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Examining the Effects of Hormonal Contraception on Injury in Collegiate Club and Recreation Sports

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Sex-Based Hormones and Injury in Collegiate Club and Recreation Sports

Examining the Effects of Hormonal Contraception on Injury in Collegiate Club and Recreation
Sports

Kaitlyn Doherty

ABSTRACT

Background: *There are differences among injury rates between males and females in collegiate sports. Hormonal contraception is used in females as a way of balancing hormones. There is limited research on the effects of hormonal contraception on injury outcomes in females.*

Purpose: *The purpose of this study was to examine the effects of hormonal contraceptives on injury in collegiate club and recreation sports.*

Methods: *A one-time survey was administered to all students enrolled in intramural sports at a mid-sized Southeastern Division I university. Questions were asked regarding injury history, menstrual cycle, and use of hormonal contraceptives.*

Results: *Analysis of survey respondents revealed that females reporting not to use hormonal contraception have approximately twice the risk of diagnosed injury compared to males ($p=.0223$). However, females who did not report hormonal contraceptive use do not have a significantly different risk of diagnosed injury compared to males ($p=.7192$).*

Conclusion: *The use of hormonal contraception acts as a moderator in the likelihood of injury in females, as females not taking HC have twice the risk of males of getting injured. Future research should examine the risk between different injury types and contraceptive use.*

INTRODUCTION

Athletes playing sports in college, whether it be for the NCAA, club sports, or the intramural level, are at an increased likelihood of experiencing an injury that negatively impacts their lives as a student-athlete. In a study by Rosa et. al. (2014), it was found that at one collegiate institution “49.91 percent of student athletes showed some type of injury”.

The most common injuries seen among college athletes are to the lower extremities, which includes knee derangement, and ankle ligament sprains (Hootman et. al., 2007). Concussions are also highly prevalent, although lower extremity injury rates are higher (Hootman et. al., 2007). The college sports with the highest, and more severe injuries are football, wrestling, gymnastics, and soccer (Kerr et. al., 2015).

There were different rates among injury types across groups. In a study on men’s and women’s volleyball, it was found that the rate of injury in women was higher compared to men. The body part with the highest rate of injury was the ankle, with 25.8 percent in men and 24.3 percent in women (Baugh et. al., 2017). Concussions were also another leading injury among these subjects. Females experienced 14.8 percent of their injuries being concussions, and males experienced 19.4 percent of their injuries being concussions (Baugh et. al., 2017). Hip and groin pain was found to be another common problem among collegiate athletes (Kerbel et. al., 2018). The study claimed that hip and groin pain has “been estimated to account for 5-6 percent of all sports injuries”. In a study on 312 amateur male soccer players, there were 208 ankle injuries recorded, and 80.6% were contact injuries. Among these injuries, there were equal rates between practice and game (Kofotolis et. al., 2007)

Rates of injury are also different when comparing competition levels. According to a study done by Boltz et. al. (2021), “the overall Division I injury rate was higher than the Division II and Division III rates”. One study examined campus recreation injury reports and found that club sport participants have a higher rate of injury to NCAA participants, and both NCAA and club sport participants were at a higher risk than intramural participants (Jameyson, 2014). Rates of injury in collegiate athletes who play club or recreation sport are less understood, making examining sex-based differences in the injury rates in this population more difficult. In a study done on club and intramural sport participation, it was found that “28.1% of respondents reported participating in either club or intramural sports” (Vasold et. al., 2019). While there are many options to pick from, some popular recreational sports include basketball, soccer, and lacrosse.

The different rates of injury between men and women can be due to a variety of factors. The anatomical and hormonal makeup of a woman’s body creates risk factors for injury that men do not experience (Hewett et. al. 2006). The sex-based differences may be explained when looking at specific injuries. For example, the different joint kinematics in females may contribute to a higher incidence of knee injuries (Hewett et. al. 2006). When making cutting motions, women have greater knee valgus and tibial internal rotation. Knee valgus is a lower leg deformity when the bone at the knee joint is angled out and away from the body’s midline (Lee et. al., 2009). Tibial internal rotation is when the shinbone twists inwards, causing the feet to face in towards the body (Stanek et. al. 2021). They also have less hip and knee flexion and hip

