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How Hormonal Contraceptives Influence Injury In Female Athletes: A Systematic Review

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HOW HORMONAL CONTRACEPTIVES INFLUENCE INJURY IN FEMALE ATHLETES: A SYSTEMATIC REVIEW

by

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ABSTRACT

Research indicates that female athletes have a higher risk of musculoskeletal injuries. Hormone fluctuations throughout the different periods of the menstruation cycle impacts the risk of injuries for women. Contraceptive use, most used in the form of an oral contraceptive pill, directly effects hormones and menstrual cycle related symptoms, with evidence of ameliorating some symptoms. Oral contraceptive use is suggested to influence musculoskeletal injuries in female athletes. However, there is little research and data that explores the direct relationship between oral contraceptive use and the injury rates of female athletes. Within this systematic review, five articles investigating this relationship fulfilled the inclusion criteria and were analyzed. Three of the reviewed articles supported a positive and potentially preventative factor, while the other two allude towards no correlation between oral contraceptive use and the rate of injury for female athletes. Findings suggest that more research needs to be conducted on this research topic to determine a concise understanding of the relationship between oral contraceptive use and the injury rates of female athletes.

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BACKGROUND

Introduction and Purpose

Within recent years, participation in female sports has tremendously spiked. It is undeniably a triumph for female athletes to compete in and possibly surpass the intensity of male sports, from high school and collegiate programs to professional athletics. It is disregarded that female athletes brave against the natural difference in their physiology, consisting of fluctuating hormone levels, looser ligaments, and bone alignment differences. Sport-related injuries are more common in female athletes than in males. An anterior cruciate ligament (ACL) tear is one of the most notable deterrents for return to sport and is two to eight times more likely to occur in females than males. By this standard, female athletes risk a lot more than their male counterparts, both physically and mentally, during the recovery period from injury. These reasons warrant resources being devoted to future research on injury prevention for female athletes, whether it targets monitoring menstruation cycles of athletes or a neuromuscular program specific to the genetic physiology and biomechanical differences in females versus males.

Menstruation is a factor that may influence injury potential in female athletes. Specifically, hormonal contraceptives, of which almost half of the athletes in a study of 189 females[1] and nearly half in a larger study of 430 elite athletes[2] reported using, may further influence injury rates in female athletes. Since hormonal contraceptives are commonly used by female athletes and directly influence their hormone levels, it is important to understand whether they are a protective or risk factor for the already increased rate of injury in females. The purpose of this paper is to evaluate the quality of the literature and gauge the influence of hormonal contraceptives on injury rates in female athletes.

Biological Predisposition

To truly grasp the urgency of this research, certain topics pertaining to the genetic predisposition and challenges of female athletes need to be elucidated. From an evolutionary and biological perspective, the female body was adapted to bear children. One of the main physical differences in the musculoskeletal system is that females have a wider pelvis. The wider pelvic structure of the female is responsible for changes in the lower extremity alignment of the knees and ankle.3 In combination, there is a natural increased risk of sport-related injuries that males are not burdened by. Similar risk factors for female injury include, but are not limited to, a smaller calf girth, and narrower space which the ACL is located in. These all contribute to females having higher loading rates, or the speed at which forces are being applied to the body, that injures ligaments.3

The endocrine system is composed of the glands and organs that create and regulate the different hormones required for daily functions. Estrogen is a key sex hormone of the endocrine system related to female reproductive organs4, as well as the regulation of menstrual bleeding.5 Therefore, females have higher estrogen levels than males.6 One hormonal function is to support the muscles and connective tissue. As a result, hormone levels are directly impacted by exercise including the decrease of sex hormones. Females that consistently exercise, and not just those who engage in sports, have a greater chance of developing menstrual disturbances.7 Disturbances can range from oligomenorrhoea, or irregular menstruation, whether they occur more often or for longer periods of time, to the absence of menstruation known as amenorrhea. During the investigation of the menstrual cycle's effect on female athletes, many significant findings were discovered.8 It is important to note that joint laxity, commonly termed loose ligaments, is directly associated with musculoskeletal injuries.9 Research shows the impact of menstruation starts from menarche, or the first period a girl experiences. Research conducted on

female athletes in high school suggests an increase in musculoskeletal injuries for athletes with irregular menstrual cycles, making it three times more likely to suffer one compared to those with regular cycles.[10]

