



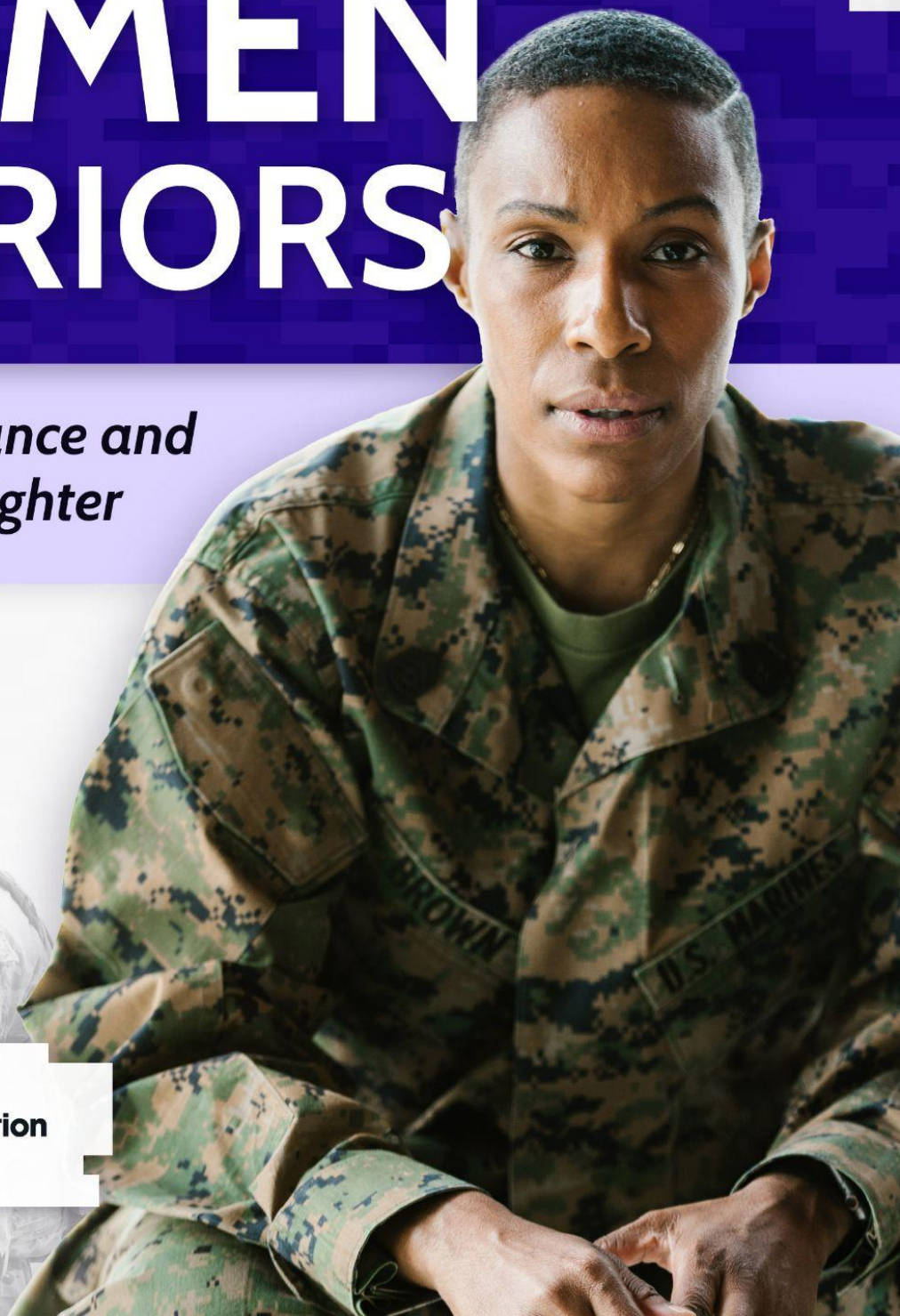
TACTICAL ATHLETE
LEADERSHIP BOARD



WHAT WE DON'T KNOW ABOUT

WOMEN WARRIORS

*Human Performance and
the Female Warfighter*



Booz
Allen.



