

# Prevalence of low back, pelvic girdle, and pelvic floor complaints in pregnant elite athletes: a narrative review

Jaclyn Kissel, DC, FRCCSS(C)<sup>1</sup>

Melissa J. Hamilton, DC<sup>2</sup>

**Objective:** *To investigate the prevalence of low back, pelvic girdle, and pelvic floor complaints in pregnant elite athletes.*

**Background:** *Common symptoms during pregnancy include low back pain, pelvic girdle pain, and pelvic floor dysfunction. There has been minimal investigation around the prevalence of these musculoskeletal disorders in the pregnant elite athlete.*

**Methods:** *A narrative review was conducted using electronic databases and hand reference searching. Articles were screened based on the inclusion/exclusion criteria.*

**Results:** *727 articles were retrieved digitally, while hand and reference searching yielded one article. After removing those that did not fit the inclusion/exclusion criteria, there were a total of three articles.*

**Prévalence de plaintes au bas du dos, à la ceinture pelvienne et au plancher pelvien chez les athlètes de haut niveau enceintes: une revue narrative**

**Objectifs:** *Enquêter sur la prévalence de plaintes au bas du dos, à la ceinture pelvienne et au plancher pelvien chez les athlètes de haut niveau enceintes.*

**Contexte:** *Les symptômes courants pendant la grossesse sont la douleur au niveau du bas du dos, la douleur au niveau de la ceinture pelvienne et un dysfonctionnement du plancher pelvien. Il y a eu peu d'enquêtes sur la prévalence de ces troubles musculo-squelettiques chez les athlètes de haut niveau enceintes.*

**Méthodes:** *Une revue narrative a été réalisée en utilisant des bases de données électroniques et des recherches manuelles de références. Les articles ont été examinés en fonction des critères d'inclusion ou d'exclusion.*

**Résultats:** *Un total de 727 articles ont été récupérés numériquement, tandis que la recherche manuelle et la recherche de références ont donné un article. Après avoir retiré ceux qui ne répondaient pas aux critères d'inclusion ou d'exclusion, il restait au total trois articles.*

<sup>1</sup> Canadian Memorial Chiropractic College

<sup>2</sup> Private practice, Waterloo, ON

Corresponding author: Jaclyn Kissel, Canadian Memorial Chiropractic College, 6100 Leslie Street, Toronto, ON M2H 3J1

Tel: 416-482-2340

e-mail: jkissel@cmcc.ca

© JCCA 2024

The authors have no disclaimers, competing interests, or sources of support or funding to report in the preparation of this manuscript.

*Summary: Prevalence of these conditions in pregnant elite athletes is variable within the literature. The values appear to change based on trimester, parity, and description of these conditions. Similarly, frequency, duration, and type of exercise may also influence the prevalence. Further investigation is warranted to help guide safe participation in elite sport activity during pregnancy.*

(JCCA. 2024;68(3):204-213)

KEY WORDS: athlete, elite, exercise, pregnant, low back pain, pelvic girdle pain, pelvic floor dysfunction, chiropractic

*Résumé: La prévalence de ces conditions chez les athlètes de haut niveau enceintes varie selon les études. Les valeurs semblent varier en fonction du trimestre, de la parité et de la description de ces conditions. De même, la fréquence, la durée et le type d'exercice peuvent également influencer la prévalence. Une enquête plus approfondie est nécessaire pour orienter une participation sécuritaire à une activité sportive d'élite pendant la grossesse.*

(JCCA. 2024;68(3):204-213)

MOTS CLÉS : athlète, élite, exercice, enceinte, douleur au niveau du bas du dos, douleur au niveau de la ceinture pelvienne, dysfonction du plancher pelvien, chiropratique

## Introduction

Common symptoms during pregnancy include low back pain (LBP), pelvic girdle pain (PGP), and pelvic floor dysfunction (PFD), including urinary incontinence (UI) and fecal incontinence (FI).<sup>1-4</sup> Pregnancy-related LBP is defined as pain located between the costal margins and the inferior gluteal folds, while PGP is pain in the symphysis pubis and/or between the posterior iliac crest and gluteal folds.<sup>5</sup> UI and FI are defined as any involuntary leakage or loss of urine and loss of flatus, liquid, or solid stool, respectively.<sup>6,7</sup> UI has been further categorized as either stress urinary and urge incontinence.<sup>6</sup> Stress UI is involuntary leakage with effort of exertion, or during sneezing or coughing.<sup>6</sup> Urge incontinence is involuntary leakage accompanied by or immediately preceded by urgency.<sup>6</sup> The prevalence of these conditions during pregnancy is high. Approximately 20-90% of pregnant individuals experience pregnancy-related LBP, 20% suffer from PGP, 3-29% FI, and 9-75% UI.<sup>5,8-10</sup>

Muscular strength and endurance training before pregnancy may have a positive influence on prevention and treatment of these conditions in the pregnant population.<sup>11-16</sup> However, there are some inconsistencies surrounding those who participate in high-level sport and determining if their activity level is in fact preventative, a risk factor, or if it is due to the type of activity.<sup>17-22</sup> Prior to pregnancy up to 80% of elite athletes may experience LBP and UI depending on the type of sport participa-

tion.<sup>20, 21, 23</sup> Elite athletes who participate in greater than eight hours of exercise a week, may be at greater risk for developing both UI (33% higher) and FI (15% higher) compared to the general exercising population before pregnancy.<sup>24</sup> Currently there is no research to date investigating the prevalence of pre-pregnancy PGP in elite athletes.

