THE RELATIONSHIP BETWEEN PELVIS INCLINATION, EXERCISE AND LOW BACK PAIN (LBP) DURING PREGNANCY

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BACKGROUND: Pain in the lower region of the back and pelvis – also called "Low Back Pain" (LBP) – is very frequent during pregnancy. According to many authors it is a major complaint of more than half of all pregnant women; it causes mental and physical discomfort. The etiology of LBP during pregnancy is still not fully known.

OBJECTIVE: The main aim of our research was to objectify the relationship between the presence of LBP, the training level of the postural muscles and the degree of the pelvic inclination of women in the third trimester of pregnancy. That is why the relationship between pelvic inclination and LBP occurrence is compared within the context of two groups – reasonable physically active as compared to physically inactive women.

METHODS: Twenty-seven pregnant probands aged 20–35 years and in the second half of their third trimester were included in the experiment. All of them complained of pain in their lumbar spine and in the pelvicarea. They were divided into two groups – 14 physically inactive women and 13 physically active women, who have been performing physical activity for at least 135 minutes per week for at least 1 year before conception and for at least 90 minutes per week during pregnancy. The exercises were focused on the functioning of the postural system, e.g. yoga, Pilates and exercises by Mojžíšová. We measured the inclination of the pelvis (using non-invasive anthropometric measuring) and observed the presence of pain in the selected area – clinically via the *Patrick-Faber test* and *posterior pelvic pain provocation test* and subjectively with the aid of a standardized LBP related survey. The statistical methods used were the t-test, the median and Wilcoxon-White test and the Spearman factor of serial correlations.

RESULTS: We observed a statistically significant difference between the pelvic inclination of physically active and inactive women (using a t-test for non-pair values with a significance level of $p = 0.01$). Another significant difference was evident between the subjective pain sensation of regularly exercising and non-exercising women, which was proved by both the median and the Wilcoxon-White tests ($p = 0.01$). A significant relationship between pelvic inclination and the sensation of pain classified in a survey by means of a 1–10 scale was proved by the Spearman factor of serial correlations ($p = 0.01$).

CONCLUSIONS: Using mathematical statistical methods, our study has proved the important role of physical activity during pregnancy – its relationship to pain sensation and to the degree of pelvic inclination. We consider these results to be very important, especially from the perspective of LBP prevention during pregnancy.

Keywords: Pregnancy, Low Back Pain (LBP), inclination of pelvis, deep spinal stabilisation system, Patrik-Faber test, provocation test of posterior pelvic pain, physical activity in pregnancy.

INTRODUCTION

The relatively short period of pregnancy constitutes a time of major somatic, mental, functional and also social changes in a woman's life.

A significant part of the health and discomfort issues experienced during pregnancy is related to the muscular-skeletal system. According to many authors (e.g. Wang, Dezinno, Maranets, & Berman, 2004; Mens & Damen, 2006), the majority of complaints of pain by pregnant women can be classed as "Low Back Pain" (LBP). Until recently the term "low back pain" bore the meaning of non-specific pain, involving both lumbar spine pain and also pain on the posterior side of the pelvis. But lately some researchers have begun to differentiate between the diagnostics and therapy of the lumbar and pelvic area (e.g. Albert, Godskesen, & Westergaard, 2002). Pregnancy related LBP may be defined as any idiopathic pain between the 12th rib and the gluteal crease. It does not involve any situations in which the pain could be connected to specific pathological phenomenon, e.g. disc herniation (Sneag, 2007). LBP problems usually originate in the period before pregnancy, due to minimal adjustment of daily non-physiological movement routines. The incidence of LBP discomfort is present in nearly fifty percent of the pregnant population (Mens & Damen, 2006) and it is a frequent cause of mental and physical discomfort.

Although both types of pain are usually referred to as Low Back Pain, their symptoms, diagnostics and therefore therapy have to be differentiated (TABLE 1).