Sports
Innovation
Lab

We are at a critical juncture as tensions rise in the Indo-Pacific and space emerges as a new conflict domain, yet we see military recruitment numbers dwindling. Stakeholders – government, industry, and academia - must invest in individualized training solutions that optimize human performance for *all* warfighters. This means developing a better understanding of the unique physiological and psychological attributes of women warfighters, including but not limited to physical fit of gear, fitness peaks in the menstrual cycle, and optimized nutrition. This research will help us challenge the status quo to create the most intelligent, lethal, and unified force in the world.

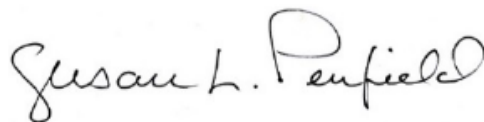
Booz Allen and Sports Innovation Lab (SIL) are leading the charge in identifying research gaps and developing technology solutions for women warfighters. We are proud to present findings in this report: *What We Don't Know About Women Warriors*. The report explores significant gaps in the knowledge and understanding of the human performance optimization of women warfighters and offers ideas for innovation.

What We Don't Know About Women Warriors is the first in a series of efforts we are driving to improve the lives and well-being of all warfighters, particularly women service members. To support the success of women warfighters and advance the field of human performance optimization, Booz Allen and the Tactical Athlete Leadership Board (TA-LB) will prioritize the following actions for 2023-2024:

- Identify and highlight additional areas for improvement
- Capture and promulgate best practices
- Provide recommendations on topics for further scientific research
- Lead the discussion through panels at summits and symposiums

U.S. military strength soars when warfighters confidently operate at peak physical, mental, and emotional acuity. Booz Allen's global team of experts works with the military to build training solutions that meet the needs of a diverse warfighting base to improve readiness and enhance the physical and cognitive abilities of all service members. We actively recruit and hire veterans and women, integrating their unique perspectives and experiences to better our teams and the outcomes we deliver to our clients. We are honored to share this report with you.

Sincerely,



Susan Penfield, Chief Technology Officer, Booz Allen

Executive Summary

With the Department of Defense facing a “recruitment crisis” in recent years and a dwindling pool of qualified young Americans available to recruit from¹, maximizing the recruitment and retention of female warfighters (currently 17.3% of the active duty force of the US Military) presents a great opportunity for growth.

Optimizing the health and performance of female warfighters is hampered by long-standing gaps and bias in applied research across the domains of training and testing standards, injury prevention and rehabilitation, nutrition and supplementation, personal equipment, and human performance technology. These gaps lead to female warfighters who are at a disadvantage when it comes to reaching an ideal level of effectiveness in their military occupational skill due to suffering through equipment and programming that is ill-suited for their needs which often leads to a higher risk of injury than their male colleagues

The Department of Defense cannot continue to ignore these gaps. The Department of Defense must look for opportunities to lead new research that will broaden society's understanding of female performance, such as how hormones and the menstrual cycle can impact training, recovery, rehabilitation, and nutrition. Other efforts, such as further research into the impact of energy deficit on warfighter health, the development of more flexible sizing options for equipment, as well as exploration into the viability and development of an individualized approach to performance optimization will offer benefits to all warfighters and increase overall readiness levels across the military.

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Statement

This report focuses on cisgender female warfighters' experiences and the gaps in research and practice that create inequitable treatment compared to cisgender male warfighters. Sports Innovation Lab recognizes and affirms the spectrum of gender and sex; however, given the complex array of issues that make up the experience of any individual in the military, we have centered our research on cisgender female warfighters to untangle the specific issues this population faces. While some of the discussions in this report (for example, the range of body types across cisgender male and female warfighters) are highly relevant to anyone's embodied experience of military service, the unique experience of transgender female or male warfighters cannot be directly transferred to the experience of their cisgender counterparts, either cisgender female or male. To support their military service, we recommend conducting similar work on the experience of and research around transgender warfighters, given the 2021 policy change allowing them to openly serve.

This report uses the term “warfighter” to represent all service members across the different branches of the US military².



Introduction

In the past ten years, the Department of Defense has introduced numerous initiatives in the field of human performance across the various branches of the military. The Army launched a new holistic health system and a new fitness test. The Air Force and Space Force rewrote their directives around physical fitness³ and launched various supporting initiatives^{4 5}. The Navy is developing a comprehensive human performance program in-house.⁶ The Marine Corps continues to develop and expand its own human performance program^{7 8}. Meanwhile, the Special Operations Command is enhancing its Preservation of the Force and Family effort, a holistic approach to readiness and resilience.

