Examining Gender Disparities in Endurance Athlete Research and Recovery Technologies

A Research Paper submitted to the Department of Engineering and Society

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

Zoe Van Winckel

Spring 2024

On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Advisor

MC Forelle, Department of Engineering and Society

Introduction

Participating in sport, whether at the professional or recreational level, is a demanding endeavor, but have you ever wondered what distinguishes exceptional athletes from the rest? Beyond rigorous training and innate talent, a key differentiator is the ability to recover quickly and smartly after workouts. Endurance athletes are notorious for undertaking large training volumes to enhance adaptations and subsequently improve performance. These high training loads often lead to an imbalance between stress and recovery. Stress is defined as the destabilization or deviation from the norm in a biological and/or psychological system (Braun-Trocchio et al., 2022). Stress can appear in two forms: physical stress, which refers to the physical fatigue induced during training and/or competition, or physiological stress, which occurs when people perceive that the demands from external situations are beyond their coping capacity. Both physical and physiological stress directly impact an endurance athlete's ability to recover (Jeffreys, 2005).

While all endurance athletes must strike a balance between stress and recovery, there is an even more specific and underserved aspect of this equation: the unique recovery needs of female athletes. Historically, the field of endurance athlete recovery, *and* sports science in general, has faced a significant gender gap. Data extracted from 1,382 original sports and exercise medicine research articles, involving a total of 6,076,580 participants, found that the average percentage of female participants per article ranged from 35% to 37% (Costello et al., 2014). Females are significantly under-represented in sports research and technology development because past efforts have predominantly focused on male athletes.

The existing bias in sports research and technology development is not simply a matter of equity. It impacts the health and performance of female athletes, who have unique physiological

characteristics that significantly influence their training, recovery, and overall well-being. One of the key factors contributing to these differences is the hormonal fluctuations that occur due to the menstrual cycle. There is a need for further research to quantify the impact of the menstrual cycle on perceived and physical performance outcomes, ultimately affecting recovery needs, in female athletes (Carmichael et al., 2021).

As a female endurance athlete, I have firsthand experience navigating the delicate balance between training and recovery. Throughout most of high school, I did not have a regular menstrual cycle — a result of overtraining and under-fueling that often goes unnoticed by young athletes like myself. Despite the abundance of resources within the endurance athlete community, no one warned me of the repercussions of not having a period, leaving me unaware of the silent toll it was taking on my body until it was too late. Several years later, I am still dealing with the consequences, which have manifested in the form of low bone density and increased susceptibility to injuries. My own experience, which is a shared reality amongst many female endurance athletes, highlights the critical need for comprehensive education and support systems within the athletic community. We must address the unique physiological needs of female athletes, not only to optimize performance but also to safeguard their long-term health and well-being.

In this paper, I will argue that the historical lack of female-specific research and technology development in the field of endurance athlete recovery has created systemic inequalities that adversely affect the performance and well-being of female athletes. This begins with a comprehensive literature review to examine the current state of female endurance athlete research and recovery technologies. I will then utilize feminist technoscience studies to analyze the co-constructive relationship between gender and technology, as well as the agency of

individuals and communities in shaping technological norms and practices. From this, my project aims to advocate for transformative practices that address the unique needs of female athletes, ultimately striving for equity and optimal performance in endurance athletes.

Literature Review

The existing body of research in sports science and exercise medicine has a pronounced gender gap, with a lack of representation and focus on female athletes. This gender disparity has been quantified: Costello et. al. (2014) conducted a comprehensive analysis of 1382 original research articles published in three major Sports and Exercise Medicine journals involving 6,076,580 participants. The average percentage of female participants per article across the journals ranged from 35% to 37%, and females were significantly under-represented across *all* the journals. This finding is not simply a statistical anomaly but signifies a systemic issue that permeates the field. For example, most of the advice and guidelines on training, racing, nutrition, and recovery for endurance sports (e.g., ultramarathons) are based on research that has largely excluded female athletes (Kelly, 2023). Consequently, a substantial portion of athletic research fails to capture the unique physiological and recovery needs of women, limiting the efficacy and applicability of current practices.