The 2019 Canadian Exercise and Pregnancy guidelines recommend the following exercises for the general population: strength training, aerobic activity, pelvic floor muscle strength training, and stretching/yoga.<sup>25, 26</sup> The exercise recommendations described in this guideline do not account for the high levels of training that an elite athlete may endure preconception and during gestation.<sup>25, 27, 28</sup> Similarly, the International Olympic Committee (IOC) Exercise and Pregnancy in Recreational and Elite Athletes guidelines do not mention any recommendations on training frequency or duration of exercise in the elite pregnant population.<sup>13, 29-31</sup> The IOC recommends that pregnant elite athletes may use perception of exertion or fatigue to gauge their training intensity.<sup>29</sup> The recommendations state that athletes should refrain from training greater than 90% of their max oxygen consumption (VO<sub>2</sub> max) and from doing strenuous strength training to avoid the Valsalva manoeuvre, which can lead to increased pressure on the pelvic floor.<sup>29</sup> In addition, the IOC suggests that if a pregnant elite athlete trains above the current recommendations there is an assumed level of risk.<sup>29</sup> This is due

to the high intensities, volumes, durations, and specific types of exercise training, which have yet to be supported as safe practice during gestation.<sup>29</sup>

The term “elite athlete” has been poorly defined within the literature. A definition of “elite” used within pregnancy related studies is “a person who is a member of any national team or other high-level representative team in any sport organized by a National Sports Federation”, however this definition does not define the training level of an elite athlete.<sup>32</sup> A systematic review of seventeen studies demonstrated that the average training

by an elite athlete was 6.5 hours per day and 5.7 times per week.<sup>33</sup> This training frequency is much higher than the 150 minutes over 3 days recommended for the general pregnant population in the 2019 Canadian Guidelines for Exercise and Pregnancy.<sup>26</sup> Elite athletes may continue to participate in high-level sport and training as they enter and progress through pregnancy.<sup>32, 34</sup> Considering the prevalence of LBP, PGP and PFD is comparable in some elite athletes before pregnancy with the general pregnant population, it is possible that pregnant elite athletes would be at risk for an increased preva-

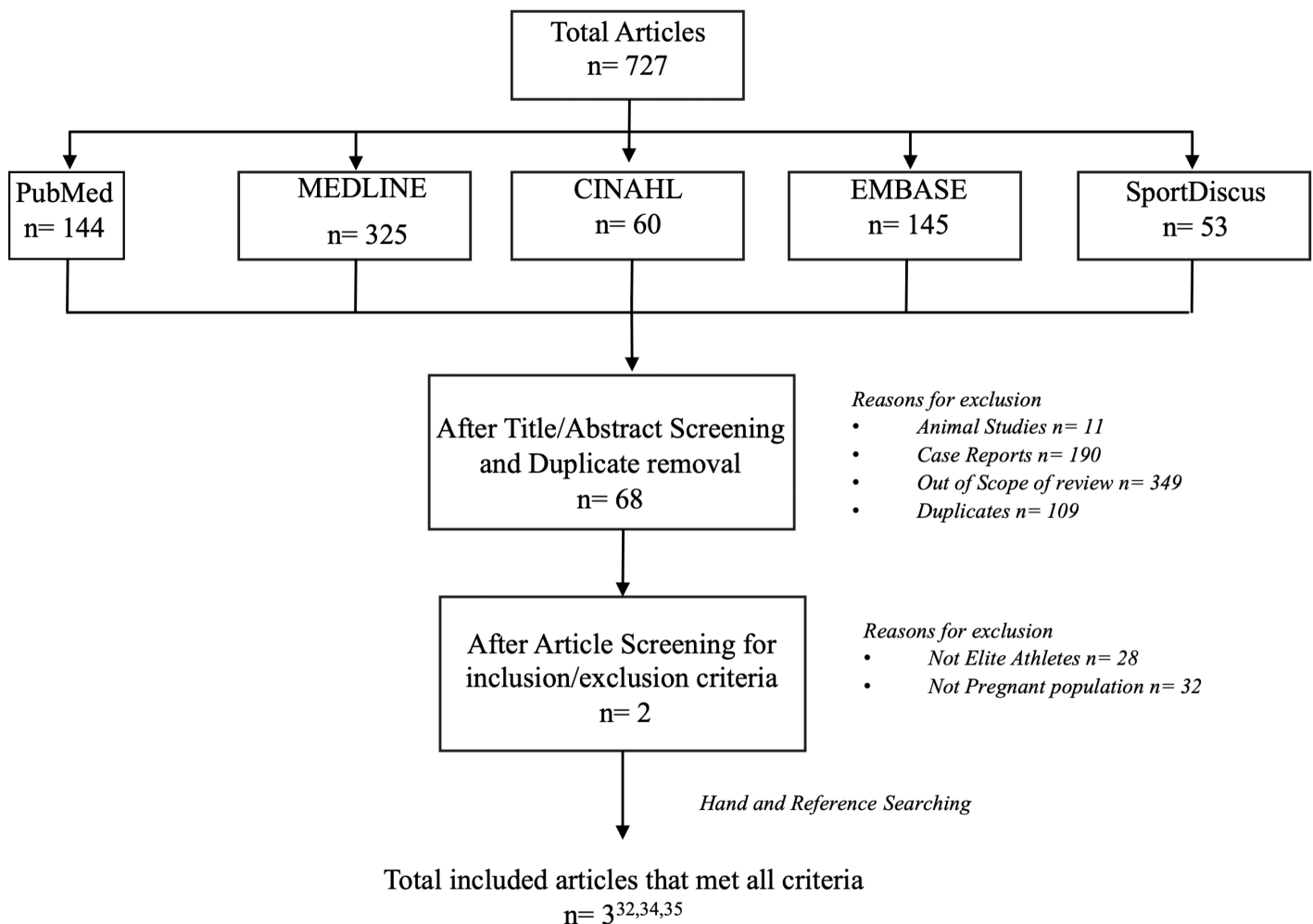


Figure 1.  
Screening process

lence of these conditions, however at this point it is unknown.<sup>8-10, 20-23</sup> To date, there has been minimal research investigating the prevalence of LBP, PGP, and PFD in pregnant elite athletes. The aim of this narrative review is to investigate the prevalence of LBP, PGP, UI, and FI in pregnant elite athletes compared to those who are less active during their pregnancy.