This focus on optimizing warfighters is crucial when viewed in concert with the growing “recruitment crisis” across the uniformed services⁹. As the DOD struggles with warfighter recruitment and retention, the female population offers an opportunity for growth.

As of 2021, women make up 17.3% of the active-duty force and 21.4% of the National Guard and reserves¹⁰. Since 50.5% of the US population in 2020 is female¹¹, the recruitment and retention of female warfighters represents a key area for growth for the Department of Defense.

As female representation across all services continues to grow, there are blind spots specific to *female* warfighters in the optimization of the health and human performance of warfighters.

Research studies and clinical trials across a variety of fields have long under-represented

females as participants^{12 13 14 15 16}. Whether due to sociocultural barriers or intentional exclusion¹⁷, this gender bias can lead to both a higher risk of injury and a feeling of unbelonging in the military for female warfighters, resulting in higher rates of attrition¹⁸.

This report explores the known gaps in female warfighter optimization around

- training and testing standards
- injury prevention and rehabilitation
- supplementation and nutrition
- equipment
- and human performance technology

Information will also be presented on why those gaps may exist today and what efforts are underway to address these problems.

Female Warfighter Perspective

People have a tendency to think about things from their own lens. Because of this historical progression, the vast majority of senior leaders are male, especially in special operations, where an extreme majority are male. These male leaders are thinking through things from their own lens. And if they don't individually appreciate those differences in training women, then it's not going to become a priority.

Active-duty female SOF officer

Testing Standards & Training

Human performance for warfighters begins with fitness tests. Every branch of the military conducts some manner of physical fitness testing both for new recruits and for current warfighters. This ensures they keep their personal level of fitness aligned with performance expectations and identifies any operational weaknesses at the individual and collective level such as non-deployable personnel or injury risks¹⁹.

Recent changes in testing attempted to equate test exercises with the realistic operational demands on the individual²⁰. The Army Combat Fitness Test (ACFT) - in development since 2013 - is perhaps the most prominent example of this effort. The ACFT is the first change to the US Army physical fitness testing since 1980.

Initial studies done by the Army on the ACFT's ability to simulate and predict performance across common Soldier demands drew criticism for a lack of female representation. The highest proportional representation of female warfighters across the initial three studies completed was only 16.2%. While this mirrored overall representation of female warfighters in the Army, there were concerns that the validation was weighted towards the physical characteristics of male warfighters^{21 22}.

These concerns contributed to the replacement of the ACFT's leg tuck by the plank. This replacement occurred after studies showed the

leg tuck was not a strong predictor of the movements associated with the common Soldier tasks^{23 24}. For the time being, the Army is moving forward with different scoring requirements for age-bands and gender²⁵.

Only 23% of young Americans are eligible for service due to poor physical fitness, medical disqualification, or other reasons²⁶. The Department of Defense must find a balance between combat readiness and recruiting targets. For example, the Army offers the Future Soldier Preparatory Course, a pre-basic training course, which provides additional training for possible recruits to prepare for the fitness and education requirements of the military^{27 28}.

In other branches of the military, there is a mix of gender-specific (different scoring criteria or test design for males and females) and gender-neutral (same standards for all genders) standards²⁹.

The fitness standard is only half of the equation. Physical training to develop and maintain a level of fitness is the other key component.

Exercise science as a field, by and large, neglects specific female needs with just five percent of studies focused exclusively on women³⁰. Two significant blind spots in knowledge today are the menstrual cycle and how fluctuations in hormones impact the female body's response to training.

Some research points to the follicular phase (pre-ovulation) as an optimal time for training: a rise in estrogen can assist in building muscle mass and strength as well as help with recovery^{31 32 33}. Meanwhile, the luteal phase

(post-ovulation) is less ideal for this type of training, as progesterone accelerates muscle breakdown and lengthens recovery times³⁴. However, studies are inconclusive on the exact impact of the menstrual cycle on performance, and this area requires further investment and research^{35 36}.

Along with a lack of research consensus, there is also substantial variation between women throughout the phases of their menstrual cycle, as well as variation in individual women's cycles³⁷. This means that generalized guidance, even if supported by research, may not be optimal for any particular female based on their own cycle. Furthermore, published research does not explore how the usage of hormonal contraceptives (and the variation across different types of birth control) impacts performance.

Where does this leave female warfighters? Female warfighters, speaking anonymously, indicated they often end up looking for training assistance outside of official military channels.