abduction with the same movements (Hewett et. al. 2006). These structures during movement lead to a higher risk of injuring the lower extremities. Women also have a wider pelvis than men, which increases the Q angle. The Q angle is the angle between the quadriceps and the patellar tendon (Malone, 2017). A normal Q angle falls between 13 to 18 degrees, with males on the lower end and females on the higher end (Malone, 2017). An increased Q angle leads to an increased risk for injury (Hewett et. al. 2006). Females also demonstrate a more erect landing posture and absorb more energy through the knees and ankle while landing. This could lead to a greater risk of injury at these joints (Decker et. al., 2003). Compared to males, females also have a greater general joint laxity. Having an increase in joint laxity makes the body more susceptible to injury (Hewett et. al. 2006). Females may also be at an increased risk for concussion due to their smaller and weaker neck size (Agel, et. al., 2007). Besides anatomical risk factors, other sex-based differences between males and females create risk factors for injury.

The literature has reported sex-based differences among injury reporting behaviors. It was found that females report injury at much higher rates compared to men (Sanderson et. al., 2016). In the same study, Sanderson states that many male athletes “undertake great efforts to avoid having their masculinity questioned”. Reversely, women generally report more bodily distress and more numerous, more intense, and more frequent somatic symptoms than men. (Barsky et. al., 2001). This focuses on the idea of pain perception and the differences people have with processing pain. In another study on sports related concussions by Wallace et. al. (2017), “males were 4 to 10 times more likely to not report”. Wallace states that the reasoning behind this was because athletes did not want to miss playing time. Another study on concussion reporting behavior found that females were more likely to report concussion symptoms, but there was no difference between males or females continuing to play with concussion symptoms (Kroshus et. al., 2016). Athletes have learned to conform to the norms of “sport ethic” and shake off injuries and deal with pain, which is something that is learned at a young age (Malcolm, 2006).

A growing amount of research is focusing on the impact of sex-based hormones as an explanation for the sex-based differences in injury rates in sports-related injuries in collegiate athletes. There are sex-related differences involving hormones. Males produce “predominantly testosterone from the testes in a relatively constant daily amount according to a circadian profile” (Lauretta et. al., 2018). Comparatively, females produce mainly “estrogens and progesterone from the ovaries in a cyclical pattern” (Lauretta et. al., 2018). During the menstrual cycle, there are cyclic changes in the amount of sex-hormones being produced in the female body. The major hormones affecting the body at this time are estrogen and progesterone. The levels of these hormones have systemic effects on the body and injury (Silberstein and Merriam, 2000). In another study done by Raj et. al., (2023), it was found that the fluctuations of estrogen in the body affects neural excitability of the primary somatosensory cortex, which could be a risk factor for ankle sprains. A study has shown that permanently low levels of female hormones in the body are detrimental for bone health and increased risk for stress fractures (Lergerlotz and Nobis 2022). One way to balance hormones in the body is through use of hormonal contraception. In

one study by Hewett et. al. (2006), it was found that athletes on oral contraceptives “demonstrated lower impact forces and reduced torques at the knee” and had “decreased knee laxity” compared to athletes who did not take oral contraceptives (Hewett et. al., 2006).

Hormonal contraception is often used by females to regulate their menstrual cycle. There are many different types of hormonal contraception, and the different characteristics associated with each type of contraceptive are selected based on each individual's needs. The most common hormonal contraceptive is the birth control pill (Cooper et. al., 2022). However, there are other forms of contraception, such as skin patches, vaginal rings, and intrauterine devices (IUD). Many of these forms of contraception are used for birth control, but hormonal contraceptives are also used for addressing hormonal imbalances. Hormonal imbalances occur when there is too much or too little of the hormone in the blood, and they tend to be a risk for injury in female athletes (Hewett et. al., 2006). In a study on collegiate athletes, it was found that hormonal contraceptive use was associated with lower odds of history of stress fractures (Cheng et. al., 2020). In another study by Herzberg et. al. (2017), it was concluded that hormonal contraception can offer up to 20 percent decrease in the risk of knee injury. Hormonal contraception provides a set amount of estrogen and progesterone per day in order to level out the hormones in the body (Brenza and Breitowich, 2022).

The purpose of this study is to examine the effects of hormonal contraception on injuries in collegiate club and recreation sports. Current literature is limited when examining sex-based hormonal differences and sports-related injuries in collegiate athletes, especially in club and recreation collegiate sports.