**Methods**

A search was performed in PubMed, MEDLINE (Ovid), EMBASE (Ovid), SportDiscus (EBSCO) and CINAHL (EMSCO) on all articles until July 27, 2023, with the aid of a reference librarian. Reference searching of any retrieved articles and hand searching was also employed. Search terms used were, but not limited to, “athletes” AND “elite” AND “exercise” AND “pregnancy” AND “low back pain” AND “pelvic girdle pain” AND “pelvic floor dysfunction”. An example search strategy, employed in PubMed, can be found in Appendix 1. One reviewer

selected the relevant papers by examining titles first, then abstracts, followed by full text. The quality of the included articles was assessed using the SIGN checklist. The screening process is outlined in Figure 1.

**Results**

The screening process is outlined in Figure 1. There was a total of 727 articles retrieved digitally, which were exported to Microsoft Word for reference management and tracking of the screening process. After removing duplicates, screening titles, and abstracts, a total of sixty-eight articles remained. Hand and reference searching yielded one article.<sup>35</sup> After removing articles that did not fit the inclusion and exclusion criteria (Table 1), a total of three articles remained.<sup>32, 34, 35</sup> Of the three articles, one was a systematic review and two were retrospective observational studies (Table 2).<sup>32, 34, 35</sup> The two retrospective studies were included in the systematic review.

Table 1.  
*Inclusion and exclusion criteria*

Inclusion Criteria	Exclusion Criteria
Published in English in a peer-reviewed journal	Articles not published in English
Experimental (Randomised Clinical Trials), observational (Cohort and Case-Control) studies and systematic review/meta-analysis that compare elite female athletes to a control group	Articles not published in peer-reviewed journals
Elite female athletes of any gestational age	Participants sought out treatment outside the scope of the study, such as spinal manipulation, acupuncture, or other manual therapies
Elite female athletes experiencing low back pain with or without leg pain, pelvic girdle pain and/or pelvic floor dysfunction (urinary and/or fecal incontinence)	Animal studies
Elite female athletes ages 18-45 who are pregnant	
Elite female athletes that compete with a national team or other high-level representative team in any sport organized by a National Sports Federation before and during pregnancy	

Table 2.  
Included papers: prevalence of LBP, PGP, UI, and FI during pregnancy

Author, year	Subject, parity	Study Type	Control Group	LBP	PGP	UI	FI
Bo K and Backe-Hansen KL, 2007 <sup>32</sup>	Pregnant elite athletes (primiparous)	Observational	Age-matched controls, less active, same parity	No rad: 18.5% With rad: 14.8%	*33.3% ** 29.6% ***22.2%	SI: 18.5% UI: 7.1% MI: 3.2%	-----
Sundgot-Borgen J, <i>et al.</i> , 2019 <sup>35</sup>	Pregnant elite athletes (primiparous and multiparous)	Observational	Age-matched controls, less active	1 <sup>st</sup> TM: 0% 2 <sup>nd</sup> TM: 12% 3 <sup>rd</sup> TM: 12%	1 <sup>st</sup> TM: 3% 2 <sup>nd</sup> TM: 9% 3 <sup>rd</sup> TM: 9%	-----	-----
Wowdzia JC, <i>et al.</i> , 2021 <sup>34</sup>	Pregnant elite athletes (primiparous)	Systematic Review	Age-matched controls, less active, same parity	-----	Sundgot-Borgen J:  1 <sup>st</sup> TM: 3.57% 2 <sup>nd</sup> TM: 10.71% 3 <sup>rd</sup> TM: 10.71%  Bo K and Backe-Hansen KL:  74.19%	Sundgot-Borgen J:  Not reported  Bo K and Backe-Hansen KL:  23.91%	-----

TM = trimester; rad = radiation; \*PGP = pubic symphysis pain ; \*\* = PGP (SIJ); \*\*\*PGP = pubic symphysis and SIJ; SI = stress incontinence; UI = urge incontinence; MI = mixed incontinence.

## Discussion

There has been minimal research investigating the prevalence of LBP, PGP, and PFD in pregnant elite athletes. The reported prevalence of these conditions is variable within the literature. Bo and Backe-Hansen were the first authors to investigate the prevalence of LBP, PGP, and PFD in primiparous pregnant athletes compared to age matched controls using a retrospective survey study design.<sup>32</sup> The study had a 77.5% and 57.5% response rate from the elite athlete group and the age matched controls respectively.<sup>32</sup> The prevalence of LBP was found to be 14.8% in those with radiation and 18.5% in those without radiation, while the prevalence in controls was reported to be 28.3% and 32.6%, respectively.<sup>32</sup> PGP was delineated by region, which included pain in the pubic symphysis, sacroiliac joints, and both areas combined.<sup>32</sup> The prevalence was

found to be 33.3%, 29.6%, and 22.2% in pregnant elite athletes and 30.4%, 26.1%, and 15.2% in controls, respectively.<sup>32</sup> Similarly, UI was differentiated into the following types, urge incontinence, stress incontinence, and mixed incontinence.<sup>32</sup> The prevalence was found to be 7.1%, 18.5%, and 3.2% in elite athletes and 8.7%, 15.5%, and 2.2% in controls.<sup>32</sup> Lastly, no elite athletes reported FI during pregnancy, however the prevalence in controls was found to be 2.2%.<sup>32</sup> Bo and Backe-Hansen reported no significant differences in the prevalence of LBP, PGP, or PFDs in elite athletes when compared to age matched controls during pregnancy.<sup>32</sup>