Some warfighters can afford to seek individualized training guidance, but this is not the case for all. For those early in their career or with dependents, the additional cost for outside training support may not be feasible.

The benefits, however, are clear. By tailoring training to an individual's specific needs and the standard, warfighters can train more efficiently or effectively. Increasing individualization in the approach and delivery of training would optimize both male and female warfighters. Although the individualized approach may present current challenges to scalable adoption, this is an area where future technology integration could help reduce the

number of non-deployable warfighters and improve overall combat readiness across the military.

Company Spotlight

There are a number of human performance technology companies aiming to help female users better understand how their menstrual cycle impacts their performance and recovery.

WHOOP®

Based on measured values like HRV and self-reported data on a user's menstrual cycle, WHOOP now offers individual recommendations on training and recovery needs³⁸.

OURA



Metrics like resting heart rate and sleep values tracked by the Oura ring can now be used as inputs in the Wild.AI algorithm which provides training recommendations based on the phases of the user's menstrual cycle³⁹.

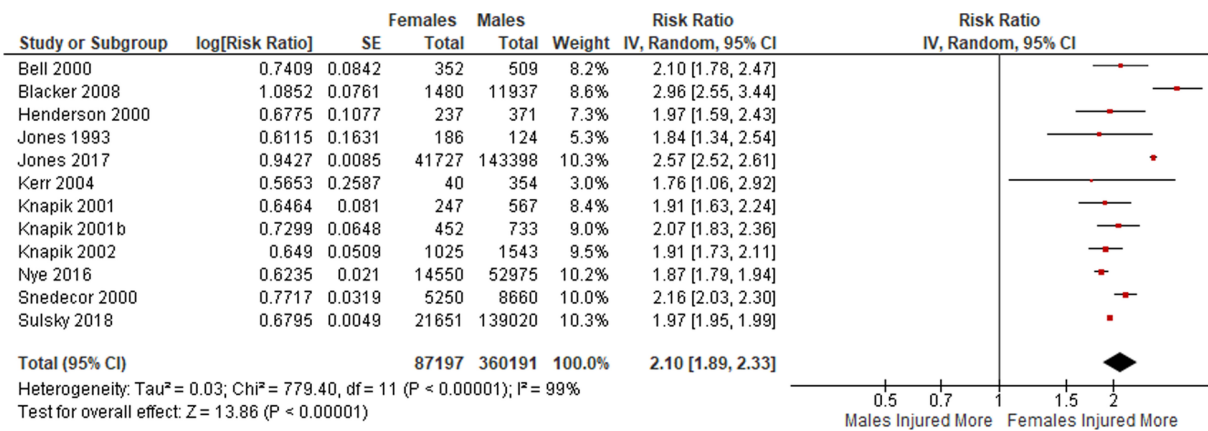
orreco

Orreco's FitrWomen app allows athletes to track their cycle and symptoms, with the data all consolidating into their FitrCoach platform to provide a team view for more effective training plans and individualized programming⁴⁰.

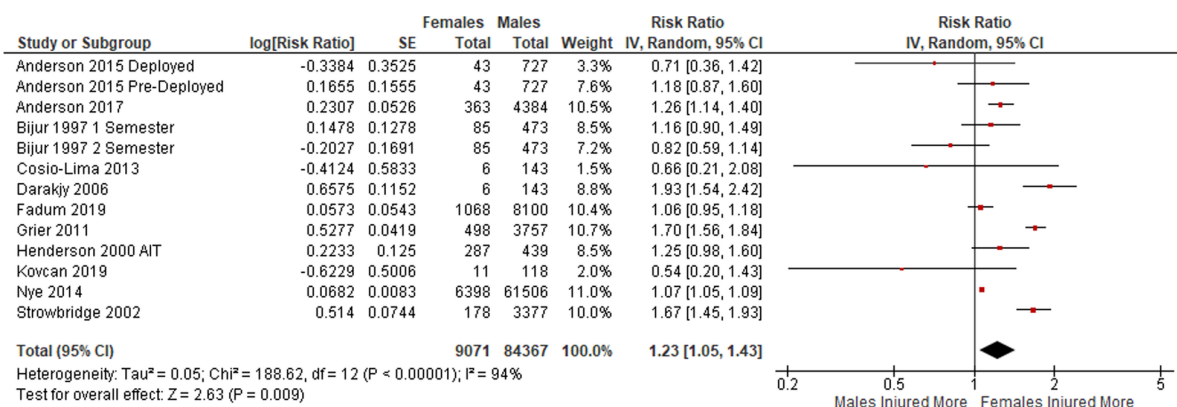
Injury Prevention & Rehabilitation

Studies show while the musculoskeletal injury rate for female warfighters may be higher during basic training compared to male counterparts, these differences decrease substantially as their military career continues. A proposed factor to explain this decrease is an overall increase in fitness levels in response to basic training⁴¹.