Female Athlete Triad

The female athlete triad is unique to physically active women, comprised of having one of more of the following symptoms: menstrual dysfunction, low energy availability (with or without an eating disorder), and low bone mineral density. This syndrome is associated with an increases risk for various other medical conditions.[11] Adolescent athletes are the most at risk to the triad's harmful effects due to bone mass peaking during this age period.[12] Research shows that the adolescent time period accumulates an estimate of 40% of total bone mass, in which peak bone mass is a predictor for the diagnosis of osteoporosis.[13] The prevalence of amenorrhea and menstrual disturbances is higher for adolescent athletes effect by the female athlete triad.[11] In a study comparing the menstrual cycles of female student athletes and sedentary students, 54% of the athlete group had menstrual abnormalities.[14] Other studies have shown musculoskeletal injuries are 3 times as likely for female athletes with menstrual abnormalities.[12]

Hormonal Contraceptives

Hormonal contraceptives such as oral contraceptive pills (OCPs), intrauterine device (IUD), and subcutaneous implants are well known for their 99% effectiveness in preventing pregnancy.[5] There are various and commonly requested non-contraceptive clinical uses such as menstrual pain or irregularity.[5] Some athletes even report being on a hormonal contraceptive for the altering menstruation effects, such as delaying their period for training and competition purposes.[15] The preferred method of birth control for most females is OCPs for the ease and lack of interruption or pain upon insertion.[5] OCPs typically simulate the average menstrual cycle

of 28 days of which an active pill is taken the first 21 days followed by seven days of placebos.[16] Progesterone is a hormone produced by females that naturally prevents ovulation, the release of eggs by the ovaries, and therefore, pregnancy. There are two types of OCPs; the most prescribed is combination pills consisting of both estrogen and progesterone, the alternative being progesterone-only pills. An important discovery is the decrease in injuries for athletes taking OCPs, potentially credited to their effectiveness minimizing premenstrual symptoms and dysmenorrhea.[17] It was established that 73.6% of the female athletes taking oral contraceptives in a study had an irregular menstruation cycle within the previous year.[15] Another study that analyzed the performance of athletes taking oral birth control during menstruation demonstrated athletic improvement due to the decrease in the female sex hormones, estrogen, and progestogen.[18]

IMPORTANCE OF RESEARCH

The successful growth in numbers of female athletes over the past decade needs to not only be maintained but continue to incline. A potential hindrance to the continuation of female participation in sports is injury and return to sport ratio, in which there is currently a lack of knowledge and research. Although there is an abundance of research supporting the direct correlation between menstruation and injuries of female athlete, there are no preventative measures implicated or even in the process of being researched to combat the findings. These findings have not been effectively communicated to female athletes of all levels, from high school and collegiate programs to professional and national teams. Female athletes have a lower rate of return to sport compared to men after suffering an ACL injury. These findings are consistent amongst differing injuries as well, making it even more dire to prevent female injuries it is recommended to require these coaches be trained to use preventative measures for warmups or educate their athletes on the risks during menstruation and effects of contraceptives.

METHODOLOGY

The research question, examining how hormonal contraceptives influence injury in female athletes, results in three possible outcomes outline by each hypothesis:

Hypothesis 1: The use of hormonal contraceptives decreases the frequency of injuries sustained by female athletes, offering a potential protective factor.