METHODS

Data Collection

Data was collected from a mid-sized Southeastern Division I university. Participants were recruited through the Division of Student Affairs. An email for participation was sent to all 6,002 students enrolled in a recreation sport during January-May 2023 and August-December 2023. Intramural sports included participants who were enrolled in indoor soccer, kickball, battleship, flag football, grass volleyball, pickleball, softball, badminton, basketball, cricket, ultimate frisbee, and outdoor soccer. Participants were also asked if they participated in club sports. This consists of climbing, baseball, golf, gymnastics, swimming, tennis, crew, cycling, fencing, lacrosse, running, triathlon, watersports, basketball, rugby, softball, field hockey, ice hockey, soccer, ultimate frisbee, sailing, volleyball, and wrestling. Injury and exposure data was collected during the months of September and October 2023. Exemption from institutional review board approval was obtained from Clemson University for this study (IRB2023-0368) (See Appendix A for survey materials).

Inclusion/Exclusion Criteria

Figure 1. Inclusion and exclusion criteria of study participants.

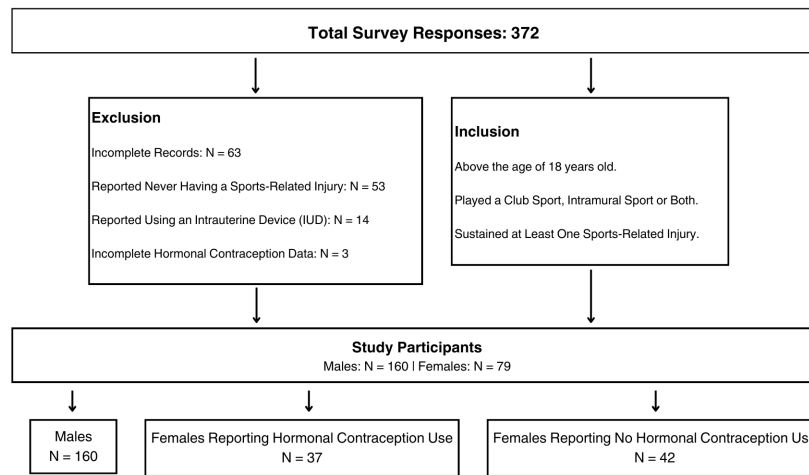


Figure 1 describes the inclusion and exclusion criteria for participants in this study. The survey received 372 responses. Of these responses, 133 were removed, leaving 239 records used. 63 records were incomplete. 53 records were removed because the respondent has never been injured. 3 records were removed from current hormonal contraceptive (HC) use data because the respondent selected “Prefer Not to Say” or did not report their HC. 14 records were removed from current HC data because the respondent reported using an intrauterine device (IUD). IUD hormonal contraception was excluded because hormonal effects are localized to the uterus rather than systematically released throughout the body.

Definition of Injury and Exposure

A sports-related injury is defined as damage to the body resulting from participating in a sport. These injuries can include shoulder injury, such as a rotator cuff tear; knee injury, such as an anterior cruciate ligament tear; foot and ankle injury, such as an ankle sprain; head injury, such as a concussion; and hip injury, such as a stress fracture.

The exposure in this study is the use of hormonal contraceptives. These forms of contraception contain estrogen and progesterone, which are used in various proportions to regulate the hormones in the female body. There are multiple forms of hormonal contraceptives, including birth control pills, intrauterine devices (IUD), patches, and others.

Instrument

The instrument used for this study was a Qualtrics survey. The survey was anonymous and voluntary for all participants. It consisted of twenty four questions. Survey questions included demographic questions (biological sex, age, race, ethnicity, year in school), sports participation questions (recreation sports level, number of sports played) and injury-related

questions (injury type, time injury occurred, injuries diagnosed by physician, undiagnosed injuries). Females were asked questions related to hormonal contraception including use of hormonal contraception and hormonal contraception type.

Statistical Analysis

Chi-Squared Tests were used to examine group demographics (age, race, ethnicity, year in school) and injury characteristics (recreation sport level, club sport contact level, number of intramural sports played, intramural sport contact level, time injury occurred) for the participants included in the study (**Table 1**). To examine sports-related injury type (shoulder injury, knee injury, foot/ankle injury, head injury, other injury), chi-squared tests were also used (**Table 2**).

