,35]. Dumas et al., however, did not distinguish between low back pain and posterior pelvic pain in their study. In other words, the fundamental idea for this distinction is not very clear.

Another reason to distinguish between low back pain and posterior pelvic pain was the assumption that the prognosis differed between the two conditions [9,28]. However, Brynhildsen et al. found no differences in the long-term prognosis between the group of women with sacro-iliac joint pain and the women with other kinds of low back pain during pregnancy [36]. In spite of the inconsistency, posterior pelvic pain was believed directly to be a different syndrome by many authors [37–41].

The search for an all-embracing definition of this “new” syndrome brought about numerous descriptions of pain locations, pain complaints, pain intensity and other related factors. Not all the researchers followed the description of posterior pelvic pain made by Ostgaard (see Table 2). Mens et al. described pelvic girdle pain as being prominent around both the sacro-iliac joints and the symphysis [4]. Albert et al. divided the pain related to the pelvic joints into five subgroups (pelvic girdle syndrome, symphysiolysis, one-sided sacro-iliac syndrome, double-sided sacro-iliac syndrome and a miscellaneous group) [28]. Hansen et al. did not only describe the pain location, but also took the negative effect of pelvic problems on the daily activities into account [42]. An interesting question would be whether the different diagnostic strategies represent a similar selection of women having PPGP or not. Bastiaenen et al. (submitted for publication) studied separate strategies of four international authors in the field of PPGP. They concluded that there was no similarity in the selection of patients with PPGP between the authors. Most of these classification strategies of PPGP are based on expert opinions. Therefore, a possible reason for the lack of similarity in the selection of patients can be that they all select different small parts of the same large patient group. We expect that during pregnancy almost every women experience some form of pain in the lower back, the buttocks, the symphyses, the groins and/or radiation into

Table 2
Differences between back pain and posterior pelvic pain (according to Ostgaard et al. [9])

Back pain	Posterior pelvic pain
A pain drawing with markings drawn above the sacrum	A pain drawing with well-defined markings of stabbing in the buttocks distal and lateral to the L5-S1 area, with or without radiation to the posterior thigh or knee, but not into the foot
Back pain experienced when the patient was in forward flexion	A history of time- and weight-bearing-related pain in the posterior pelvis, deep in the gluteal area
Decreased motion in the lumbar spine	Pain-free intervals
Pain from palpation of the erector spina muscle	Free range of motion in the hips and spine and no nerve root syndrome
Negative posterior pelvic pain provocation test results	Positive posterior pelvic pain provocation test results

the legs. This pain is probably caused by hormonal and physiological changes, which are normal during pregnancy. However, some women experience pain in a very early stage of pregnancy, while others only experience pain in the final stage of pregnancy. In addition, some women are more limited in their activities due to pain than other women. This suggests that other factors might influence the hormonal or physiological changes during pregnancy. Most women who had developed PPGP during pregnancy will soon recover after delivery.

4.2. Risk factors of pregnancy-related pelvic girdle pain

During the past 25 years, several possible causes of pregnancy-related pelvic girdle pain have been studied, resulting in a multitude of potentially relevant variables (see Table 3).

Due to the hormonal changes during pregnancy, associations between several hormonal factors (such as relaxin concentration and former use of oral contraceptives) and PPGP have been studied. The results, however, are conflicting. An association between PPGP and serum concentrations of relaxin has been reported [7,43], but not confirmed [19]. Former use of oral contraceptives (OC's) is often believed to increase the risk of LBP and/or PPGP and some of the studies also found a relation, however, almost an equal number of studies did not find a significant relation [26,44–46]. Therefore, hormonal factors could play a role in the development of PPGP, but their role is still not clear.

Factors such as parity and maternal age were studied in many research projects, showing conflicting results. Parity was considered to be an important predicting factor of pregnancy-related pelvic girdle pain [4,8,24,40,46–49]. On the other hand, several studies showed no significant relationship between parity and pelvic girdle pain during present pregnancy [3,5,26,27,50–55]. Probably, parity does not provoke PPGP, but a history of PPGP or LBP does. On one point, all study results were consistent. Previous low back pain and previous pelvic girdle pain increase the risk of developing pelvic girdle pain in subsequent pregnancies (see Table 3).

Remarkably, while some studies failed to find a significant relation between work-related factors and PPGP, studies where previous LBP or PPGP were taken into account showed significant relations with strenuous work. This could suggest interaction between previous low back pain and work-related factors. One might hypothesize that women with previous low back pain tend to estimate their work as heavier than women without such problems [36].

Pregnancy-related factors such as twin pregnancy, maternal weight, delivery position, etc. seemed to have no effect on PPGP, but not many studies have taken these factors into account.

Based on previous findings, it is not surprising that there is little consistency in study results of etiologic studies. By using different diagnostic classification strategies, the

selected population differed between the studies. In order to avoid selection bias, it may be better to use an extensive description in order to identify the etiologic factors of PPGP.

5. Discussion

During and after pregnancy women can experience serious pain around the pelvic area and/or the lower back. Several attempts have been made to explain this phenomenon. A common assumption about pain is that it always results from the presence of underlying organic pathology [56]. Historical research has usually been based on finding the organic cause of pregnancy-related pelvic girdle pain, resulting in the assumption that relaxation of the joints was the cause of pain. This assumption became questionable when several studies found no relation between the degree of relaxation and the presence of pain. Other possible organic causes showed the same inconsistencies. These inconsistencies led to the assumption that there is no single one-to-one correspondence between the report of pain and the presence of underlying disease [56].