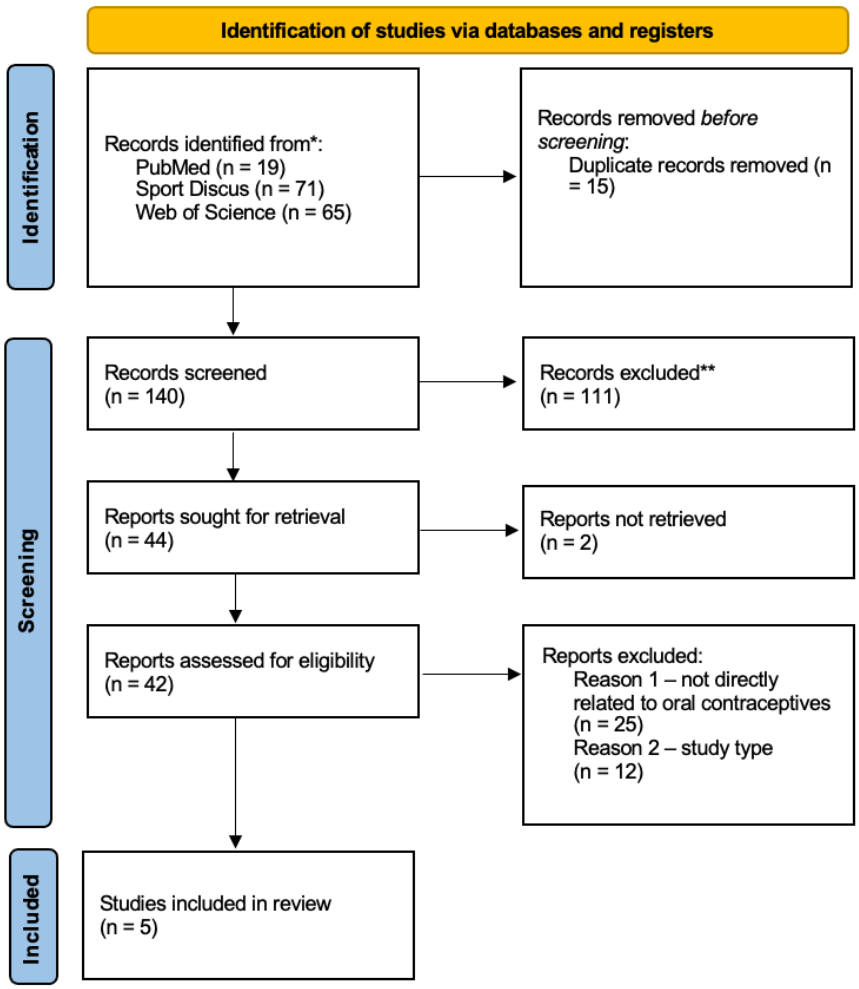
Hypothesis 2: The use of hormonal contraceptives increases the frequency of injuries sustained by female athletes, serving as a possible risk factor.

Hypothesis 3: The use of hormonal contraceptives has no significant effect on the frequency of injuries sustained by female athletes.

To conduct the search for the potential study candidates for this systematic review examining the influence of hormonal contraceptive and injury in female athletes, specific databases will used. The three databases consisted of PubMed, SPORTDiscus, and Web of Science. The search used keywords, both independently and in combination: hormonal contraceptive, oral contraceptive, intrauterine device, female athlete(s), injury, musculoskeletal injury, female athlete triad, irregular menstruation, menstrual disturbance, and menstrual cycle. For the study to be included in the systematic literature review, it must meet certain criteria. This criterion included a publication date between 2000 and 2024, available in the English language, the availability of the full text article, and investigated the effects of contraceptives on athletic injury in females. Acceptable study designs include randomized controlled trials (RCT), cohort studies, and case- controlled studies, Systematic literature reviews and case reports will be excluded. The appraisal for inclusion involved the consensus of the lead author and committee chair.

APPENDIX A: FIGURE 1: CONSORT FLOW DIAGRAM

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only



*Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers).