Meta-analysis of injury rates in basic training⁴¹



Meta-analysis of injury incidence rates post basic training⁴¹



Looking at musculoskeletal injuries as a whole, estrogen's impact on the body is most commonly referenced when considering the higher likelihood of ACL knee injuries in females^{42 43}. Some research attributes this increased risk to the menstrual cycle⁴⁴, while others point to anatomy and biomechanics⁴⁵.

The sociocultural factors that may make the body more susceptible to injury throughout girls' and women's development are perhaps the least considered. These factors are much more difficult to evaluate and include gendered behavioral and societal expectations of women and girls⁴⁶.

Expert Insight

We tend to talk about women and girls as being inherently more prone to injury, especially when we see rates of women and girls being three to six times more likely to get knee injuries or ACL injuries than boys and men. . . . And I think for me, that's one of the big gaps and one of the big myths that we . . . need to work on. For me, we need to move I think a little bit closer to what I call sociocultural shifts. So, understanding how women and girls' bodies are *made* weaker, or *made* more risky or *made* more prone to injury.

**Dr. Sheree Bekker, Assistant Professor,
Department of Health, University of Bath**

Post-injury fields also require further research. Studies are currently underway to design female-specific rehabilitation programming that examines this impact and response⁴⁷.

Outside of musculoskeletal injuries, another commonly held statistic is that females suffer a higher risk of a traumatic brain event than their male counterparts, including lengthier concussion recovery times⁴⁸. A 2020 traumatic brain event literature review of 25 studies presented evidence females may be more susceptible to concussions and suffer from prolonged symptoms. However, this same study also reported females were more likely to report a concussion and highlighted the lack of research into this area, noting 270 published articles examined male athletes and concussion⁴⁹.



Nutrition & Supplements

The Female Athlete Triad, first named in 1992, references a combination of low energy availability (with or without an eating disorder), menstrual dysfunction, and low bone mineral density⁵⁰. More recent studies include this syndrome under the broader term Relative Energy Deficiency in Sport (RED-S)⁵¹. RED-S can affect both male and female warfighters and is highlighted by an energy deficit leading to numerous physical and cognitive performance impairments of the warfighter's system⁵². In short, the body is not receiving enough dietary energy compared to the energy being expended, causing numerous disruptions to occur in body function.

Warfighters may experience disturbances in the endocrine system, which handles the body's hormones. Meanwhile, increases in cortisol can impact skeletal health. Other symptoms can include immune system suppression, iron deficiency, and mood disturbances.

Overall, the impact of RED-S on warfighters during training courses and field exercise where energy deficit takes place is vastly under-researched. There are conflicting studies on how both physical and mental performance are impacted by energy deficit, as well as understanding the long-term effects of energy deficiency and recovery alongside military training. Even less is understood on the impact of energy deficiency on female warfighters.

The energy deficit that leads to RED-S highlights the importance of nutrition for all warfighters. Some military branches have

begun efforts to educate warfighters on the importance of balancing nutrition with operational and fitness demands⁵³, but, as with physical training, warfighters often look for outside assistance when it comes to optimizing their dietary needs.

Female Warfighter Perspective

The lack of access to non-broad-brush nutrition, healthcare, and fitness coaching is a pink tax. It especially reveals a care gap for junior enlisted women. I shouldn't have to pay out of pocket for these services. But I have the option to do it, if I so choose, because I have the money to do it as an officer.

Active-duty female SOF officer

Aligning female warfighter dietary needs with their menstrual cycle and training provides an opportunity for further optimization. Some studies show the body uses carbohydrates more efficiently during the follicular phase, and fats and amino acids more efficiently during the luteal phase⁵⁴. Other research points to women taking supplements of collagen and vitamin C during the follicular phase, as well as hydration with electrolytes and sodium during the luteal phase as potentially benefiting overall performance³⁴.