TABLE 1
Different kinds of LBP (Sneag, 2007)

Localisation	Lumbar spine	Pelvic region
Course	Mostly chronic	More likely acute
Time	More frequent and intensive incidence during confinement	Mostly during pregnancy
Characteristics	Painful palpation of paravertebral muscles of lumbar spine	Back pain, deep pain, inaccurately localised and radiating in caudal direction on posteral-lateral side of femur all the way to ankle

From a biomechanical point of view, os sacrum and os ilium form an anatomically and functionally tight complex. Mechanical forces of the growing uterus and other factors occurring during pregnancy could influence the axial system and therefore enhance the development of LBP. Pelvis inclination and spinal curvatures may be influenced not only by the mechanical forces occuring during pregnancy but also by improper activity (weakness or coordination) of the so called deep spinal stabilisation system (Neumann, 2002).

Today's therapy involves, above all, rest, sometimes complemented by the active building of the pelvic and spinal muscular corset or passive fixation using a pelvic belt. The importance of exercise activating the postural muscles prior to pregnancy in order to prevent future LBP is not clear yet. There is no evidence as to whether the biochemical and biomechanical changes occurring during pregnancy have a more excessive impact on the female body than the state of her muscular apparatus itself. However, we believe that proper exercise prior to pregnancy helps pregnant women deal with the discomfort in their lower back area. This alleviation of pain should occur thanks to better support for the growing uterus and also thanks to a higher awareness of the body helping to prevent the pain by avoiding certain kinds of movements.

Despite the high incidence of LBP occurrence during pregnancy, our knowledge of pathogenesis, clinical demonstrations and therapy is insufficient so far. Foreign literature does contain some articles on the topic of LBP during pregnancy, Czech scientific journals present very few related articles and there are virtually no study materials for obstetricians at all.

Mechanisms of LBP occurence during pregnancy

The etiology of LBP during pregnancy is still theoretical; there are 3 main occurrence mechanisms mentioned in the literature: biomechanical/muscular-skeletal, hormonal and vascular.

The common goal of many pregnancy and LBP related studies is to discover the origin and factors contributing to the perception of sensation (e.g. Fast & Shapiro, 1987; Sneag, 2007; Wang, Dezinno, Maranets, & Berman, 2004, etc.). But multiple conclusions drawn from these studies have brought multiple results and the question of risk factors identification still remains unanswered.

Could proper physical activity during pregnancy affect LBP?

Sometimes it is difficult to directly pinpoint structures as well as factors which cause pain in the lumbosacral region. Ignorance of the etiology makes choosing proper therapy a difficult task. In many cases some relief can be obtained by using a pelvic belt which compresses the sacroiliacal joint, and thus replaces passive ligamental fixation as well as active muscular stabilisation, specifically of *m. transversus abdominis* and *mm. multifidi* (Richardson, Snijders, & Hides, 2002). But Mens and Damen emphasize that the excessive use of passive support contributes to myoatrophy and therefore to counterproductive consequences (Mens & Damen, 2006).

Theoptimal prevention of LBP consists in deep stabilisation system activation before conception as well as carefully chosen physical activity in the later phase of pregnancy that can lead to decreasing potential pain. There are many publications and videos on the market today about exercises focused on strengthening postural muscles. No matter whether a woman starts exercising during pregnancy or before, she should focus on special pregnancy modified programs which exclude positions not suitable for pregnant women. Inexperienced women should always exercise under an expert's supervision.

We present the 3 most frequently used methods for helping to alleviate back pain (not only during pregnancy): the Pilates method, Yoga and exercises by Mojžíšová.

The Pilates method was inspired by tai-chi and yoga. Individual exercises are focused on the local strengthening and stretching of global muscle groups, thereby contributing to keeping one's bodily balance and learning proper body posture (King & Green, 2006). The main goal of these exercises is, however, the activation of the so called "power house" which, according to the Pilates method, comprises the diaphragm, pelvic floor and abdominal wall. Modification of the Pilates method for pregnant women contributes, among other things, to the enhancing of cardiovascular and respiration function, relaxation and well being.