**If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

For more information, visit: http://www.prisma-statement.org/

APPENDIX B: STUDIES REVIEWED

(1) MÖLLER-NIELSEN, J.; HAMMAR, M. Women's Soccer Injuries in Relation to the Menstrual Cycle and Oral Contraceptive Use. *Med. Sci. Sports Exerc.* **1989**, *21* (2).
(2) Martineau, P. A.; Al-Jassir, F.; Lenczner, E.; Burman, M. L. Effect of the Oral Contraceptive Pill on Ligamentous Laxity. *Clin. J. Sport Med.* **2004**, *14* (5).
(3) Rodriguez, L. I.; Liu, Y.; Soedirdjo, S.; Thakur, B.; Dhaher, Y. Oral Contraception Use and Musculotendinous Injury in Young Female Patients: A Database Study. *Med. Sci. SPORTS Exerc.* **2024**, *56* (3), 511–519. https://doi.org/10.1249/MSS.0000000000003334.
(4) Cheng, J.; Santiago, K. A.; Abutalib, Z.; Temme, K. E.; Hulme, A.; Goolsby, M. A.; Esopenko, C. L.; Casey, E. K. Menstrual Irregularity, Hormonal Contraceptive Use, and Bone Stress Injuries in Collegiate Female Athletes in the United States. *PM R* **2021**, *13* (11), 1207–1215. https://doi.org/10.1002/pmrj.12539.
(5) Ruedl, G.; Ploner, P.; Linortner, I.; Schranz, A.; Fink, C.; Sommersacher, R.; Pocecco, E.; Nachbauer, W.; Burtscher, M. Are Oral Contraceptive Use and Menstrual Cycle Phase Related to Anterior Cruciate Ligament Injury Risk in Female Recreational Skiers? *Knee Surg. Sports Traumatol. Arthrosc.* **2009**, *17* (9), 1065–1069. https://doi.org/10.1007/s00167-009-0786-0.

APPENDIX C: TABLE 1: DESCRIPTION OF STUDIES BY DATE OF PUBLICATION

Authors	Study Title	Date of Publication	Study Type	Purpose	Sample	Key Findings	OC Effect
Möller-Nielsen and Hammar	Women's Soccer Injuries in Relation to the Menstrual Cycle and Oral Contraceptive Use	1989	Prospective Study	To investigate when women soccer players incurred more traumatic injuries: during the premenstrual and menstrual phases, or during the rest of the menstrual cycle, to analyze whether the use of oral contraceptives inlfuenced the rate of injury during any part of the menstrual cycle.	108 women soccer players from the First, Second, and Third Leagues of Swedish Football	Women soccer players were more susceptible to traumatic injuries during the premenstrual and menstrual periods compared to the rest of the cycle. Women using contraceptive pills had a lower rate of traumatic injuries than those not using contraceptive pills. Oral contraceptives ameliorate some symptoms relating to the pre- and menstrual periods, which correlates with the decreased risk of injury.	POSITIVE/ PREVENTATIVE
Martineau et al.	Effect of the Oral Contraceptive Pill on Ligamentous Laxity	2004	Blinded, single factor and posttest-only control group design	Analyze the difference in ligamentous laxity between oral contraceptive pill (OCP) users and nonusers.	127 female McGill University varsity athletes.	Oral contraceptive pill use yielded statistically significant decreases in anterior translation of the tibia as compared with nonusers. The OCP may have a role to play in the prevention of ACL injuries by prophylactically targeting one of the variables responsible for the increased ACL injury rates in women.	POSITIVE/ PREVENTATIVE
Ruedl et al.	Are Oral Contraceptive Use and Menstrual Cycle Phase Related to Anterior Cruciate Ligament Injury Risk in Female Recreational Skiers?	2009	Case Control Study: Self-reported Questionare (answered within 2 days of injury)	Twofold objectives: (1) to investigate a possible protective effect of oral contraceptive use against ACL injuries in recreational skiers and (2) to compare the frequencies of non-contact ACL injuries in the preovulatory phase with that in the postovulatory phase of the menstrual cycle in recreational skiers.	A total of 93 female recreational skiers with a non-contact ACL injury and 93 age matched controls participated in this study. Out of 136 females with non-contact ACL injuries, 102 fulfilled the inclusion criteria. For the control, out of 277 interviewed female skiers, 157 fulfilled the inclusion criteria; 93 controls were randomly matched to the subjects with regard to age.	Oral contraceptive use showed no protective effect against ACL injuries, while the preovulatory phase is associated with a twofold elevated ACL injury risk.	NEUTRAL
Cheng et al.	Menstrual Irregularity, Hormonal Contraceptive Use, and Bone Stress Injuries in Collegiate Female Athletes in the United States	2021	Online Cross-Sectional Survey	To examine the prevalence of and relationship between HC use, MI, and bone stress injuries in female collegiate athletes in the United States (U.S)	1020 U.S. female collegiate athletes (age≥18 years)	Stress fractures occurred most commonly in the foot and did not appear to be associated with the type of hormones contained in OCPs (oral contraceptive pills). However, use of injectable HCs and past MI status were associated with increased odds of stress fractures.	NEUTRAL & NEGATIVE
Rodriguez et all.	Oral Contraception Use and Musculotendinous Injury in Young Female Patients: A Database Study	2024	Statistical Analysis: PearlDiver Platform (for-fee healthcare database)	Characterize the effect of sex and the influence of oral contraception usage on musculotendinous injury (MTI)	PearlDiver Database: 1476 skeletal MTI (musculotendinous injury) in the male group, 1078 in non-OC (non-oral contraceptive) females, and 231 in OC (oral contracetive) females.	Females are less likely to develop MTI to total injuries, when compared with males. Oral contracetptve using females are the least likely to develop a MTI, followed by non-oral contraceptive females.	POSITIVE/ PREVENTATIVE