However, comprehensive nutrition research throughout the menstrual cycle is lacking and there is a need to better understand the relationship between diet, training, and menstruation⁵⁵.

Equipment

Military equipment is often listed as a contributing factor to injury rates for female warfighters⁴¹, which reveals a hard truth: the bulk of military equipment was designed with male warfighters in mind. Whether with the dimensions and weight of personal equipment such as backpacks or weapons, or larger items such as vehicles, female warfighters often deal with poor ergonomics which results in an increased risk of injury⁵⁶.

Advancements in virtual human technology, such as Santos and Sophia from the University of Iowa's Technical Institute, can provide a means for equipment to be designed in a virtual environment and tested against biomechanically accurate digital human models (both male and female) and iterate on the design more quickly with lower financial overhead, compared to full production⁵⁷.

The US Government stepped in to ensure female warfighters have access to correctly sized body armor and personal protective equipment (PPE). As part of the Female Body Armor Modernization Act, the Department of Defense will track the prevalence of injury resulting from ill-fitting PPE and ensure that flexible options are available for all warfighters to have the optimal fitting equipment⁵⁸.

Equipment considerations extend into uniforms, with some female warfighters pointing out that basic clothing such as uniform pants is not always optimal for the average female form. For example, additional fabric may potentially impact the effectiveness of performance and raise injury risk. It was also noted some female warfighters, after leaving

the service, started their own businesses to design tactical pants specifically tailored to the needs of tactical warfighters. Even boots on the ground for female warfighters are being considered, with an active study underway by Army Footwear Researchers in the U.S. Army Combat Capabilities Development Command Soldier Center⁵⁹.

Company Spotlight



Developed and led by female veterans, KADRI clothing makes functional, tactical clothing designed for women across the tactical space, including military, firefighters, EMS, and law enforcement. With female warfighters sometimes required to tailor men's pants to have an adequate solution, KADRI offers 72 different sizing combinations to allow for a proper fit without sacrificing functionality⁶⁰.

By providing flexible options around personal equipment and looking at a broader range of human body shapes for ergonomic design decisions, the resulting design and usage of updated equipment will not only benefit female warfighters but will optimize the performance of all warfighters.

Human Performance Technology

As the study of human performance and sport science continues to gain prominence both inside and outside of the tactical environment, a burgeoning human performance technology market is developing in parallel to assist in evaluating, monitoring, assessing, and quantifying performance across various areas of focus.

However, without underlying research and understanding around female human performance, products hitting the market often suffer from blind spots through basing algorithms and recommendations on existing male-dominant research⁶¹. This presents a risk both for the practitioner in the identification of outliers and for the subjects themselves.

These risks are further exacerbated by human performance technologies attempting to preserve their proprietary approaches and unique value propositions in a competitive market. “Black box” systems essentially depend on blind trust when proceeding with these recommendations, as inputs are entered into a deep learning data model and recommendations are presented without transparency or visibility⁶². These structures are sometimes knowingly used by human performance technology systems but ultimately confuse and fail the practitioner and subjects.

Even in systems where analysis is transparent and validated, there are risks associated with

the increased usage of artificial intelligence and how models are trained⁶³. Artificial intelligence has begun to find a role in the analysis and recommendation of interventions in the human performance space⁶⁴. The risks presented here for female warfighters can be attributed to the design and usage of artificial intelligence models based on misinformed (or gender-biased) datasets and will only further propagate incorrect outcomes to females⁶⁵. For female warfighters looking to use human performance technology to optimize their own performance, these risks could result in injury or a lack of overall readiness for operational duties.

Expert Insight

Let's actually start to ask some intelligent questions about it if we want to actually move the needle within a female population. You have to be real. I'm sorry, we don't fit into a box. I'm sorry, that we're complicated to have to deal with. But that's what makes us awesome. We're so close to unlocking this potential and understanding so much more about how the human body functions and operates and how you can optimize human performance within that.

Dr. Meg Garvey, Senior Scientist, Nix Biosensors

In Conclusion

When forecasting the next twenty years of US military operations, one fact is immediately clear: it will look remarkably different from the past twenty years. This fact places great emphasis on the importance of recruiting, retaining, and ensuring the operational readiness of warfighters across all branches, including female warfighters.