Sundgot-Borgen *et al.* 2019, used a questionnaire to ask 34 Norwegian elite primiparous and multiparous athletes and 34 less active controls various health related questions, including those related to musculoskeletal

conditions.<sup>35</sup> All participants in the study had been pregnant in the previous five years.<sup>35</sup> The authors looked at prevalence during the first, second, and third trimesters.<sup>35</sup> The prevalence of LBP in elite athletes was found to be 0%, 12%, and 12%, while the prevalence in controls was found to be 12%, 21%, and 38%, respectively.<sup>35</sup> A significant difference was noted during the third trimester compared to controls; however no significant difference was noted at any other time points throughout pregnancy for the prevalence of LBP.<sup>35</sup> prevalence of PGP.<sup>35</sup> However, the prevalence was reported to be approximately between 3-9% in pregnant elite athletes and between 0%-15% in controls.<sup>35</sup>

A 2021 systematic review and meta-analysis by Wowdzia *et al.*<sup>34</sup> reported on the prevalence of PGP and UI in primiparous pregnant elite athletes. After pooling the total events of PGP from Bo and Backe-Hansen<sup>32</sup>, they found the prevalence to be 74.19% in elite athletes and 71.73% in controls<sup>34</sup>. Using Sundgot-Borgen *et al.*<sup>35</sup>, the authors removed the multiparous elite athletes to solely examine the primiparous elite athletes<sup>34</sup>. Wowdzia *et al.*<sup>34</sup> found the prevalence of PGP in primiparous elite athletes during trimesters one, two, and three to be 3.57%, 10.71%, and 10.71%, respectively. The prevalence in controls during the first, second, and third trimester was reported to be 0%, 10.34%, and 17.24% respectively.<sup>34</sup> Lastly, they reported the prevalence of UI based on pooled total events from Bo and Back-Hansen<sup>32</sup> to be 22.58% in pregnant elite athletes, while it was 23.91% in controls<sup>34</sup>. The authors concluded that there were no significant differences in the prevalence of these conditions compared to age matched controls.<sup>34</sup> This systematic review concluded that elite athletes have a 62% reduction in the odds of experiencing pregnancy-related LBP compared to age matched controls, however the authors classified it as low certainty of evidence.<sup>34</sup> They also demonstrated no association between preconception competitive sporting exposure of PGP and UI in elite athletes.<sup>34</sup> This was classified as very low certainty of evidence by the authors.<sup>34</sup> Due to a minimal number of studies, small sample sizes, and high bias linked to the studies included in Wowdzia *et al.*'s<sup>34</sup> systematic review, the authors deemed the quality of evidence low for these subgroup complaints.

It appears that prevalence values may be influenced by trimester, parity, and description of these conditions.

The included studies are not consistent when controlling for these variables. As seen in Bo and Backe-Hansen<sup>32</sup>, they included specific descriptions of LBP, PGP, and UI while Sundgot-Borgen *et al.*<sup>35</sup> was non-specific. Furthermore, Bo and Backe-Hansen<sup>32</sup> reported prevalence results for LBP and PGP were not contingent on trimester, whereas Sundgot-Borgen *et al.*<sup>35</sup> specifically looked at prevalence of LBP and PGP during the three trimesters. Lastly, Bo and Backe-Hansen<sup>32</sup> included singleton pregnancies, while Sundgot-Borgen *et al.*<sup>35</sup> included singleton and multiparous pregnancies. These factors may contribute to the variability in the reported prevalence results due to inconsistent categorization of the conditions, changes in biomechanics throughout the trimesters, and parity.

Training frequency, duration, and type of sport (high vs low impact) are all factors that may impact the prevalence of LBP, PGP and PFD.<sup>17-22</sup> Wowdzia *et al.*<sup>34</sup> did not comment on training or sport participation of the elite athletes they were investigating. Bo and Back-Hansen<sup>32</sup> found that the mean training hours in the elite athlete group was recorded at 14 hours/week before pregnancy. This is less than the reported average training of 6.5 hours per day and 5.7 times per week reported in a 2014 systematic review looking at elite athlete training before pregnancy.<sup>33</sup> Bo and Backe-Hansen<sup>32</sup> also reported that a significant number of elite athletes complete specific strength training exercises for the abdominal and back muscles during pregnancy. There was no difference found between elite athletes and age matched controls for pelvic floor strength training during pregnancy.<sup>32</sup> Sundgot-Borgen *et al.*<sup>35</sup> found that both endurance and strength training volume were significantly higher in the elite athletes compared to controls before and during pregnancy. Before pregnancy, elite athletes participated in approximately 750 mins/week of endurance training and 115 mins/week of strength training.<sup>35</sup> This frequency of training is comparable to the frequency reported by Bo and Backe-Hansen.<sup>32</sup> During pregnancy, elite athletes participated in 550-700 mins/week of endurance training and 55-90 mins/week of strength training, with the training time varying based on trimester of pregnancy.<sup>35</sup> The type of sport was not documented by the athletes who completed either survey, leaving no indication if high versus low impact sports were of high participation.<sup>32,35</sup>



### Limitations

The authors of this narrative review recognize that there are limitations including uncertainty if the pain reported by the athletes in the studies was indeed due to their pregnancy and not due to a previous injury/pathology. The type of sport participation was not identified in the included studies, which may skew the results. The term “elite athlete” is poorly defined in the literature. A standard definition that includes training intensity, frequency and duration fails to exist. Lastly, the quality of the studies included in the review are of low to moderate quality. They had poor sample sizes, high heterogeneity, were observational retrospective survey studies, and used only those living in Norway.