RESULTS

Through this systematic review, as seen in the PRISMA diagram, only five articles met the criteria we screened for. Of these five reviewed articles, three articles allude that oral contraceptives have a positive effect and act as a preventative measure for injuries. These three articles support Hypothesis 1 where the use of hormonal contraceptives decreases the frequency of injuries sustained by female athletes, offering a potential protective factor. Two of the articles support neutrality, as stated in Hypothesis 3, that the use of hormonal contraceptives has no significant effect on the frequency of injuries sustained by female athletes. None of the articles reviewed suggest that there is a negative effect of taking birth control in direct relation to athletic injuries. Therefore, there was no support found through this systematic review for Hypothesis 2, that the use of hormonal contraceptives increases the frequency of injuries sustained by female athletes, serving as a possible risk factor.

DISCUSSION

The three articles that supported a protective factor of hormone contraceptives. The first was a prospective study by Möller-Nielsen and Hammar, which found that the female athletes in their trials, both those who were and were not taking oral contraceptives, were more likely to sustain an injury during the premenstrual and menstrual phases within the cycle[1]. The study concluded that using oral contraceptives showed a decreased rate of traumatic injuries by $P<0.05$, which was attributed to the effects of oral contraceptives on menstruation that were found during the experiment[1]. The study conducted by Martineau et al. was a blinded, single factor experiment that focused on the relationship of oral contraceptives and ligamentous laxity, regarding ACL related injuries. Evidence showed the anterior translation of the tibia had a statistically significant decrease in the female athletes taking oral contraceptives[2]. This specific occurrence in tibia translation is the most common risk factor of an ACL tear, and significantly increase the risk for an ACL tear in women. Due to the decrease found in this risk factor, it was suggested that oral contraceptives are potentially a preventative method for ACL tears[2]. The third study that supports Hypothesis 1, conducted most recently, and being published in 2024 was a statistical analysis of the PearlDiver Database by Rodriguez et all. This article emphasizes that research that supports a substantial disparity in musculoskeletal injuries between the biological sexes. Of musculoskeletal injuries, research typically favors ACL injuries, where females are eight times more likely to sustain than males.[3] The analysis resulted with oral contraceptive using females to attain a MTI (musculotendinous injury) when compared to non-oral contraceptive females, and both of these female groups were less likely compared to males[3]. Oral-contraceptive using females having a notable lower occurrence of musculotendinous injuries than non-oral contraceptives support a potential protective factor.