In tandem with this gender gap, existing literature highlights the importance of recovery to an endurance athlete's performance and success. Specifically, optimum performance requires a balance between training stress and recovery. Braun-Trocchio et. al. (2022) emphasize the multidimensional nature of recovery involving physiological, psychological, emotional, social, and behavioral aspects. Despite its significance, recovery remains comparatively under-researched compared to training principles and competition strategies (Braun-Trocchio et. al., 2022). This imbalance in research focus not only perpetuates the gender gap but also diminishes

our ability to completely understand and address the recovery needs of endurance athletes. Jeffreys (2005) stresses the complexity of fatigue and subsequent recovery, advocating for a comprehensive approach that addresses the multifaceted nature of recovery and utilizes short- and long-term strategies. Thus, a critical gap exists in understanding and applying recovery strategies in endurance athletes.

Recent research has also shed light on the sex differences in the physiology of endurance exercise, with growing recognition of the impact of gender on recovery. The primary difference is the presence of a menstrual cycle in females, with certain phases of the menstrual cycle associated with higher injury risks, increased susceptibility to fatigue, and altered responses to training loads. Neglecting these nuances can lead to inadequate recovery practices, decreased performance, and potential health issues for female athletes (Temm et al., 2022). To optimize training, recovery, and athlete monitoring programs of eumenorrheic female athletes, there is a need for further research to quantify the impact of the menstrual cycle phase on perceived and physical performance outcomes and recovery (Carmichael et. al., 2021).

In line with the sex difference in the physiological effects of exercise, researchers have advocated for customized recovery strategies. For example, female athletes benefit from using cooling recovery methods, such as cold-water immersion due to their lower thermolytic capacities than males. Additionally, research has shown that active recovery is more beneficial for female athletes because they have a greater decrease in arterial blood pressure after exercise compared to males (Braun-Trocchio et. al., 2022). Despite these findings, the overall lack of sports medicine research conducted on elite female athletes makes it challenging to develop evidence-based training and recovery practices. As noted by Emmonds et. al. (2019), the prevalent reliance on research conducted on male athletes means that applying evidence

developed in male athletes to female athletes may be erroneous. Specifically, sports science practices (e.g., training and recovery protocols, nutritional strategies, injury prevention interventions) in female sports are often underpinned by research conducted on male athletes due to the limited representation of female athletes in the sports performance literature.

My synthesis of existing literature reveals a critical need to address the gender gap in sports science research and develop tailored recovery strategies that account for the unique physiological and recovery needs of female endurance athletes. This highlights the importance of prioritizing gender-inclusive research practices to ensure equitable support and performance optimization for athletes of all genders.

I will examine the historical lack of female-specific research and technology development in endurance athletes through the lens of feminist technoscience studies. This framework provides insights into the co-constructive relationship between gender and technology, highlighting how gender biases can permeate technological developments in sports science. Feminist technoscience studies emphasize the interdependency of social, cultural, and scientific/technological aspects, underscoring the need to critically examine how technology in sports has often been designed with a male-centric approach (Åsberg & Lykke, 2010). This approach excludes the specific needs and experiences of female athletes, perpetuating systemic inequalities within the field of endurance athlete recovery.

Feminist STS can also be used to assess the agency of individuals and communities in shaping technological norms and practices. Through this lens, we can investigate how female athletes navigate and resist dominant technological paradigms, offering insights into grassroots organizations and advocacy efforts aimed at challenging and transforming gendered norms within endurance athlete recovery. In doing so, feminist STS highlights the transformative

potential of female athletes in reshaping technological landscapes to better address their unique needs and experiences.

Methods

I will conduct an ethnographic analysis through the lens of feminist science studies, with an emphasis on the role that cultural norms play in the decision-making process. I will immerse myself in the world of female endurance athletes and the challenges they face. I will gather primary evidence from interviews with collegiate and professional female endurance athletes. I will gather secondary sources, mainly academic journal articles and podcasts/opinion pieces that highlight the current state of recovery technologies and sports science. Additionally, I will only examine publications from the late 1970s and onwards. This is around the time that the heat rate monitor and power meter were invented, which made it possible to collect more accurate data on athletes' physiological responses to training and recovery. It was also when women were first allowed to compete in the Olympic marathon.

Analysis

Bias against female participants in sports science and sports medicine research (SSSM), which is particularly evident in studies focused on enhancing athletic performance, has entrenched a male-centric perspective in the field. Across SSSM research, the bias against female participants was most prevalent in studies investigating strategies to enhance athletic performance (Smith et. al., 2022). The gender bias in research not only limits the inclusivity of studies but also perpetuates a male-centric perspective in sports science. As a result, most sports science research relates to the male experience. This results in data analytics, wearables, and other aspects of performance technology that are inherently tailored toward male athletes.