### Conclusion

With minimal high-quality research available, it appears that the prevalence of LBP, PGP, and PFD in pregnant elite athletes is variable. The prevalence appears to change based on trimester, parity, and description of these conditions. Similarly, frequency, duration, and type of exercise may also lead to the variability in the reported prevalence numbers. Due to a lack of studies on this topic, definitive conclusions cannot be drawn. As more and more elite athletes continue participating in high-level sport and training throughout their pregnancy, there is a need for further investigation surrounding the prevalence of these conditions in pregnant elite athletes in order to provide the necessary information to support these athletes' safe participation in sport at an elite level.

### References

1. Casagrande D, Gugala Z, Clark SM, Lindsey RW. Low back pain and pelvic girdle pain in pregnancy. *J Amer Acad Orthopaed Surg*. 2015; 23(9): 539-549.
2. Bump RC, Norton PA. Epidemiology and natural history of pelvic floor dysfunction. *Obstetr Gynecol Clin North Am*. 1998; 25(4):723-746.
3. Thom DH, Rortveit G. Prevalence of postpartum urinary incontinence: a systematic review. *Acta Obstetricia Gynecolog Scand*. 2010; 89(12): 1511-1522.
4. Boyle R, Hay-Smith EJ, Cody JD, Mørkved S. Pelvic floor muscle training for prevention and treatment of urinary and fecal incontinence in antenatal and postnatal women: a short version Cochrane review. *Neurourol Urodynam*. 2014; 33(3): 269-276.
5. Weis CA, Barrett J, Tavares P, *et al*. Prevalence of low back pain, pelvic girdle pain, and combination pain in a pregnant Ontario population. *J Obstetr Gynaecol Canada*. 2018; 40(8): 1038-1043.
6. Abrams P, Cardozo L, Fall M, *et al*. The standardisation of terminology in lower urinary tract function: report from the standardisation sub-committee of the International Continence Society. *Urology*. 2003; 61(1): 37-49.
7. Sultan AH. Anal incontinence after childbirth. *Curr Op Obstetr Gynecol*. 1997; 9(5): 320-324.
8. Cęprnja D, Chipchase L, Gupta A. Prevalence of pregnancy-related pelvic girdle pain and associated factors in Australia: a cross-sectional study protocol. *BMJ Open*. 2017;7(11): e018334.
9. Moosdorff-Steinhaus HF, Berghmans BC, Spaanderman ME, Bols EM. Prevalence, incidence and bothersomeness of urinary incontinence in pregnancy: a systematic review and meta-analysis. *Intl Urogynecol J*. 2021; 22:1-20.
10. Vleeming A, Albert HB, Östgaard HC, Stuesson B, Stuge B. European guidelines for the diagnosis and treatment of pelvic girdle pain. *Eur Spine J* 2008; 17: 794-819.
11. Marín-Jiménez N, Acosta-Manzano P, Borges-Cosic M, *et al*. Association of self-reported physical fitness with pain during pregnancy: the GESTAFIT Project. *Scand J Med Sci Sports*. 2019; 29(7):1022-1030.
12. Wiezer M, Hage-Fransen MA, Otto A, *et al*. Risk factors for pelvic girdle pain postpartum and pregnancy related low back pain postpartum; a systematic review and meta-analysis. *Musculoskel Sci Pract*. 2020; 48:102154.
13. Bo K, Artal R, Barakat R, Brown W, *et al*. Exercise and pregnancy in recreational and elite athletes: 2016 evidence summary from the IOC expert group meeting, Lausanne. Part 1-exercise in women planning pregnancy and those who are pregnant. *Br J Sport Med*. 2016; 50(10): 571-589.
14. Davenport MH, Nagpal TS, Mottola MF, *et al*. Prenatal exercise (including but not limited to pelvic floor muscle training) and urinary incontinence during and following pregnancy: a systematic review and meta-analysis. *Br J Sport Med*. 2018; 52(21):1397-1404.
15. Owe KM, Bjelland EK, Stuge B, *et al*. Exercise level before pregnancy and engaging in high-impact sports reduce the risk of pelvic girdle pain: a population-based cohort study of 39 184 women. *Br J Sport Med*. 2016; 50(13): 817-822.
16. Mogren IM, Pohjanen AI. Low back pain and pelvic pain during pregnancy: prevalence and risk factors. *Spine*. 2005; 30(8): 983-991.
17. Bø K. Urinary incontinence, pelvic floor dysfunction, exercise and sport. *Sports Med*. 2004; 34: 451-464.
18. Bø K, Engh ME, Hilde G. Regular exercisers have stronger pelvic floor muscles than nonregular exercisers at midpregnancy. *Am J Obstetr Gynecol*. 2018; 218(4): 427-e1.
19. da Silva Borin LC, Nunes FR, de Oliveira Guirro EC. Assessment of pelvic floor muscle pressure in female athletes. *J Injur Function Rehabil*. 2013; 5(3):189-193.