To further evaluate the two articles that reflect neutrality, both articles emphasize there was no discovered relationship between subjects taking oral contraceptives and injury rate. The first article is a cross-sectional online survey, analyzed by Cheng et al., that focused on bone stress injuries. It was found that amongst the female athletes studied, 65% used a form of hormonal contraceptive, of which the most frequent type taken was oral contraceptives[4]. Although there was no support for a correlation between oral contraceptive use and injuries, an increase in stress fractures occurred both in those using injectable hormonal contraceptives and those with a history menstrual irregularity[4]. Another factor evaluated in the survey revealed that the use of hormonal contraceptives was most common for athletes with menstrual irregularity with the intention of regulating their menstrual cycles[4]. The final article reviewed by Ruedl et al. was based on a self-reported questionnaire answered within two days of injury due to skiing. This evaluated each subject's oral contraceptive usage or nonuse, menstrual history, and history of knee injuries. The analysis supports that OC use showed no protective effect against, or any association with the ACL injury rate[5]. This study's data shows a twofold elevated ACL injury risk associated with the preovulatory phase, where an ACL injury was significantly more likely to occur for skiers in the preovulatory phase than those in the postovulatory phase of their cycle[5]. It is important to note that the study reports five limitations that have been taken into consideration. This includes potential inaccuracy with the questionnaire data and classifying the menstrual phase (preovulatory and postovulatory). Additionally, for those answering yes to using oral contraceptives, the questionnaire did not specify the type being used, such as estrogen-progesterone or progesterone-only. Based on the type of OC prescribed and its percentage of estrogen, there are variations of ovulation prevention and hormonal effects. The study acknowledges that the lack of specifying which OC a participant is taking may lead to different

results and associations concerning the ACL injury rate. Where no associations were found, the possibility that there is an increased or decreased rate of injury depending on the type of OC taken has not been completely ruled out, just not examined within this particular study. Lastly, it was notable that the study addressed having a low number of participants within the study, with only 93 subjects fitting into the study's criteria, out of the 136 female skiers that were interviewed within the two month time frame, and the 93 control subjects that were randomized and age-matched[5]. Therefore, it can be argued that there were not enough participants to establish accurate and replicable conclusions. The defense is that, although there were less than 100 participants studied, it was the highest sample size that had been obtained within this area of research, as well as being one of only two case control studies conducted at the time of publication.

CONCLUSION

This systematic review is based on five articles, which were screened and fit within the criteria that was set. The overall results of the five articles reviewed were three positive associations that show preventive effects of female athletes taking hormonal contraceptives, potentially decreasing injury rates, and two neutral articles that found no association with the rate of injury. Due to the range of results, and the lack of available articles to review, the results concerning the effects of hormonal contraceptives influence on injuries in female athletes are inconclusive. The overall conclusion of this systematic review is that more research needs to be conducted. There should be more research available on female athletes due to the fact that women are biologically more likely to sustain a musculoskeletal injury.

LIST OF REFERENCES

1. Larsen B, Morris K, Quinn K, Osborne M, Minahan C. Practice does not make perfect: A brief view of athletes' knowledge on the menstrual cycle and oral contraceptives. *J Sci Med Sport*. 2020;23(8):690-694. doi:10.1016/j.jsams.2020.02.003

2. Elliott-Sale KJ, McNulty KL, Ansdell P, et al. The Effects of Oral Contraceptives on Exercise Performance in Women: A Systematic Review and Meta-analysis. *Sports Med*. 2020;50(10):1785-1812. doi:10.1007/s40279-020-01317-5

3. Lin CY, Casey E, Herman DC, Katz N, Tenforde AS. Sex Differences in Common Sports Injuries. *PM&R*. 2018;10(10):1073-1082. doi:10.1016/j.pmrj.2018.03.008