Feminist technoscience highlights the inherent complexities associated with considering women as research subjects, challenging traditional scientific approaches that prioritize male experiences. In SSSM research, involving female participants necessitates additional methodological considerations, often leading researchers to consider women as more complex subjects than men. This perception has resulted in a tendency to exclude women from research trials (Elliot-Sale et. al., 2021). For example, researchers face the challenge of controlling for sex differences in concentrations of the reproductive hormones, as well as intra-female fluctuations in estrogen and progesterone due to the menstrual cycle (MC) phase, the use of hormonal contraceptives (HC), or impaired menstrual function. Female athletes are also more likely to experience nutritional issues, such as iron deficiency or low energy availability, adding to the screening burden or risk of interference in study outcomes (Areta et. al., 2020). Collectively, these factors have created a tendency to exclude women from SSSM research. Consequently, findings from studies primarily involving male participants are often extrapolated to formulate recommendations for female athletes. This practice lacks consideration of sexual dimorphisms and fails to account for the distinct physiological responses and recovery needs of female athletes when developing sports technology.

Feminist technoscience critically examines the prevailing male-centric design of sports technology, highlighting its dependence on social and cultural norms that prioritize male experiences and physiology. For women involved in sports, the incidence of menstrual irregularities has been reported to be higher compared to the general population. High physical demands and insufficient recovery, together with long-term inadequate nutritional intake and psychological stress are potential factors that cause an imbalance in the neuroendocrine process responsible for controlling female reproduction (De Souza et. al., 2009). However, despite these

known factors, most studies in sports science historically overlook the menstrual cycle as a crucial consideration in research designs, resulting in a significant knowledge gap regarding female athletes' physiological responses.

This oversight leads to the development of inadequate recovery strategies and training recommendations for female athletes, potentially exacerbating their risk of hormonal imbalances, bone health issues, injuries, and compromised overall well-being. In addition, the menstrual cycle impacts fluid dynamics and thermoregulation in women, yet there remains a lack of female-specific hydration guidelines. Despite having more sweat glands, women exhibit lower sweat rates than men during exercise, leading to a greater thermoregulatory strain at lower dehydration levels (Santisteban et. al., 2022). Until the 1980s, it was widely assumed that physiological responses to exercise did not truly differ between men and women. New research has disproved this notion, and current guidelines extrapolated from male-centric research put women at a disadvantage. For example, women's narrower margins for correcting hydration levels necessitate specific guidelines to prevent dehydration. A greater understanding of the physiological differences between men and women will improve injury prevention and treatment, training schedules, and nutrition plans.

Feminist technoscience provides a critical framework for understanding how the development and adoption of recovery technologies in sports are influenced by social constructions shaped by gender norms and biases. Historically, femininity has been considered nonathletic. Research finds some athletes describe a perception that being a "woman" and an "athlete" are almost opposing identities (Krane et. al., 2004). This perception reflects ingrained gender norms that impact sports science and technology development. It may contribute to the underrepresentation of female athletes in research, limiting understanding and potentially leading

to less-tailored recovery technologies. Systemic and unconscious bias has also discouraged women from pursuing careers in sports and technology, which are traditionally male-dominated industries (Charlesworth & Banaji, 2019). This gender gap in the workforce of sports science and technology industries can influence the design and application of recovery technologies, as decisions may be made from a predominantly male perspective. Consequently, the distinctive needs of female athletes may be overlooked, further perpetuating gender disparities in sports technology.

I was fortunate to be able to conduct interviews with several female athletes on the University of Virginia's cross-country and track teams. All athletes at UVA have access to an array of recovery tools and technologies, ranging from traditional methods like ice baths and foam rollers to more advanced devices such as compression boots and massage guns. These technologies are integral parts of their training routines, aiding in the alleviation of muscle soreness, reduction of fatigue, and enhancement of overall recovery. Despite the availability of these tools, several issues surfaced during the interviews. One recurring challenge was the lack of recovery technologies and strategies tailored to female athletes. For instance, the compression boots, which are sized for average-sized male athletes, overlook the diverse body types of female athletes. This reflects a broader trend of male-centric design in sports technology.