20. Nygaard IE, Thompson FL, Svengalis SL, Albright JP. Urinary incontinence in elite nulliparous athletes. *Obstetr Gynecol.* 1994; 84(2): 183-187.
21. Eliasson K, Larsson T, Mattsson E. Prevalence of stress incontinence in nulliparous elite trampolinists. *Scand J Med Sci Sport.* 2002; 12(2): 106-110.
22. Casey EK, Temme K. Pelvic floor muscle function and urinary incontinence in the female athlete. *Phys Sportsmed.* 2017; 45(4): 399-407.
23. Trompeter K, Fett D, Platen P. Prevalence of back pain in sports: a systematic review of the literature. *Sports Med.* 2017; 47: 1183-1207.
24. Vitton V, Baumstarck-Barrau K, Brardjanian S, *et al.* Impact of high-level sport practice on anal incontinence in a healthy young female population. *J Women Health.* 2011; 20(5): 757-763.
25. American College of Obstetricians and Gynecologists. Committee opinion no. 650. *Obstetr Gynecol.* 2015;126(6): e135-142.
26. Mottola MF, Davenport MH, Ruchat SM, *et al.* 2019 Canadian guideline for physical activity throughout pregnancy. *Br J Sport Med.* 2018; 52(21): 1339-1346.
27. Artal R, O'Toole M. Guidelines of the American College of Obstetricians and Gynecologists for exercise during pregnancy and the postpartum period. *Br J Sport Med.* 2003; 37(1): 6-12.
28. Evenson KR, Barakat R, Brown WJ, *et al.* Guidelines for physical activity during pregnancy: comparisons from around the world. *Am J Lifestyl Med.* 2014; 8(2):102-121.
29. Bø K, Artal R, Barakat R, *et al.* Exercise and pregnancy in recreational and elite athletes: 2016/2017 evidence summary from the IOC expert group meeting, Lausanne. Part 5. recommendations for health professionals and active women. *Br J Sport Med.* 2018; 52(17):1080-1085.
30. Bø K, Artal R, Barakat R, Brown W, *et al.* Exercise and pregnancy in recreational and elite athletes: 2016 evidence summary from the IOC expert group meeting, Lausanne. Part 2—the effect of exercise on the fetus, labour and birth. *Br J Sport Med.* 2016; 50(21):1297-1305.
31. Bø K, Artal R, Barakat R, Brown WJ, *et al.* Exercise and pregnancy in recreational and elite athletes: 2016/17 evidence summary from the IOC expert group meeting, Lausanne. Part 4- recommendations for future research. *Br J Sports Med.* 2017; 51(24):1724-1726.
32. Bø K, Backe-Hansen KL. Do elite athletes experience low back, pelvic girdle and pelvic floor complaints during and after pregnancy? *Scand J Med Sci Sport.* 2007; (5): 480-487.
33. Swann C, Moran A, Piggott D. Defining elite athletes: issues in the study of expert performance in sport psychology. *Psychol Sport Exercise.* 2015; 16: 3-14.
34. Wowdzia JB, McHugh TL, Thornton J, *et al.* Elite athletes and pregnancy outcomes: a systematic review and meta-analysis. *Med Sci Sports Exercise.* 2021; 53(3): 534-542.
35. Sundgot-Borgen J, Sundgot-Borgen C, Myklebust G, Sølvsberg N, Torstveit MK. Elite athletes get pregnant, have healthy babies and return to sport early postpartum. *BMJ Open Sport Exercise Med.* 2019; 5(1): e000652.



Appendix 1.