4. Delgado BJ, Lopez-Ojeda W. Estrogen. In: *StatPearls*. StatPearls Publishing; 2023. Accessed July 31, 2023. http://www.ncbi.nlm.nih.gov/books/NBK538260/

5. Cooper DB, Patel P, Mahdy H. Oral Contraceptive Pills. In: *StatPearls*. StatPearls Publishing; 2023. Accessed July 31, 2023. http://www.ncbi.nlm.nih.gov/books/NBK430882/

6. Chidi-Ogbolu N, Baar K. Effect of Estrogen on Musculoskeletal Performance and Injury Risk. *Front Physiol*. 2019;9:1834. doi:10.3389/fphys.2018.01834

7. Arena B, Maffulli N, Maffulli F, Morleo MA. Reproductive Hormones and Menstrual Changes with Exercise in Female Athletes: *Sports Med*. 1995;19(4):278-287. doi:10.2165/00007256-199519040-00005

8. Martínez-Fortuny N, Alonso-Calvete A, Da Cuña-Carrera I, Abalo-Núñez R. Menstrual Cycle and Sport Injuries: A Systematic Review. *Int J Environ Res Public Health*. 2023;20(4):3264. doi:10.3390/ijerph20043264

9. Wolf JM, Cameron KL, Owens BD. Impact of Joint Laxity and Hypermobility on the Musculoskeletal System: *Am Acad Orthop Surg*. 2011;19(8):463-471. doi:10.5435/00124635-201108000-00002

10. Thein-Nissenbaum JM, Rauh MJ, Carr KE, Loud KJ, McGuine TA. Menstrual Irregularity and Musculoskeletal Injury in Female High School Athletes. *J Athl Train*. 2012;47(1):74-82. doi:10.4085/1062-6050-47.1.74

11. De Souza MJ, Koltun KJ, Etter CV, Southmayd EA. Current Status of the Female Athlete Triad: Update and Future Directions. *Curr Osteoporos Rep*. 2017;15(6):577-587. doi:10.1007/s11914-017-0412-x

12. Weiss Kelly AK, Hecht S, COUNCIL ON SPORTS MEDICINE AND FITNESS, et al. The Female Athlete Triad. *Pediatrics*. 2016;138(2):e20160922. doi:10.1542/peds.2016-0922

13. Baroncelli GI, Bertelloni S, Sodini F, Saggese G. Osteoporosis in Children and Adolescents: Etiology and Management. *Pediatr Drugs*. 2005;7(5):295-323. doi:10.2165/00148581-200507050-00003

14. Hoch AZ, Pajewski NM, Moraski L, et al. Prevalence of the female athlete triad in high school athletes and sedentary students. *Clin J Sport Med Off J Can Acad Sport Med*. 2009;19(5):421-428. doi:10.1097/JSM.0b013e3181b8c136

15. Schaumberg MA, Emmerton LM, Jenkins DG, Burton NW, Janse De Jonge XAK, Skinner TL. Use of Oral Contraceptives to Manipulate Menstruation in Young, Physically Active Women. *Int J Sports Physiol Perform*. 2018;13(1):82-87. doi:10.1123/ijspp.2016-0689

16. Anderson FD, Gibbons W, Portman D. Safety and efficacy of an extended-regimen oral contraceptive utilizing continuous low-dose ethinyl estradiol. *Contraception*. 2006;73(3):229-234. doi:10.1016/j.contraception.2005.09.010

17. Lebrun CM. Effect of the Different Phases of the Menstrual Cycle and Oral Contraceptives on Athletic Performance: *Sports Med*. 1993;16(6):400-430. doi:10.2165/00007256-199316060-00005

18. Redman LM, Weatherby RP. Measuring Performance during the Menstrual Cycle: A Model Using Oral Contraceptives: *Med Sci Sports Exerc*. 2004;36(1):130-136. doi:10.1249/01.MSS.0000106181.52102.99