In Yoga, the activation of postural muscles is reached through asanas (exercising positions) as well as pranayama (breathing exercises), because there is a close mutual relationship between respiration and postural muscles. Breathing exercises might be facilitated by upper limbs positioned in given poses and gestures. This technique is called "mudra". According to Véle (2006) these exercises affect erect body posture and thus support the function of the deep stabilisation system.

The Mojžíšová's method is acknowledged in the Czech Republic as an exercise and as therapy for functional female sterility, based on the reflexive effect on the neuromuscular apparatus. The pelvic floor is affected by means of influencing the lumbar spine, sacrum, coccyx, pelvic muscles and their mutual positions. The method consists of education, 10 plus 2 exercises and mobilisation and is used not only as a form of functional sterility therapy, but its elements can be found in functional vertebrogenic issues therapy, juvenile scoliosis therapy, coccyx pain therapy, etc. (Strusková & Novotná, 2003).

OBJECTIVES

The main aim of our research was the objectivisation of the relationship between LBP occurrence, the training level of the postural muscles and the degree of the pelvic inclination of women in the third trimester of pregnancy. That is why the relationship between pelvic inclination and LBP occurrence was compared within the context of two groups – reasonably physically active as opposed to physically inactive women.

HYPOTHESES

1. Regular physical activity focused on the deep stabilisation system before and during pregnancy significantly affects the degree of pelvic inclination.
2. Regular physical activity focused on the deep stabilisation system before and during pregnancy alleviates pain in lower segments of the lumbar spine and sacroiliacal joint.
3. The degree of pelvic inclination correlates with subjective pain sensation in the lower spinal and pelvic segments.

METHODS

Research group

Of the 30 women originally addressed and examined, 27 pregnant probands aged 20–35 years and in the second half of the third trimester were included in the experiment. All of them indicated that they suffered from pain in the lumbar spine and pelvicregion. The chosen subjects were limited to those in a good state of health with no present structural pathology of movement apparatus nor any other serious health conditions. They were divided into two groups:

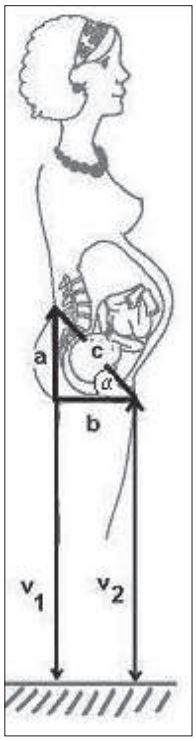
A) 13 physically active women,
B) 14 physically inactive women.

To be assigned to the active group, physical activity had to be performed for at least 45 minutes, at least 3 times per week for at least 1 year before conception. During pregnancy, the exercise time needed was reduced to 30 minutes for at least 3 times per week, e.g. 90 minutes every week. Asymmetrically body overloading activities were dropped (tennis, squash, etc.) while activities focused on postural muscle activation were given preference (i.e. yoga, Pilates, breath gymnastics, gym ball exercises, etc.).

Into the B group we assigned women who performed no physical activity or did not match the previously mentioned qualitative and quantitative movement conditions.

For the objective evaluation of deep stabilisation system (DSS) status in the third trimester of pregnancy we discovered no clinical test in the academic literature. Distributing probands into two groups and thus the approximation of their DSS's training level took place based on evaluating their medical historical data. This was performed in view of the fact that most women who fulfilled the condition of regular exercising mentioned postural-muscles-activation focused methods in their training programs (Pilates, yoga, gym ball exercises, etc.).

Fig. 1



Data detection and examination took place at a private rehabilitation clinic and at the Clinic of Obstetrics and Gynecology at Charles University's 1st Faculty of Medicine.

