FEMALE ATHLETE HEALTH IN WOMEN'S FOOTBALL

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INTRODUCTION

Women's football is growing rapidly around the world with FIFA reporting the number of female football players at all levels of competition has steadily grown over the past several decades, with an estimated 30 million female football players in 2014. In 2018-2019, over 28,000 women participated in NCAA women's football, making it the second leading sport for collegiate women in the United States, just behind outdoor track and field[1]. Interest in women's football is increasing too! The average live match audience of the FIFA Women's World Cup increased by 106%, from 8.4 million in 2015 to 17.27 million in 2019[2]. Keeping pace with the growth and interest in women's football is a burgeoning of research in the health of the female athlete.

Gender-specific considerations arise when managing female football injuries as there exists a greater injury burden in women than men. Despite incurring half the number of injuries of their male counterparts, Larruskain, et al. found that elite female football players lost 21% more days from their injuries, secondary to higher incidence of severe knee and ankle ligament injuries[3]. There are different physiologic demands of the female football game, ranging from reproductive health considerations and differing recovery time from injury whose understanding is necessary to adapt return to play strategies and avoid early re-injury[4]. All these differences influence athletic performance, psychological health as well as the risk of injury for female players. Implementing knowledge from the burgeoning research enables medical providers, coaches, and athletes to understand female-specific components of physiology, injury, psychological wellness, treatment plans and prevention.

PHYSIOLOGIC DEMANDS

Elite level female players are on average between 20-27 years old, stand 1.61-1.70 m tall, weigh 57-65kg, and have a body fat percentage of 14.6-20.1% with a lean muscle mass of approximately 45.7kg[5]. With these physiometric measurements in mind, increasing research has improved our understanding of the physiologic demands of football on the female athlete.

Several studies have examined heart rate (HR) data during competitive female match-play and have noted an average HR of 86% maximum HR and a peak HR of 98% of maximum HR. Elite players also are found to have VO2max values of 49.4-57.6 ml/kg/min and the average VO2 during match-play in these players has been estimated to be 77-80% of VO2max[5]. Peak match-play values of 96% of VO2max have been noted[6]. This suggests significant aerobic demand for the women's game.

Training regimens that show benefit in the female footballer include interval training given the importance of high energy sprints to decisive moments in game play. Interval training between 5-120 seconds was able to increase mean values for Vo2max by 13.2 %, anaerobic threshold by 16.8%, and 1-min heart rate recovery by 36.9%[5]. Another method which has shown benefit is the "Speed, Agility, Quickness (SAQ)" method as described by Polman[7]. The method involves aspects of assisted and resisted sprint training and provided improvements in mean performance in sprint to fatigue (11.6 %), 25-m sprint (4.4 %), left and right side agility (4.5 and 4.0 %, respectively), and vertical and horizontal power tests (18.5 and 7.7 %, respectively) following 12 weeks of SAQ training compared with a control group[7]. Research outcomes can be used to develop female athlete-specific training programs to maximize performance and limit injury.

MENSTRUAL CYCLE

The menstrual cycle (MC) involves a complex interconnection of hormones affects systems beyond the reproductive system, including the cardiovascular, respiratory, metabolic, and neuromuscular systems.

Image: Womens World Cup 1999 match USA vs Brazil. California, USA. Illustration.

McNulty et al. published a systematic review and meta-analysis summarizing athletic performance effects of the menstrual cycle in eumenorrheic women: exercise performance might be trivially reduced during the early follicular phase when compared with all other MC phases[8]. Estrogen has anabolic effects, increasing glycogen uptake and sparing glycogen stores, and may have neuroexcitatory effects as well. Estrogen's antioxidant properties might also protect against exercise -induced muscle damage and inflammatory[8]. Progesterone is thought to have anti-estrogen effects; therefore, the beneficial effects of estrogen may be greatest in the late follicular and ovulatory phase when it is unopposed. Muscular performance and recovery for the female athlete may be best be optimized at this time. As most studies included in this meta-analysis were low in quality with large between-study variance, a personalized approach should be taken instead, considering an individual's unique response to performance across the cycle.

The MC has been theorized to be a factor in injury risk for women. Several studies have found the risk of ACL injury highest in the late follicular and ovulatory phases when estrogen concentrations are highest[9]. This may be attributed to increased ACL laxity, however studies have demonstrated conflicting results: Shultz et al., showed knee laxity gradually increased in women as estradiol levels began to rise while Martin et al. found that injury rates were 47% and 32% greater in the late follicular phase compared to the follicular phase and luteal phase[10,11].

HORMONAL CONTRACEPTION

Hormonal contraception plays a valuable role in hormonal modification of the menstrual cycle and may be useful for female athletes. These medications are commonly used for cycle control and/or for pregnancy prevention. In a recent poll of 430 elite female athletes, almost 50% were hormonal contraceptive users, with 68% of those reporting using oral contraceptive pills[11]. The effects of hormonal contraception on athletic performance are likely trivial, with superior performance generally observed for naturally menstruating women compared to OCP using counterparts[12].