*PubMed search strategy*

(((((“Intervertebral Disc/injuries”[Mesh])) OR (“Intervertebral Disc Degeneration”[Mesh] OR “Intervertebral Disc Displacement”[Mesh])) OR (“Osteoarthritis, Spine”[Mesh])) OR (“Spinal Injuries”[Mesh])) OR (“Spondylolysis”[Mesh])) OR (“Synovial Cyst”[Mesh])) OR (“Spinal Curvatures”[Mesh])) OR (“Polyradiculopathy”[Mesh])) OR (“Zygapophyseal Joint/injuries”[Mesh])) OR (“Spinal Diseases”[Mesh])) OR (“Spinal Stenosis”[Mesh])) AND ((lumbar\*[Title/Abstract] OR (low back[Title/Abstract]) OR low-back\*[Title/Abstract] OR (lower back[Title/Abstract]) OR lower-back\*[Title/Abstract] OR thoracolumbar\*[Title/Abstract] OR thoraco-lumbar\*[Title/Abstract] OR lumbosacral\*[Title/Abstract] OR lumbo-sacral\*[Title/Abstract] OR sacral\*[Title/Abstract] OR sacro-iliac\*[Title/Abstract] OR sacroiliac\*[Title/Abstract]))) OR (((((((((((((((((((((((((((“Low Back Pain”[Mesh]) OR (“Back Pain”[Mesh])) OR (“Back Injuries”[Mesh:NoExp])) OR (“Back Muscles/injuries”[Mesh])) OR (“Lumbar Vertebrae/injuries”[Mesh])) OR (“Lumbosacral Plexus/injuries”[Mesh])) OR (“Lumbosacral Region/injuries”[Mesh])) OR (“Piriformis Muscle Syndrome”[Mesh])) OR (“Sacrococcygeal Region/injuries”[Mesh])) OR (“Sacroiliac Joint/injuries”[Mesh])) OR (“Coccyx/injuries”[Mesh])) OR (“Sacrum/injuries”[Mesh])) OR (“Sciatica”[Mesh])) OR (lumbar disk extrusion[Title/Abstract] OR lumbar disk degeneration[Title/Abstract] OR lumbar disk herniation[Title/Abstract] OR lumbar disk prolapse[Title/Abstract] OR lumbar disk protrusion[Title/Abstract] OR lumbar disk avulsion[Title/Abstract] OR herniated lumbar disk[Title/Abstract] OR slipped lumbar disk[Title/Abstract] OR prolapsed lumbar disk[Title/Abstract] OR degenerated lumbar disk[Title/Abstract] OR extruded lumbar disk[Title/Abstract] OR protruded lumbar disk[Title/Abstract] OR avulsed lumbar disk[Title/Abstract] OR lumbar herniated disk[Title/Abstract]))) OR (lumbar pain[Title/Abstract] OR lumbar facet[Title/Abstract] OR lumbar nerve root[Title/Abstract] OR lumbar osteoarthritis[Title/Abstract] OR lumbar radiculopathy[Title/Abstract] OR lumbar stenosis[Title/Abstract] OR lumbar spondylolysis[Title/Abstract] OR lumbar zygapophyseal[Title/Abstract] OR lumbar injuries[Title/Abstract] OR lumbar discomfort[Title/Abstract] OR lumbar soreness[Title/Abstract] OR lumbar herniation[Title/Abstract] OR herniated lumbar[Title/Abstract])) OR (back ache[Title/Abstract] OR backache[Title/Abstract] OR back injuries[Title/Abstract] OR back pain[Title/Abstract] OR back sprain[Title/Abstract] OR back strain[Title/Abstract])) OR (back pain[Title/Abstract] OR back-pain[Title/Abstract])) OR (back muscle[Title/Abstract] OR lumbar fascia[Title/Abstract] OR coccydynia[Title/Abstract] OR coccyx[Title/Abstract] OR coccygodynia [Title/Abstract] OR coccalgia [Title/Abstract] OR coccygalgia [Title/Abstract] OR coccygeal pain[Title/Abstract] OR dorsalgia[Title/Abstract] OR lumbarsacr\*[Title/Abstract] OR lumbago\*[Title/Abstract] OR lumbar-sacral\*[Title/Abstract] OR lumboischialgia[Title/Abstract] OR lumbosacr\*[Title/Abstract] OR lumbo-sacral\*[Title/Abstract] OR piriformis syndrome[Title/Abstract] OR sacral pain[Title/Abstract] OR sacral radiculopathy[Title/Abstract] OR sacral nerve root[Title/Abstract] OR sacrococcygeal pain[Title/Abstract] OR sacroiliac\* [Title/Abstract] OR sacro-iliac[Title/Abstract] OR sciatic\*[Title/Abstract] OR SI joint[Title/Abstract] OR spinal stenosis[Title/Abstract] OR tailbone pain[Title/Abstract] OR tailbone radiculopathy[Title/Abstract] OR tailbone nerve root[Title/Abstract] OR vertebrogenic pain[Title/Abstract] OR poly-radicul\* [Title/Abstract] OR polyradicul\*[Title/Abstract] OR lumbar neuropathy[Title/Abstract] OR lumbar-sacral neuropathy[Title/Abstract] OR lumbo-sacral neuropathy[Title/Abstract] OR sacral neuropathy[Title/Abstract] OR low back neuropathy[Title/Abstract] OR low back radiculopathy [Title/Abstract] OR low-back radiculopathy[Title/Abstract] OR lower back radiculopathy[Title/Abstract] OR lower-back radiculopathy[Title/Abstract] OR lumbar radiculopathy[Title/Abstract] OR lumbo-sacral radiculopathy[Title/Abstract] OR lumbar-sacral radiculopathy[Title/Abstract] OR L1 radiculopathy[Title/Abstract] OR L2 radiculopathy[Title/Abstract] OR L3 radiculopathy[Title/Abstract] OR L4 radiculopathy[Title/Abstract] OR L5 radiculopathy[Title/Abstract] OR radiating low back[Title/Abstract] OR radiating low-back[Title/Abstract] OR radiating lower-back[Title/Abstract] OR radiating lumbar[Title/Abstract] OR radiating lumbo-sacral[Title/Abstract] OR L1 radiating[Title/Abstract] OR L2 radiating[Title/Abstract] OR L3 radiating[Title/Abstract] OR L4 radiating[Title/Abstract] OR L5 radiating [Title/Abstract] OR radicular low back[Title/Abstract] OR radicular low-back[Title/Abstract] OR radicular lower back[Title/Abstract] OR radicular lower-back[Title/Abstract] OR radicular lumbar[Title/Abstract] OR radicular lumbo-sacral[Title/Abstract] OR radicular L1 [Title/Abstract] OR radicular L2[Title/Abstract] OR radicular L3 [Title/Abstract] OR radicular L4[Title/Abstract] OR radicular L5[Title/Abstract] OR L1 radicular[Title/Abstract] OR L2 radicular[Title/Abstract] OR L3 radicular[Title/Abstract] OR L4 radicular[Title/Abstract] OR L5 radicular [Title/Abstract] OR pelvic girdle pain [Title/Abstract] OR pelvic pain[Title/Abstract] OR pelvis pain[Title/Abstract])) OR (“Pelvic Girdle Pain”[Mesh])) OR (“Pelvic Pain”[Mesh])) OR (urinary