Logistic regression was used to examine if there was an association between sports-related injuries and hormonal contraceptive use. Year in school, recreation sport level, club and intramural sport contact level were included as covariates in the adjusted model.

See Appendix B for definitions of statistical terms.

RESULTS

Demographics

A total of 239 responses were included in this study. Of those responses, 160 (66.95%) were males and 79 (33.05%) were females. A total of 42 (17.57%) females reported not using hormonal contraception (HC-) and 37 (15.48%) females reported using hormonal contraception (HC+). A majority (90.79%) of participants identified as white. Most participants (81.17%) reported that they played intramural sports. Year in school and club sport contact level were significantly different between groups ($p = .004$; $p = .0359$, respectively).

Among all HC+ females, 31 (86.11%) reported oral contraceptive pill (OCP), 3 (8.33%) reported NuvaRing (releases similar progestin and estrogen levels into the bloodstream as OCP), 2 (5.56%) reported a Nexplanon (an implant placed under the skin of the upper arm).

Table 1. Respondent Demographics.

Variables	Males N (%)	Females Reporting Not Using Hormonal Contraception N (%)	Females Reporting Using Hormonal Contraception N (%)	P-Value
N	160 (66.95)	42 (17.57)	37 (15.48)	
Demographics				
Age (Years), Mean (Std.)				
Race/Ethnicity, N (%)				.7216
Caucasian	145 (90.63)	40 (95.24)	32 (86.49)	
African American	2 (1.25)	0 (0.00)	0 (0.00)	

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Other	12 (7.50)	2 (4.76)	5 (13.51)	
Prefer Not to Say	1 (.63)	0 (0.00)	0 (0.00)	
Ethnicity, N (%)				.5255
Not Hispanic or Latino	151 (94.38)	41 (97.62)	34 (91.89)	
Hispanic or Latino	9 (5.63)	1 (2.38)	3 (8.11)	
Year in School, N (%)				.004
Freshman	28 (17.50)	16 (38.10)	5 (13.51)	
Sophomore	28 (17.50)	12 (28.57)	8 (21.62)	
Junior	41 (25.63)	7 (16.67)	8 (21.62)	
Senior	37 (23.13)	5 (11.90)	15 (40.54)	
Fifth Year	7 (4.38)	1 (2.38)	1 (2.70)	
Graduate School	19 (11.88)	1 (2.38)	0 (0.00)	
Injury Characteristics				
Recreation Sport Level, N (%)				.1730
Intramural Sport	134 (83.75)	30 (71.43)	30 (81.08)	
Club Sport	4 (2.50)	4 (9.52)	3 (8.11)	
Intramural Sport & Club Sport	22 (13.75)	8 (19.05)	4 (10.81)	
Club Sport Contact Level, N (%)				.0359
Non-Contact	13 (50.00)	6 (50.00)	6 (85.71)	
Limited Contact	0 (0.00)	0 (0.00)	1 (14.29)	
Contact/Collision	13 (50.00)	6 (50.00)	0 (0.00)	
Number of Intramural Sports Played, N (%)				.1056
One Intramural Sport	76 (48.72)	23 (60.53)	21 (61.76)	
Two Intramural Sport	35 (22.44)	10 (26.32)	9 (26.47)	
Three Intramural Sport	32 (20.51)	5 (13.16)	1 (2.94)	
Three or More Intramural Sport	13 (8.33)	0 (0.00)	3 (8.82)	
Time Injury Occurred, N (%)				.3642
In Practice	42 (29.17)	18 (46.15)	13 (36.11)	
In Competition	73 (50.69)	16 (41.03)	17 (47.22)	
In Practice & In Competition	29 (20.14)	5 (12.82)	6 (16.67)	

Total Injuries Report

Half of respondents (51.46%) reported sustaining a foot and ankle injury. In females reporting using hormonal contraception, shoulder injury (10.81%) and hip injury (10.81%) were the least common injury. Similarly, in females not reporting using hormonal contraception, hip

injury (4.76%) and shoulder injury (11.90%) was the least common injury. In males, hip injury (8.13%) was the least common injury. Shoulder injury (22.50%), knee injury (24.38%), head injury (26.88%) and other injuries (26.88%) were similarly reported injuries sustained by males.

Table 2. Respondents Reported Injuries.