During the preseason preparation for UVA's cross-country and track teams, female athletes must undergo routine blood work and medical tests to assess their overall health and well-being. These tests serve as crucial checkpoints to ensure that athletes are in an optimal condition to compete safely and effectively. If any abnormalities are detected, such as an extremely low body mass index (BMI), athletes may be deemed ineligible to practice and compete with the team until the issue is resolved. While this protocol prioritizes the health and

well-being of the athletes, it also highlights a significant gap in support systems. The athletes receive little guidance on how to address flagged issues, leaving them to navigate potential health concerns on their own. This lack of guidance can be particularly challenging for athletes who do not have access to comprehensive resources or expert advice.

Furthermore, the interviews shed light on deeper-seated issues related to body image pressures and societal expectations. Several athletes shared their struggles with body image insecurities and the prevailing idea that femininity and athleticism are incompatible. The notion that lighter equals faster is a pervasive belief within endurance sports like cross-country and track, and it can have significant implications for the eating habits and overall well-being of female athletes. The pressure to maintain a low body weight in pursuit of improved performance can lead to disordered eating behaviors, inadequate nutrition, and ultimately, negative impacts on both physical health and athletic performance. When female athletes are flagged for a low BMI, they are often advised to gain weight without receiving more specific guidance tailored to their gender-specific needs. The importance of gaining weight to achieve a normal menstrual cycle and ensure optimal physiological functioning may not be adequately emphasized for these athletes. Consequently, these challenges not only impact their relationship with sport and recovery but also affect their overall well-being and confidence as athletes.

Some might argue that while there may be biases in the design of sports technology, these biases are simply a reflection of the majority of users, who historically have been male athletes. Under the basis of utilitarianism, sports technology companies will prioritize the needs of their primary consumer base to maximize utility, which inadvertently leads to a focus on male-centric features and specifications. This counterargument suggests that since male athletes have traditionally dominated sports participation and research in the field, it is natural for sports

technology to be tailored to their needs and preferences. However, this argument fails to acknowledge the historical inequalities that have resulted in the sports science landscape that we are familiar with today. It also overlooks the fact that the exclusion of female athletes from research and technology development perpetuates a cycle of male-centric design and reinforces gender disparities within sports science. From a utilitarian perspective, it is essential to recognize that catering exclusively to the needs of the majority can lead to inequitable outcomes and overlook the potential benefits of designing technology that is inclusive and accessible to all athletes (Bednar & Spiekermann, 2022).

A feminist technoscience perspective provides a nuanced understanding of the roles of key stakeholders in the development and application of recovery technologies for female athletes. These stakeholders include researchers, sports technology companies, female endurance athletes and their coaches, and sports governing bodies. In recent years, there has been a significant increase in financial support and resources directed towards female-centric initiatives by sports governing bodies. (Lesch et. al., 2022) This surge in investment reflects a growing acknowledgment of the potential within female sports, creating a conducive environment for advancements in sports science and technology. This financial backing is also essential for the development of recovery technologies tailored to the unique needs of female athletes. In addition, brands and broadcasters are increasingly investing in and showing interest in female sports, leading to record-breaking sponsorship and media deals (Balasaygun, 2023). This heightened interest from external entities is reshaping the landscape of women's sports, contributing significantly to its growth and visibility. The influx of support reflects a collective desire for enhanced female athletic performance, which necessitates further research and recovery technologies tailored to optimize the well-being and performance of female athletes.

WHOOP, a leading human performance company, has established the Women's Performance Collective (WPC), showcasing a dedicated commitment to advancing education, content, and research on women's performance and physiology (Whoop, 2021). This initiative demonstrates the strategic role of sports technology companies, such as WHOOP, as key stakeholders in driving advancements in women's sports science. By assembling a diverse coalition of experts through the WPC, WHOOP aims to educate and empower women in managing critical aspects like sleep, recovery, fueling, and training. The collaboration between WHOOP and the WPC signifies a proactive effort to address the existing research and education gap within women's performance. By considering the social, cultural, and scientific dimensions of technology development, stakeholders can collaborate to create more inclusive and effective solutions that address the diverse needs of female athletes.