incontinence[Title/Abstract] OR fecal incontinence[Title/Abstract])))) OR (((pelvi\* pain\*[Title/Abstract] OR (pelvi\*
 injur\*[Title/Abstract] OR (pelvi\* ach\*[Title/Abstract] OR (pelvi\* myalg\*[Title/Abstract] OR (pelvi\* symptom\*[Title/
 Abstract] OR (pelvi\* syndrome\*[Title/Abstract] OR (pelvi\* discomfort\*[Title/Abstract] OR (pelvi\* sore\*[Title/Abstract]
 OR (pelvi\* impairment\*[Title/Abstract] OR (pelvi\* disorder\*[Title/Abstract] OR (pelvic floor dysfunction\*[Title/
 Abstract] OR (pelvi\* dysfunction\*[Title/Abstract] OR (pelvi\* tear\*[Title/Abstract] OR (pelvi\* imping\*[Title/Abstract]
 OR (pelvi\* sprain\*[Title/Abstract] OR (pelvi\* strain\*[Title/Abstract])) OR (pfd[Title/Abstract])) AND
 (((((((((((("Pregnancy"[Mesh] OR ("Pregnant Women"[Mesh])) OR ("Pregnancy Outcome"[Mesh:NoExp])) OR
 ("Pregnancy Complications"[Mesh:NoExp])) OR ("Prenatal Care"[Mesh])) OR ("Parturition"[Mesh])) OR (antenatal[Title/
 Abstract] OR "ante natal"[Title/Abstract] OR ante-natal[Title/Abstract] OR prenatal[Title/Abstract] OR "pre natal"[Title/
 Abstract] OR pre-natal[Title/Abstract] OR perinatal[Title/Abstract] OR "peri natal"[Title/Abstract] OR peri-natal[Title/
 Abstract])))) OR ("Pregnancy Outcome"[Mesh])) OR ((antepartum[Title/Abstract] OR ante-partum[Title/Abstract] OR
 prenatal\*[Title/Abstract] OR intrapartum[Title/Abstract] OR intra-partum[Title/Abstract] OR perinatal\*[Title/Abstract] OR
 peri-natal\*[Title/Abstract])) OR ((gestation\*[Title/Abstract] OR obstetric\*[Title/Abstract] OR (expectant mother\*[Title/
 Abstract] OR mother-to-be[Title/Abstract] OR mothers-to-be[Title/Abstract] OR maternit\*[Title/Abstract] OR
 maternal[Title/Abstract] OR "before delivery"[Title/Abstract] OR childbearing[Title/Abstract] OR child-bearing[Title/
 Abstract] OR gravidit\*[Title/Abstract])))) AND (((((((((((("Athletes"[Mesh] OR ("Sports"[Mesh])) OR ("Athletic
 Performance"[Mesh])) OR ("Athletic Injuries"[Mesh])) OR ("Games, Recreational"[Mesh])) OR ("Psychology,
 Sports"[Mesh])) OR ("Return to Sport"[Mesh])) OR ("Sports Medicine"[Mesh])) OR ("Sports Nutritional Sciences"[Mesh]
 OR "Sports Nutritional Physiological Phenomena"[Mesh])) OR (sport\*[Title/Abstract] OR athlet\*[Title/Abstract] OR
 soccer\*[Title/Abstract] OR play\*[Title/Abstract] OR game\*[Title/Abstract] OR elite\*[Title/Abstract] OR olympi\*[Title/
 Abstract] OR competitive\*[Title/Abstract] OR competition\*[Title/Abstract] OR recreation\*[Title/Abstract] OR
 varsity\*[Title/Abstract] OR hockey\*[Title/Abstract] OR baseball\*[Title/Abstract] OR basketball\*[Title/Abstract] OR
 taekwondo\*[Title/Abstract] OR rugby\*[Title/Abstract] OR swim\*[Title/Abstract] OR tennis\*[Title/Abstract] OR
 skiing\*[Title/Abstract] OR archer\*[Title/Abstract] OR badminton\*[Title/Abstract] OR biath\*[Title/Abstract] OR
 bmx\*[Title/Abstract] OR bobsle\*[Title/Abstract] OR bowling\*[Title/Abstract] OR bowler\*[Title/Abstract] OR
 boxing\*[Title/Abstract] OR boxer\*[Title/Abstract] OR basketball\*[Title/Abstract] OR baseball\*[Title/Abstract] OR
 canoe\*[Title/Abstract] OR cricket\*[Title/Abstract] OR curling\*[Title/Abstract] OR cycling\*[Title/Abstract] OR
 cyclist\*[Title/Abstract] OR diving\*[Title/Abstract] OR diver[Title/Abstract] OR divers[Title/Abstract] OR equest\*[Title/
 Abstract] OR fencing\*[Title/Abstract] OR fencer\*[Title/Abstract] OR golf\*[Title/Abstract] OR football\*[Title/Abstract] OR
 gymnast\*[Title/Abstract] OR hockey\*[Title/Abstract] OR jiu jitsu[Title/Abstract] OR jiu-jitsu[Title/Abstract] OR ju
 jitsu[Title/Abstract] OR ju-jitsu\*[Title/Abstract] OR jogging\*[Title/Abstract] OR jogger\*[Title/Abstract] OR judo\*[Title/
 Abstract] OR karate\*[Title/Abstract] OR kayak\*[Title/Abstract] OR kendo\*[Title/Abstract] OR kung fu[Title/Abstract] OR
 kung-fu\*[Title/Abstract] OR lacrosse\*[Title/Abstract] OR luge[Title/Abstract] OR martial arts[Title/Abstract] OR
 mountaineer\*[Title/Abstract] OR qigong\*[Title/Abstract] OR qi-gong\*[Title/Abstract] OR racquet\*[Title/Abstract] OR
 ringette\*[Title/Abstract] OR rower\*[Title/Abstract] OR rowing\*[Title/Abstract] OR rugby\*[Title/Abstract] OR
 runner\*[Title/Abstract] OR running\*[Title/Abstract] OR sailing\*[Title/Abstract] OR sailor\*[Title/Abstract] OR
 shooter\*[Title/Abstract] OR shooting\*[Title/Abstract] OR soccer\*[Title/Abstract] OR skiing\*[Title/Abstract] OR
 skier\*[Title/Abstract] OR skating\*[Title/Abstract] OR skater\*[Title/Abstract] OR sled\*[Title/Abstract] OR
 snowboard\*[Title/Abstract] OR softball\*[Title/Abstract] OR speed skating[Title/Abstract] OR speedskat\*[Title/Abstract]
 OR sprinting\*[Title/Abstract] OR sprinter\*[Title/Abstract] OR squash\*[Title/Abstract] OR swim\*[Title/Abstract] OR
 taekwondo\*[Title/Abstract] OR tai chi[Title/Abstract] OR tai ji[Title/Abstract] OR taiji\*[Title/Abstract] OR taichi\*[Title/
 Abstract] OR tennis\* [Title/Abstract] OR triath\*[Title/Abstract] OR volleyball\*[Title/Abstract] OR wakeboard\*[Title/
 Abstract] OR water polo[Title/Abstract] OR wrestling\*[Title/Abstract] OR wrestler\*[Title/Abstract] OR weightlift\*[Title/
 Abstract] OR weight lift[Title/Abstract] OR walking\*[Title/Abstract] OR "return to play"[Title/Abstract] OR
 competition[Title/Abstract] OR competitive\*[Title/Abstract] OR elite\*[Title/Abstract] OR game\*[Title/Abstract] OR
 olympi\*[Title/Abstract] OR recreational\*[Title/Abstract] OR varsity\*[Title/Abstract]))))