Measuring the inclination of the pelvis

The inclination of the pelvis was detected using simple anthropometric measuring. We used "Doležal's method" (Doležal & Gutvirth, 1977), i.e. we measured the *inclinatio pelvis* against a horizontal line.

For an evaluation of pelvic inclination we needed to detect (Fig. 1.), ground – upper symphysis edge distance ($\mathbf{v_2}$), ground – Michaelis route distance ($\mathbf{v_1}$), Michaelis route – upper symphysis edge distance (**c**).

From the difference ($\mathbf{v_1}$–$\mathbf{v_2}$) we obtained side **a** and angle α

$$\sin\alpha = \frac{a}{c} \qquad (1)$$

To keep measurement error as low as possible all measurements were performed by one person and standardised external conditions were maintained (room temperature, lighting, air humidity).

Clinical LBP findings

Lumbar area pain demonstrates itself mainly by a decreased mobility of the lumbar spine and pain, summoned by torso anteroflexion. Posterior pelvic area pain can be detected by specialised tests. Sneag indicates the existence of more than 15 tests to identify pain level in the posterior pelvic area (Sneag, 2007). Research however has discovered that only three of them are highly sensitive and effective – the Patrick-Faber test, the Menell test and the posterior pelvic pain provocation test. In this study we used the Patrick-Faber test and the posterior pelvic pain provocation test, mostly because of the supine position of probands during testing. The position of the Menell test is inappropriate for the third pregnancy trimester.

Patrick-Faber test – the patient lies in the supine position. She performs flexion, abduction and outer rotation of the hip joint and flexion of the knee joint of one lower limb. The second lower limb is extended, including hip and knee joints. A physiotherapist slowly presses the flexed knee (tested side) in one direction while holding the pelvis steady on the opposite side. The test is positive if pain is thereby provoked in the sacroiliacal joint or hip joint.

Posterior pelvic pain provocation test – the patient lies in the supine position with flexion in the hip joint of 90° with a flexed knee joint. The tester induces sheer tension on the sacroiliacal joint through the femur. It is important to avoid excessive adduction of the hip joint while testing, because it causes pain even to healthy individuals with simultaneous flexion. The test is declared positive if it causes discomfort to the patient while testing the monitored area.

Subjective classification of pain

As a part of the examination, the probands filled in a medical historical survey about their health condition, regular sports activities as well as the character and localisation of their pain.

There is quite an extensive range of standardised LBP related surveys available for the non-pregnant population, e.g. The Quebec Back Pain disability scale, Aberdeen Low Back Pain scale, etc. All of these were, however, found inappropriate for pregnant women, as they included manoeuvres difficult to perform even for entirely healthy pregnant women in the 3rd trimester (such as carrying heavy objects, short track running, etc.). So we used a newly created medical historical survey for the subjective classification of pain. We used the previously mentioned surveys when assembling this survey (The Quebec Back Pain disability scale and Aberdeen Low Back Pain scale). A numeric scale of 1–10 was added to pain related questions (1 – the slightest pain, 10 – the greatest pain) as well as a diagram for marking pain localisation.

Statistical analysis

Because both monitored sets were extensive enough, we used standard mathematical statistical methods, the pelvic inclination of exercising and non-exercising women was compared by a t-test for non-pair values, whereas subjective "pain level" values between both sets were compared using two non-parametric methods – the common, but weaker median test and the stronger Wilcoxon-White test. The relationship between pelvic inclination and subjective pain sensation was tested by the non-parametric Spearman factor of serial correlations.

RESULTS

The numeric values measured are displayed in TABLE 2.