Pregnancy-related pelvic girdle pain seems to be a far more complicated phenomenon, in which there may be considerable confounding by cases with “common” low back pain. Previous studies could not convincingly distinct PPGP from low back pain, and perhaps pregnancy-related “back pain” forms one specific syndrome (with no distinction between PPGP and LBP) [25].

In order to obtain more knowledge about pregnancy-related pelvic girdle pain, it is necessary to perform a comprehensive study in which all features of the patients can be studied. This could be done by performing a prospective cohort study in which a large number of pregnant women are followed during a period of time. Such a study will provide more insight in PPGP. Albert et al. [28] and Ostgaard et al. [52] performed such a cohort study, but they distinguished, in advance, several subgroups based on different classification strategies (see Table 1). In the study of Albert et al., only women who were classified into the four classification groups and the miscellaneous group were followed up [28]. Information about healthy women (without complaints) was obtained at 33 weeks of pregnancy, but data from the last few weeks of pregnancy and the period after childbirth was missing. It is important to study every feature of PPGP and by a selective follow-up of subgroups the contribution of some of these features will be lost.

A large-scale cohort study is called for to study PPGP from the onset. At this moment, the Maastricht PPGP cohort study ($N = 7526$) is in progress. The purpose of the Maastricht PPGP cohort study is to provide adequate information about pregnancy-related pelvic girdle pain without distinguishing subgroups in advance and at least to establish whether associations that were found in previous (smaller) studies, are true, due to chance findings or due to invalid assumptions. In this study, we decided to use a wide-

Table 3
Potential risk factors of pregnancy-related pelvic girdle pain during or after pregnancy

Studies	Increasing relaxin	Older maternal age	Number of pregnancies	Years since last delivery	Maternal height	Maternal weight	Foetal weight	Twin pregnancy	Maternal ethnicity (western)	Oral contraceptives	Smoking	Alcohol	Low socioeconomic status	Strenuous work	Unstable working condition	Participation sports	Previous low back pain	Previous PPGP	Previous abortion	Epidural anaesthesia	Low education	Increased lumbar lordosis	Delivery position (bent spine)	Instrumental delivery	Cesarean section	Early menarche	Prevalence PPGP or LBP (%)	
Mantle [24]		+	+		0	0	0																				48.0	
Nwuga [8]		++	++																								89.9	
Mademan [7]	+++																					0					##	
Bullock [51]		0	0		0	0	0		+																		88.2	
Fast [3]		0	0																								56.0	
Berg [26]		0	0							0	+++						++										49.0	
Svensson [46]		++	++		0	0	0			±				+			++										24.0	
Ostgaard [29]	---	---	---		0	0	0			±				+++			+++										49.0	
Ostgaard [47]	---	---	---																								##	
Ostgaard [52]	---	---	---																								##	
Saugstad [45]		0	0		0	0	0			+	0	0				0											49.0	
Saugstad [50]		0	0		0	0	0			+													±	0			##	
Orvieto [5]		0	0		0	0	0						+				+++						0	0			##	
Endresen [37]		0	0		0	0	0		-				+				+++						0	0			##	
Kristiansson [40]		0	+		0	0	0			0			+				+++										54.8	
Kristiansson [43]	+	0	±		0	0	0			0			+				+++										76.4	
Mens [4]		+	+		0	0	0			0							+++										76.4	
Hansen [19]		0	0		0	0	0	+++																			##	
Larsen [27]		0	0		0	0	0				0						++										##	
Worku [48]		0	+++										+++				++										##	
Albert [28]		+	+		0	0	0			0			0				++										14.0	
Damen [49]		0	+		0	0	0			0			0				0										58.5	
Stapleton [53]	---	0	0		0	0	0			0			0				0										22.6	
To [54]	++	0	0		0	0	0			0			0				+++										44.8	
Wang [55]	---	0	0		0	0	0		-	0	0	0	0				++										35.5	
Total score	2/0	5/6	11/0	0/0	0/0	3/0	3/0	1/0	1/2	4/0	2/0	0/0	3/0	5/0	2/0	0/1	9/0	4/0	1/0	0/0	4/0	0/0	1/0	2/0	0/1		76.0	
+/-	8		12	3	9	10	3	1	0	4	6	1	1	4	3	2	0	0	2	4	1	1	0	3	4		68.5	
NS																												0

Positively significant (++++): <0.005; (+++): <0.01; (++): <0.05; (+): <0.1; (0): NS; negatively significant (----): <0.005; (---): <0.01; (-): <0.05; (0): NS.

ranging definition to describe PPGP because it is still not possible to make a satisfactory choice between the different existing diagnostic strategies. In order to study the etiology of PPGP, women were considered as cases when they developed pain during pregnancy in the lower back, the buttocks, the symphyses, groins and/or radiation into the legs. For the prognosis of PPGP, women were considered as cases if they had pain in the lower back, the buttocks, the symphyses, groins and/or radiation into the legs during pregnancy, which did not disappear until at least 2 weeks after delivery. By using a wide-ranging definition instead of an unsupported specific definition we aim to provide an evidence-based overall picture of PPGP.

It should be emphasized that PPGP is a complex syndrome, in which biological, psychological and social factors may play an important role. For future research, it is useful to study the influences of several risk factors on hormone levels, but also the role of PPGP in social participation or the influence of psychological factors on the prognosis of PPGP should be highlighted.

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