Variables	Males N (%)	Females Reporting Not Using Hormonal Contraception N (%)	Females Reporting Using Hormonal Contraception N (%)	P-Value
N	160 (66.95)	42 (17.57)	37 (15.48)	
Sports-Related Injury Type				
Shoulder Injury	36 (22.50)	5 (11.90)	4 (10.81)	.1174
Knee Injury	39 (24.38)	10 (23.81)	10 (27.03)	.9348
Foot and Ankle Injury	83 (51.88)	22 (52.38)	18 (48.65)	.9313
Head Injury	43 (26.88)	9 (21.43)	12 (32.43)	.5441
Hip Injury	13 (8.13)	2 (4.76)	4 (10.81)	.6054
Other Injury	43 (26.88)	13 (30.95)	14 (37.84)	.4041

Hormonal Contraception Use

Results for the association between sports-related injuries diagnosed by a physician and contraception use at the time of injury can be found in **Table 3**. Females who did not report hormonal contraceptive use have approximately twice the risk of diagnosed injury compared to males. The difference is statistically significant ($p = 0.0223$). Females reporting to use hormonal contraception do not have a significantly different risk of diagnosed injury compared to males ($p = 0.7192$).

Table 3. Association Between Sports-Related Injury Diagnosed by a Physician and Contraception Use at the Time of Injury.

		Crude Model			Adjusted Model			
(Ref = Males)	Point Estimate	95% Wald CI		P-Value	Point Estimate	95% Wald CI		P-Value
Sports-Related Injury								
No Reported HC Use	2.027	1.084	3.789	0.0268	2.120	1.113	4.037	0.0223
Reported HC Use	1.081	0.570	2.048	0.8816	1.128	0.586	2.171	0.7192

DISCUSSION

The purpose of this study was to examine the effects of sex-based hormones and hormonal contraceptives on injury outcomes in collegiate club and recreation sports. We observed that females who reported not using hormonal contraception have approximately twice the risk of diagnosed injury compared to males. We also observed that females reporting to use hormonal contraception do not have a significantly different risk of diagnosed injury compared to males. There was no significant difference in injury type between groups. The highest rate of injury among males was foot and ankle injury, with 51.88% of male respondents reporting this type. The injury with the lowest rate among males was hip injury, with only 8.13% of male respondents reporting this type of injury. Among females not taking contraceptives, the injury with the greatest rate was foot and ankle, with 52.38% of this population reporting this type of injury. The lowest rate of injury among females not taking contraceptives was hip injury, with only 4.76% of the population reporting this type of injury. Among females taking hormonal contraceptives, the most popular injury was foot and ankle, with 48.65% of the population reporting having sustained this type of injury. The injuries with the lowest rate in this population were shoulder and hip injury, with 10.81% of the population reporting a shoulder injury and 10.81% of the population reporting a hip injury. Based on this study's findings, hormonal contraception may protect female athletes from injury in collegiate club and recreation sports. However, there is no evidence to support that hormonal contraception or sex-based hormones impact the type of injury sustained from collegiate club and recreation sports.

Two demographic variables were observed to be statistically significant between groups in this study, year in school and club sport contact level. A higher proportion of females in intramural and club sports reported to be freshman or sophomores whereas males reported to be juniors or seniors. This may be explained by previous literature which found that females rely on relationships and socialization experiences to aid their transition into college compared to males. These findings indicate females may be more likely to join a club or intramural sport earlier in their college career to help them through their transition into college (Holmbeck and Leake, 1999). When stratified by contraception use, the higher proportion of females not using hormonal contraception reported being a freshman whereas the highest proportion of females using hormonal contraception reported being a senior in college. This matches previous literature that observed increased levels of hormonal contraception use in seniors compared to freshman (Siegel et. al., 1999). There were also significant findings with the club sport contact level. Males were more likely to play a contact sport (50%) compared to females (31%). Previous research supports this finding. A study by Lin et. al. 2018, found that males are more likely to be injured through contact with another player. When stratified into hormonal contraception use, no females using hormonal contraception reported playing a contact sport, while half of the females not using hormonal contraception use reported playing a contact sport. This finding may be limited by the small sample size reporting playing a club sport.