TABLE 2
Measured data

Inclination of pelvis (degrees)		Pain (scale 1–10)		
Active	**Inactive**	**Inactive**	**Active**	
33	25	8	2	
28	26	6	4	
29	25	8	1	
28	25	7	2	
27	27	6	3	
27	24	4	3	
29	26	3	4	
27	25	7	1	
27	27	4	4	
23	24	7	2	
29	25	5	2	
26	26	6	3	
25	23	6	1	
28		3		
27.571	**25.231**			**Average**
2.195	**1.120**			**Std. deviation**
		6	**2**	**Median**

As we expected, at significance level 0.01 there is a statistically significant difference between the pelvic inclination of physically active and inactive women (n = 27, the counted t-test value is 3.396, the table value is 2.086). Based on this proven difference we can assume that the regular physical activity of women reduces the creation of excessive pelvic anteversion during pregnancy.

The calculations also proved a significant difference between the subjective pain sensations felt by regularly exercising and non-exercising women. This difference is statistically significant on a significance level of 001 for both non-parametric tests we used – the median test (the calculated value of the chi squared test criterion is 9.258, the table value being 6.635) and the Wilcoxon--White test (the calcuated testing criterion was U = 72.5, whereas the table value was 53).

Using a non-parametric correlation factor, we have proven a statistically significant relationship between pelvic inclination and the sensation of pain classified in a survey by a 1–10 scale (n = 27, counted correlation coefficient 0.563, table value 0.465, significance level 0.01).

We have proven all three hypotheses.

DISCUSSION

We consider the definite confirmation of all three hypotheses using mathematical statistical methods to be very important. Our study contributes to the significance of appropriate physical activity before gestation as a form of prevention of LBP during pregnancy. There are increased demands placed on a pregnant woman's body due to the increase in abdominal volume and also increased elasticity of the supportive muscular and ligamental apparatus caused by increased relaxin and estrogen production. Accordingly, activated postural muscles become a supporting pillar during pregnancy. The cooperation of all parts of the postural system is especially important during pregnancy, because it leads to uncomplicated delivery and lessens the probability of LBP in the mother's future life.

Regular sport activity had an effect on the subjective sensation of LBP in our study. We assume that this conclusion was not only caused by the physiological effect of sport activity but also its proven influence on the psyche of the exercising person (Křivohlavý, 1992). LBP affected persons do not enjoy either physical nor mental comfort, which is a definition of health according to the WHO. Pregnancy LBP is a topic of many foreign studies, but the results have not been very coherent (e.g.Vařeka, 1996; Sneag, 2007; Bastiaenen, 2004; Sturreson, Uden, & Uden, 1997). That is why there is still a lack of clear conclusions regarding the etiology and therapy of this problem, which causes significant physical and mental discomfort to future mothers. LBP prevention is what should be accentuated. Enough physical activity and procedural precautions like avoiding positions and movements that cause LBP are considered appropriate prevention. There are few cases of the complete "healing" of LBP during pregnancy, yet therapy is usually successful in reducing pain (its intensity and frequency of occurrence). This therapy consists mostly of exercises for correcting muscular disbalance. Pregnancy should not become an obstacle to active movement, it should moreover be a reason to keep moving or even start doing so. All pregnant women should, however, consult their physical activity with a doctor or physiotherapist.

In addition to other things, the survey contained questions about LBP characteristics – levels of pain classified on a 1–10 scale and its localisation. Because we were aware of some degree of subjectivity in the sensation of pain, we also included two clinical tests used for the precise localisation of LBP – the Patrick-Faber and posterior pelvic pain provocation tests. Distinguishing pain using manual tests almost corresponded to the subjective feelings of the pregnant women and their marks in the picture diagram contained in the survey. Only 4 probands out of 27 had both their clinical tests negative despite the occurrence of subjective pain. Křivohlavý moreover states that scales of painful behaviour are valid methods of pain level detection (Křivohlavý, 1992).

Pelvic inclination evaluation was performed according to Doležal and Gutvirth (1977). The authors say that, in 1977, the average value of pelvic inclination in the 3rd trimester in their study was 27.53°. This angle tends to rise with an increasingly anteverted pelvis position. The average presented by the authors almost exactly agrees with the result of our physically inactive group (27.57°), while the physically active group had it 2.28° lower (25.23°). The significance of this difference was proven by mathematical statistics.