In addition, sports for development (SFD) initiatives have emerged as powerful tools for promoting social change, particularly in challenging gender norms and fostering gender equality. Originating from the feminist movement in sport in the late 1970s, these programs aim to make sport accessible to all, leveraging its potential alongside life-skills classes to address pressing societal issues (Welty Peachey et. al., 2019). Studies evaluating SFD programs globally have demonstrated their effectiveness in shifting gender norms and empowering participants, especially girls and young women. For instance, research conducted by organizations like the International Center for Research on Women (ICRW) and Women Win has shown that girls who participate in sports-based programs are more likely to stay in school longer, delay marriage, and report improved mental well-being (ICRW, IFS & Manjari Foundation, 2019). These programs also contribute to expanding social networks, boosting confidence, and challenging restrictive gender norms related to girls' education, mobility, and participation in public spaces. SFD

initiatives have also been instrumental in promoting positive body image and self-esteem among participants, challenging stereotypes about how women and girls should look and behave in sports. By providing opportunities for girls to engage in physical activities openly, these programs contribute to breaking down norms that portray women as fragile and weak, empowering participants to challenge restrictions in mobility and decision-making within their households. Through the lens of feminist technoscience, these sport-for-development programs highlight the agency of individuals and communities in challenging gender norms, promoting gender equality, and fostering positive social change within communities worldwide.

Conclusion

This paper has highlighted the pervasive gender disparities in sports science research and technology development, particularly concerning the recovery needs of female endurance athletes. Through the lens of feminist technoscience, I have explored how historical biases and ingrained gender norms have shaped the design and application of recovery technologies, often overlooking the unique physiological and recovery needs of female athletes. By critically examining the co-constructive relationship between gender and technology, I have identified systemic inequalities that perpetuate the underrepresentation of female athletes and limit the efficacy of current practices. However, this analysis also points towards opportunities for transformative change.

Researchers, engineers, policymakers, and other stakeholders can leverage the insights gained from this paper to advocate for gender-inclusive research practices and develop tailored recovery strategies that address the diverse needs of female athletes. Future research endeavors should prioritize the inclusion of female participants and consider the menstrual cycle as a fundamental factor in research designs. Additionally, there is a need for increased collaboration

between sports technology companies, researchers, and sports governing bodies to drive advancements in women's sports science and technology. These efforts to challenge and transform gendered norms within endurance athlete recovery must extend beyond technological solutions. This necessitates addressing systemic barriers, advocating for gender equity in sports, and promoting cultural shifts that value the contributions of female athletes. Overall, it is critical that we take a holistic approach rooted in feminist principles and guided by an understanding of the interplay between gender, technology, and society, to address the gender disparities in sports science and technology. By taking these future steps, we can strive towards a more equitable and inclusive landscape for female athletes, ultimately enhancing their well-being and performance in endurance sports.

References

Areta, J. L., Taylor, H. L., & Koehler, K. (2020). Low energy availability: History, definition and evidence of its endocrine, metabolic and physiological effects in prospective studies in females and males. *European Journal of Applied Physiology, 121*(1), 1–21. https://doi.org/10.1007/s00421-020-04516-0

Åsberg, C., & Lykke, N. (2010). Feminist technoscience studies. *European Journal of Women's Studies, 17*(4), 299–305. https://doi.org/10.1177/1350506810377692

Balasaygun, K. (2023, March 4). For women's sports, the media buys are becoming a big deal. *CNBC*. https://www.cnbc.com/2023/03/04/for-womens-sports-the-media-buys-are-becoming-a-big-deal.html

Braun-Trocchio, R., Graybeal, A. J., Kreutzer, A., Warfield, E., Renteria, J., Harrison, K., Williams, A., Moss, K., & Shah, M. (2022). Recovery strategies in endurance athletes. *Journal of Functional Morphology and Kinesiology, 7*(1), 22. https://doi.org/10.3390/jfmk7010022

Bednar, K., & Spiekermann, S. (2022). Eliciting values for technology design with Moral Philosophy: An empirical exploration of effects and shortcomings. *Science, Technology, & Human Values*, 016224392211225. https://doi.org/10.1177/01622439221122595

Carmichael, M. A., Thomson, R. L., Moran, L. J., & Wycherley, T. P. (2021). The impact of menstrual cycle phase on athletes' performance: A narrative review. *International Journal of Environmental Research and Public Health, 18*(4), 1667. https://doi.org/10.3390/ijerph18041667

Charlesworth, T. E. S., & Banaji, M. R. (2019). Gender in science, technology, engineering, and mathematics: Issues, causes, solutions. *The Journal of Neuroscience, 39*(37), 7228–7243. https://doi.org/10.1523/jneurosci.0475-18.2019