The rates of certain injury types were relatively similar across populations, with the greatest injury rate involving the foot or ankle, and the lowest injury rate involving the hip. Previous literature supports our finding, observing that foot and ankle injuries are the most common sport injuries among college athletes (Hootman et. al., 2007). We observed similar knee

injury rates among males, females HC-, and females HC+. This deviates from prior studies slightly. A study by Loës et. al. (2008) found that females were more likely to sustain a knee injury in six sports: alpinism, downhill skiing, gymnastics, volleyball, basketball and team handball. Four of these sports, gymnastics, volleyball, basketball and team handball, were reported to be played by females in both hormonal contraception groups (Loes et. al., 2008). Among shoulder injury, males reported the highest rate of injury population. This is approximately double the rate of HC- and HC+ females. The difference in rates could be due to the difference in male and female sports, specifically football. The aggression and repetitive throwing motion in this sport could possibly have an impact on the shoulder injury rate among collegiate athletes (Gibbs et. al., 2015). Head injury had similar rates among populations. This differs from previous literature which indicates that females are more likely to sustain a sports-related concussion (Koerte et. al., 202). Our study might differ from these findings because a majority of literature focuses on varsity collegiate sports (Patricios et. al., 2022). Additionally, club and intramural athletes receive less injury-based education and may not know the symptoms associated with a concussion and in turn are less likely to know they sustained a concussion (Kanny et. al., 2022).

The primary sex-based hormones are testosterone, estrogen, and progesterone. Testosterone is the predominant hormone for males. The cycle for testosterone functions in a 24 hour cycle, peaking in the morning and steadily decreasing the rest of the day. The primary hormone for females is estrogen. Estrogen is a group of hormones that plays a role in growth and reproductive development in women. In females, progesterone prepares the body for ovulation and menstruation (Tokatli et. al., 2022). However, males also produce progesterone. The progesterone in a male is used for sperm production, and it has a role in the central nervous system (Oettel et. al., 2004). Compared to males, the average hormonal cycle for a female is 28 days. The cycle prepares the female's body for pregnancy and restarts if an individual is not pregnant. The menstrual cycle has four phases: menstruation, the follicular phase, ovulation, and the luteal phase. The follicular phase has high levels of estrogen while the luteal phase has high levels of progesterone (Vidafar et. al., 2022). Menstrual periods should last between 4 and 7 days and occur around every 28 days. Irregular menstruation includes periods that occur fewer than 21 days or more than 35 days apart, missing three periods in a row, periods lasting longer than 7 days, or flow that is much heavier or lighter than usual (Foster et. al., 2018). An imbalance in any or multiple sex-based hormones can cause irregular periods (Klussmann et. al., 2023). One way to regulate an irregular cycle is through hormonal contraceptives. Hormonal contraceptives help to control irregular periods, excessive bleeding, painful cramps, and premenstrual syndrome (Foster et. al., 2018). There are many types of contraception that can be utilized. Some options include the birth control pill, skin patches, vaginal rings, and intrauterine devices (IUD). Hormonal contraceptives contain progestin or estrogen, or both. With an IUD, the hormone is released directly into the uterus, while other methods have a systemic effect on the body. Also, some IUDs are not hormonal forms of contraceptives (Britton et. al., 2020). By releasing the hormones into the body, contraceptive methods have the ability to regulate the flow of hormones, making the stability of hormones similar to that of males. Evidence from our study shows that hormonal contraceptives may have a protective factor on injury risk and outcome. Results from this study agree with previous findings that suggest hormonal contraceptive use leads to lower injury rate.

This study observed that females taking hormonal contraceptives had a lower rate of injury when compared to females not taking hormonal contraceptives. These findings are consistent with some literature studying the effect of hormonal contraception. In a systematic review on contraceptives and ACL injury, it was found that taking hormonal contraception had a 20% reduction of risk in injury (Herzberg et. al., 2017). In another study on female collegiate athletes, it was observed that athletes on a natural cycle (not taking contraceptives) had a higher rate of injury compared to athletes taking contraceptives (Bakkensen, Hoover, and Smith, 2022). In a study on concussions in adult female athletes, it was found that oral contraceptive use was associated with better outcomes. Females on contraceptives reported fewer concussion symptoms and less severity of symptoms (Chace et. al., 2017). Hormonal contraceptive use could have a protective effect on the body, limiting injury overall. Contraceptive use can reduce the fluctuation of hormones that the body releases throughout the menstrual cycle. By doing this, the release of hormones may be more similar to the hormonal release in males.