PREGNANCY

The risks associated with playing football football during pregnancy can be divided into physiologic risk and risk of trauma/collision. The American College of Gynecology (ACOG) recommends avoiding contact sports, which includes football, during pregnancy as participation could increase the risk of abdominal, and therefore, fetal trauma. The current recommendation is that women who habitually engage in vigorous intensity aerobic exercise can continue physical activity during pregnancy if they stay healthy and follow up closely with their healthcare provider. Healthcare providers should follow up more closely with an elite athletes who are continuing to train in order to ensure adequate caloric intake during pregnancy. In general, pregnant female football players may continue to participate in noncontact aerobic conditioning as well as strength training.

During pregnancy, several physiologic changes such as increased heart rate (at rest and during activity), increased cardiac output, increased minute ventilation, and increased oxygen consumption occur as early as the first couple weeks. This increase in oxygen consumption may cause some women to experience a decline in exercise tolerance. A small number of studies have measured VO2 max during pregnancy. Some studies have shown that well-conditioned athletes who maintain a high level of fitness during pregnancy may experience an increase in VO2 max following pregnancy[13].

Increased ligamentous laxity occurs during pregnancy secondary to the hormone relaxin, as well as increased estrogen. Given this increased laxity,

pregnant female athletes may consider avoiding ballistic activities and unnecessary loads on joints to decrease injury risk. Pregnant athletes, especially football players who may experience increased load on the pelvic floor during jumps and other high-impact exercises, may also want to consider participation in pelvic floor training to reduce the risk of urinary incontinence and other pelvic floor complications[14].

POSTPARTUM AND BREASTFEEDING

The postpartum period has been typically defined as the first 6 weeks following delivery, although time of recovery may vary tremendously. Postpartum return to sport should be an individualized process. Studies on physically fit soldiers have found that the amount of time needed for postpartum soldiers to return to pre-pregnancy fitness levels ranged from 2 to 24 months, with a mean of 11 months.

Post-partum considerations include concerns about risk of urinary incontinence, pelvic prolapse, diastasis recti while no research has specifically investigated these issues in female athletes. In general, postpartum women should return to exercise gradually and progress their time, frequency, and intensity as tolerated by their body[12].

INJURY SPECIFIC CONSIDERATIONS

Anterior Cruciate Ligament Rupture

Numerous studies over recent decades indicate that female football players are more susceptible to ACL injuries compared to their male counterparts[15,16].The gender disparity in injury risk stems from anatomical, hormonal, biomechanical, and neuromuscular differences between men and women, as well as playing surfaces[17,18].

ACL tears in athletes require operative intervention with ligament reconstruction to enable return to the cutting and pivoting maneuvers required of football; non-operative treatment of ACL injuries, with physical therapy and bracing, with resultant knee instability, would place injured athletes at risk for further knee damage like meniscus tears or cartilage damage forcing a career-ending decision. With regards to surgical technique, no special considerations have prove to be superior based on female gender. Adolescent female football players have similarly high satisfaction and outcomes scores independent of autograft choice for their ACL graft surgery[19].

Operative treatment of ACL rupture with ACL reconstruction allows women an opportunity to return to football with the possibility to reach elite levels as adults, though the chances are fairly small regardless of ACL reconstruction or not[20]. Rehabilitation from an ACL reconstruction requires 9-12 months, and sometimes longer, and may still result in early retirement from recreational or professional sports. In a study of young football players from the United States, 31% of female athletes were still playing 7 years after ACL reconstruction[21]. In a study of female football players, which included a matched control group, the players with ACL reconstructions were reported to be more likely to have quit playing at the 2-year follow-up than players without knee injuries[22]. This injury and its subsequent surgical treatment results in significant time loss from competitive play, placing a great burden on women's football across the world, given the implications for the individual football player as well as women's teams as a whole.

Unfortunately, a significantly high risk of recurrent ACL injury in young female athletes has been well documented in the literature, especially in those returning to football after ACL reconstruction[23,24,25,26,27,28]. Two-thirds of female football players who have undergone ACL reconstruction and returned to competitive play are at risk of a new knee injury within 5-10 years of surgery, with 42% of the injuries being a new ACL injury[29]. Given the high re-injury rate, efforts have been made in developing ACL injury prevention programs and implementing them broadly in football clubs. In women's football, there is evidence that multicomponent, exercise-based programs reduce overall and ACL injuries significantly[31].

Return to sport is the ultimate goal following ACL reconstruction treatment. On the elite level, a 90% return to play rate after ACL reconstruction was seen in National Women's Soccer League (NWSL), though with a lower percentage of minutes played in the first year of return. However, the serious knee health concerns after an ACL reconstruction may play a role in return to sport decisions. Knee-related physical issues and fear of re-injury rank high among women football players and are often cited as reasons for not returning to or quitting football[33,34,35]. Though the reasons for dropping out of football as players advance are likely multifactorial, the ability to address these issues with young female athletes and improve outcomes can alter decisions.

CONCLUSION

The demands of the game of football on women versus men differ given the physiologic and anatomic differences that are inherent between the genders. This is especially true when taking into account the hormonal differences and demands that the female football player faces. Taking these differences into account will help the clinician better understand female football players' performance on the football pitch as well as predisposition to injuries and management strategies. The management of female football injuries should take into consideration the unique physiology and anatomy of the female athlete in implementing treatment strategies. While the literature currently lacks significant coverage of gender differences in the management of female football injuries, the future holds promise that gender differences in injury and treatment will become more prominent in the literature.

References
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