Costello, J. T., Bieuzen, F., & Bleakley, C. M. (2014). Where are all the female participants in sports and exercise medicine research? *European Journal of Sport Science, 14*(8), 847–851. https://doi.org/10.1080/17461391.2014.911354

De Souza, M. J., Toombs, R. J., Scheid, J. L., O'Donnell, E., West, S. L., & Williams, N. I. (2009). High prevalence of subtle and severe menstrual disturbances in exercising women: Confirmation using daily hormone measures. *Human Reproduction, 25*(2), 491–503. https://doi.org/10.1093/humrep/dep411

Elliott-Sale, K. J., Minahan, C. L., de Jonge, X. A., Ackerman, K. E., Sipilä, S., Constantini, N. W., Lebrun, C. M., & Hackney, A. C. (2021). Methodological considerations for studies in sport and exercise science with women as participants: A Working Guide for Standards of Practice for research on women. *Sports Medicine, 51*(5), 843–861. https://doi.org/10.1007/s40279-021-01435-8

Emmonds, S., Heyward, O., & Jones, B. (2019). The challenge of applying and undertaking research in female sport. *Sports Medicine - Open, 5*(1). https://doi.org/10.1186/s40798-019-0224-x

ICRW, IFS & Manjari Foundation. (2019*). Pushing Boundaries by Engaging Adolescent Girls and Communities: Evidence from Evaluation of the PAnKH Program*. New Delhi, India: ICRW.

Jeffreys, I. (2005). A multidimensional approach to enhancing recovery. *Strength and Conditioning Journal, 27*(5), 78–85. https://doi.org/10.1519/00126548-200510000-00014

Kelly, C. P. (2023). Is there evidence for the development of sex-specific guidelines for ultramarathon coaches and athletes? A systematic review. *Sports Medicine - Open*, *9*(1). https://doi.org/10.1186/s40798-022-00533-9

Krane, V., Choi, P. Y., Baird, S. M., Aimar, C. M., & Kauer, K. J. (2004). Living the paradox: Female Athletes Negotiate Femininity and muscularity. *Sex Roles, 50*(5/6), 315–329. https://doi.org/10.1023/b:sers.0000018888.48437.4f

Lesch, L., Kerwin, S., & Wicker, P. (2022). State politics and Gender Diversity in Sport Governance. *Economics of Governance, 23*(3–4), 385–409. https://doi.org/10.1007/s10101-022-00275-0

Pinch, T. J., & Bijker, W. E. (1984). The Social Construction of Facts and Artefacts: Or How the Sociology of Science and the Sociology of Technology might Benefit Each Other. *Social Studies of Science, 14*, 339–441. https://doi.org/10.1177/030631284014003004

Riebock, A., & Bae, J. (2013). Sexualized representation of female athletes in the media: How does it affect female college athletes' body perceptions? *International Journal of Sport Communication*, *6*(3), 274–287. https://doi.org/10.1123/ijsc.6.3.274

Santisteban, K. J., Lovering, A. T., Halliwill, J. R., & Minson, C. T. (2022). Sex differences in vo2max and the impact on endurance-exercise performance. *International Journal of Environmental Research and Public Health*, *19*(9), 4946. https://doi.org/10.3390/ijerph19094946

Smith, E. S., McKay, A. K. A., Ackerman, K. E., Harris, R., Elliott-Sale, K. J., Stellingwerff, T., & Burke, L. M. (2022). Methodology review: A protocol to audit the representation of female athletes in sports science and sports medicine research. *International Journal of*

Sport Nutrition and Exercise Metabolism, *32*(2), 114–127. https://doi.org/10.1123/ijsnem.2021-0257

Temm, D. A., Standing, R. J., & Best, R. (2022). Training, wellbeing and Recovery Load Monitoring in female youth athletes. *International Journal of Environmental Research and Public Health*, *19*(18), 11463. https://doi.org/10.3390/ijerph191811463

Welty Peachey, J., Schulenkorf, N., & Spaaij, R. (2019). Sport for Social Change: Bridging the theory–practice divide. *Journal of Sport Management, 33*(5), 361–365. https://doi.org/10.1123/jsm.2019-0291

Whoop. (2021, November 15). Women's performance collective and VOICEINSPORT. *WHOOP*. https://www.whoop.com/us/en/press-center/womens-performance-collective-voiceinsport-partnership/