CONCLUSIONS

Monitoring 27 pregnant probands in the 2nd half of the 3rd trimester has proven a statistically significant difference between the pelvic inclination of both regularly physically active and inactive women. The average value measured on 14 physically inactive women almost perfectly matched average values presented by Doležal and Gutvirth (1977), whose method of detecting pelvic inclination we used.

We further proved that the inclination of the pelvis correlates with pain occurrence in the lower parts of the spine and pelvis. The occurrence of pain was detected by both a survey containing graphical pain localisation

and its classification on a 1–10 scale and by two clinical tests for precise LBP localisation.

Using two non-parametric tests we also proved that regular and appropriate physical activity focused on the functioning of the postural system (e.g. Pilates, yoga, swimming, gym ball exercises, exercises by Mojžíšová, etc.) before and during pregnancy reduces pain sensation in the lower segments of the lumbar spine and sacroiliacal joint. We consider these results to be very important mostly from the perspective of LBP prevention during pregnancy.

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VZTAH MEZI BOLESTÍ ZAD, SKLONEM PÁNVE A VHODNOU POHYBOVOU AKTIVITOU V TĚHOTENSTVÍ

(Souhrn anglického textu)

VÝCHODISKA: Bolesti v oblasti bederní páteře a pánve – tzv. „Low Back Pain" (LBP) – jsou v těhotenství velmi časté. Podle mnoha autorů si na tyto bolesti, které přinášejí psychické i tělesné nepohodlí, stěžuje více než polovina těhotných. Příčiny těchto bolestí během těhotenství nejsou stále ještě zcela známé.

CÍLE: Hlavním cílem našeho výzkumu byla objektivizace vztahu mezi výskytem LBP, trénovaností posturálního svalstva a mírou inklinace pánve u žen ve třetím trimestru těhotenství. Proto byl vztah mezi sklonem pánve a výskytem LBP porovnán v rámci dvou skupin – přiměřené sportujících a nesportujících žen.

METODIKA: Do experimentu bylo zahrnuto 27 těhotných probandek ve věkové kategorii 20–35 let, které byly ve druhé polovině třetího trimestru. Všechny probandky udávaly bolest v oblasti bederních segmentů páteře a pánve. Tento soubor byl rozdělen do dvou skupin – 14 nesportujících žen a 13 pravidelně sportujících žen, které se v průběhu těhotentsví účastnily komerčních cvičebních kurzů – minimálně 3krát týdně po 45 minutách; cvičení byla zaměřena na aktivaci posturálních svalů (např. jóga, Pilates, cvičení dle Mojžíšové). Zjišťovali jsme sklon pánve (pomocí neinvazivního antropometrického měření) a sledovali jsme existenci bolesti v této oblasti, a to klinickým vyšetřením pomocí Patrik-Feberova testu a provokačního testu posteriorní pá-

nevní bolesti, a subjektivně pomocí standardizovaného dotazníku týkajícího se LBP.

VÝSLEDKY: Statistická analýza pomocí t-testu pro nezávislé výběry prokázala významný rozdíl mezi sklonem pánve žen pravidelně sportujících a nesportujících. Analýza pomocí Wilcoxon-Whiteova i pomocí mediánového testu prokázala, že existuje významný rozdíl mezi subjektivním pociťováním bolesti u žen pravidelně cvičících a necvičících. Dále byl pomocí Spearmanova korelačního koeficientu prokázán statisticky významný vztah mezi sklonem pánve a cítěním bolesti stanovené v dotazníku škálou 1–10 bodů.

ZÁVĚRY: Pomocí metod matematické statistiky naše studie potvrdila významnou roli tělesné aktivity v období gravidity ve vztahu k cítění bolesti a ke sklonu pánve. Tyto výsledky považujeme za velmi důležité zejména z hlediska prevence LBP u těhotných.

Klíčová slova: těhotenství, sklon pánve, hluboký stabilizační systém.

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