The menstrual cycle and hormonal fluctuation in the female body have been observed to have an increasing effect on tissue laxity, making the ligaments softer and more prone to injury (Hicks-Little et. al., 2007). In order to decrease injury risk, it would be important to manage the laxity of the tissue due to hormone changes. Based on the findings in our study, one could hypothesize that hormonal contraceptives may decrease tissue laxity, causing a decrease in injury. However, literature with this idea is inconsistent. The studies that agree with our results state that females taking oral contraceptives have less tissue laxity than females not taking oral contraceptives. One study found that the use of hormonal contraceptives decreased the risk of ACL laxity (Konopka et. al., 2019). Another study found that the oral contraceptive pill provided statistically significant decreases in anterior translation of the tibia. This is when the shinbone is able to move forward, a strong predictor of knee injuries (Martineau et. al., 2004). A study by Cheng et. al. (2020) observed that less use of hormonal contraception was associated with greater odds of history with stress fractures. Additionally, hormonal fluctuations were observed to be a possible explanation for the increased risk of concussion in females compared to males (McGroarty, Brown, Mulcahey, 2020). In comparison, some studies have opposing findings. One study suggests that oral contraceptives have no protective effect against ACL injuries (Ruedl et. al., 2009). Another study also states that the “increased serum levels of estrogen and progesterone” in oral contraceptive users increases peripheral joint laxity, which impacts joints including the hip, shoulder and knee joints (Hicks-Little et. al., 2007). The literature is overall inconsistent with the findings that hormonal contraceptives cause a decrease in sports-related injury.

Limitations

Sample size was a limitation for this study. While the overall sample size of the study was strong, more males responded to the survey than females. This caused the sample sizes for the hormonal contraception groups to be small in comparison to the males. Another limitation in this study was a lack of diversity in race/ethnicity. Of the 239 respondents, 217 were Caucasian/White. Since the diversity of the sample was limited, it may not be accurate to extend the data to other racial groups. Lastly, the survey was based on self-reported data. Data is limited to the responses of participants, which may not be completely accurate.

Conclusion

The purpose of this study was to examine the effects of sex-based hormones and hormonal contraceptives on injury outcomes in collegiate club and recreation sports. It was observed that females who reported not using hormonal contraception have approximately twice the risk of diagnosed injury compared to males. Also, it was observed that females reporting to use hormonal contraception do not have a significantly different risk of diagnosed injury compared to males. Thus, this study indicates that hormonal contraception use may protect from injury risk in female collegiate club and intramural sport athletes. However, injury type among populations has no significant difference, indicating both sex-based hormones and hormonal contraception may not be a mechanism for the type of injury an individual sustains. Future research should expand upon these findings to better understand the collegiate club and intramural sport population and their injury risk. Additional research about the outcomes associated with each of these injury types is needed to create more accurate injury protocols for this population.

APPENDIX A

Communication via Email:

My name is Kaitlyn Doherty. I am a Clemson University student pursuing departmental honors in the Department of Public Health. As part of the requirements to graduate with honors, I must conduct my own research study. For my project, I am examining the relationship between sex-based differences and sports-related injuries.

I have created a short survey with questions related to my study. The survey should take less than 10 minutes to complete. This study is voluntary and all answers are anonymous, so your responses will not be traced back to you. If you have time to complete this survey as soon as possible, it would be greatly appreciated.

Here is a link to the survey:

Survey Questions

1. What is your current age?

1. Fill in the blank answer

2. What is your biological sex?

1. Female
2. Male
3. Prefer Not to Say

3. What is your race?

1. White
2. Black or African American
3. American Indian/Alaska Native
4. Asian
5. Native Hawaiian/Other Pacific Islander
6. Other
7. Prefer not to say

4. What is your ethnicity?

1. Hispanic/Latino
2. Non-Latino/Hispanic

5. Do you play a collegiate club sport or intramural sport? Check all that apply.

1. Club Sport

1. *If club sport is selected...* What collegiate club sport(s) do you play?
 1. Fill in the Blank Answer
2. Intramural Sport
 1. *If intramural sport is selected...* What collegiate club sport(s) do you play?
 1. Fill in the Blank Answer
3. I do not play a collegiate club sport or intramural sport.
 1. *If does not play sport is selected...* Survey will end.
4. Prefer not to say
 1. *If prefer not to say is selected...* Survey will end.

6. What year in college are you?

1. Freshman
2. Sophomore
3. Junior
4. Senior
5. Fifth Year
6. Graduate School

INJURY QUESTIONS

1. Have you ever been injured while playing a recreation sport in your lifetime (can be during practice or during a game)?

1. Yes
 1. How many sports-related injuries have been diagnosed by a doctor?
 1. Fill in the Blank Answer
 2. How many sports-related injuries do you suspect to have, but were not diagnosed?
 1. Fill in the Blank Answer
 3. Have you ever injured your anterior cruciate ligament (ACL)?
 1. Yes
 1. *If yes is selected...* participants are sent to ACL questions.
 2. No
 1. *If no is selected...* participants are sent to menstrual cycle questions.
 3. Prefer Not to Say
 1. *If prefer not to say is selected...* survey ends.
2. No
 1. *If “no” and “biological sex female” is selected...* participants are sent to menstrual cycle questions.
3. Prefer Not to Say
 1. *If prefer not to say is selected...* Survey will end.

ANTERIOR CRUCIATE LIGAMENT QUESTIONS (ACL)

1. How many times have you injured your ACL?

1. 1
2. 2
3. 3
4. 4
5. 5
6. Other (If more than 5, write the number of times injured here)

2. What was the extent of your ACL injury(s)? Check all that apply.

1. Grade 1 — least severe ACL injury. Means you stretched but didn't quite tear the ACL. The ligament can still keep the knee joint stable.
 2. Grade 2 — a partial tear. Means you stretched the ACL, making it loose. ... 3.
 3. Grade 3 — most severe ACL injury. Means a complete or near complete tear.
- <https://www.upmc.com/services/sports-medicine/services/acl-program/symptoms-and-diagnosis>

3. How old were you when you sustained your ACL injury(s)? Check any age group that applies to when you sustained your ACL injury(s).

1. ≤ 11 years old
2. 12-14 years old
3. 14-17 years old
4. 18-21 years old
5. 22-25 years old

4. What sport were you playing when you injured your ACL?

1. Fill in the Blank Answer

5. When did you get injured?

1. During Practice
2. During Competition
3. Other

MENSTRUAL CYCLE QUESTIONS:

Menstrual Cycles are the process of ovulation and menstruation in women. An irregular menstrual cycle is defined as your period coming more frequently than every 21 days or less often than every 35 days. To have a regular menstrual cycle, you have at least 10 periods per year (12 months). Less than 10 periods per year (12 months) is considered having irregular menstrual cycles.

1. Do you currently have irregular menstrual cycles?

1. Yes
2. No
3. Unsure
4. Prefer Not to Say

2. At the time you sustained your ACL injury(s) were you experiencing irregular menstrual cycles?
 1. Yes
 2. No
 3. Unsure
 4. Did Not Have Menstrual Cycle Yet
 5. Prefer Not to Say

3. Are you currently on any form of hormonal contraception? (Ex: birth control pill, IUD, patch, etc.)
 1. Yes
 1. *If yes is selected...* What type of contraception are you currently using?
 1. Fill in the Blank Answer
 2. No
 3. Prefer Not to Say

4. At the time you sustained your ACL injury(s) were you using hormonal contraception?
 1. Yes
 1. *If yes is selected...* What type of contraception are you currently using?
 1. Fill in the Blank Answer
 2. No
 3. Unsure
 4. Prefer Not to Say

APPENDIX B

Term	Definition
Adjusted Model	a model of logistic regression that examines how a single factor affects an outcome while incorporating the covariates
Chi-Square Test	a goodness of fit test that compares observed frequencies of an event with the expected frequencies of the event
Covariates	a variable that has an effect that is of no direct interest
Crude Model	a model of logistic regression that examines how a single factor affects an outcome while ignoring covariates
Logistic Regression	a linear model in which the dependent variable is a logit and at least one explanatory variable is continuous; shows the relationship between the dependent variable and the independent variable
N	abbreviation for sample size
P-value	(probability value) a number that describes how likely it is that the data is observed by random chance
Risk	the estimated probability of an outcome
Statistical Significance	measures the probability that of the null hypothesis being true; determination that the results are not explainable by chance alone (p-value < .05)

Dictionary of Statistics (Upton, 2014)

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