The gaps in knowledge when it comes to the optimization and performance of female warfighters are varied and no single initiative will overcome the multiple blindspots. However, concentrated efforts will not only result in the success of *female* warfighters but lead to insights to improve the health and performance of all warfighters.

Three key areas to explore are:

- 1) A fully individualized approach to training, recovery, and nutrition programming may not be feasible across all forces at this time but embracing the need now will help inform future program design and technology development to bridge that gap in the near and long term future.
- 2) The design and procurement of more flexible sizing options around personal equipment, and leveraging digital technology with a diverse set of human models to develop new equipment and vehicles is another key area of benefit to all warfighters.
- 3) Finally, additional research into understanding the relationship between energy deficit and injury, as well as continuation and expansion of pre-basic training opportunities to improve fitness

levels of potential new recruits, could result in a military force with lower instances of injury and higher levels of readiness.

Expert Insight

When we make things better for a certain population, all populations will benefit. Our soldiers aren't all the same. They're not all white men. They have different heritage, they have different body types, their bodies work in different ways and have different forces. When we find things that are working better, people are getting hurt less and we're taking better care of those people that serve us, then you're going to have an easier time recruiting them. And we know recruiting and maintaining individuals in the services is very challenging right now. So, it's a win-win for everybody.

Dr. Joellen Sefton, Director, Warrior Research Center and Professor, Auburn University

For female warfighters in particular, additional research into the impact of hormones and the different phases of the menstrual cycle on performance, whether that be optimizing training, recovery, rehabilitation, nutritional needs or other aspects of human performance is required.

The female warfighter represents an area of growth for military recruiting. Improving our understanding of how to best train and optimize these warfighters will not only improve their success and capabilities while serving but will also contribute to understanding and improving female performance in other fields.

End Notes

1. Novelly T. (2023, March 7). Air Force will likely miss recruiting goals, Service Secretary says. Military.com.
<https://www.military.com/daily-news/2023/03/07/air-force-will-likely-miss-recruiting-goals-service-secretary-says.html>
2. Reynolds J. (2003, March 16). FOOD; Ration-a-l Thinking. New York Times.
<https://www.nytimes.com/2003/03/16/magazine/food-ration-a-l-thinking.html>
3. Department of the Air Force (2022, April 21). Department of the Air Force Physical Fitness Program. Department of the Air Force Manual 36-2905.
<https://www.afpc.af.mil/Portals/70/documents/FITNESS/dafman36-2905.pdf?ver=ld3Ns7RUvFqg-xpwrkIGMw%3d%3d>
4. Mueller K. (2022, July 25). Propelling Airmen to a higher level of readiness. Air Education and Training Command.
<https://www.aetc.af.mil/News/Article-Display/Article/3105578/propelling-airmen-to-a-higher-level-of-readiness>
5. 71st Flying Training Wing Public Affairs. (2002, September 15). Vance | How to 'CRAFT' a more effective, resilient pilot. Air Education and Training Command.
<https://www.aetc.af.mil/News/Article-Display/Article/3159950/vance-how-to-craft-a-more-effective-resilient-pilot/>
6. Fuentes G. (2022, December 20). Ships and Human Performance: Surface Forces Take Holistic Approach to Sailors, Crew Training. Seapower Magazine.
<https://seapowermagazine.org/ships-and-human-performance-surface-forces-take-holistic-approach-to-sailors-crew-training/>
7. Dresbach J. (2013, April 22). HITT Program to stream-line already fit Marines. US Army.
https://www.army.mil/article/101585/hitt_program_to_stream_line_already_fit_marines
8. Phillips A. (2018, July 13). Semper Fit, FFI Increase Force Readiness. US Marines.
<https://www.marines.mil/News/News-Display/Article/1573911/semper-fit-ffi-increase-force-readiness/>
9. Horton A. (2022, September 21). Pentagon bedeviled by recruitment failures as solutions prove elusive. Washington Post.
<https://www.washingtonpost.com/national-security/2022/09/21/us-military-recruiting-crisis/>
10. US Department of Defense. (2022, December 14). Department of Defense Releases Annual Demographics Report - Upward Trend of Women Serving Continues.
<https://www.defense.gov/News/Releases/Release/Article/3246268/departments-of-defense-releases-annual-demographics-report-upward-trend-in-numbe/>
11. United States Census Bureau (2020, April 1). QuickFacts.
<https://www.census.gov/quickfacts/fact/table/US/SEX255221#SEX255221>
12. Holdcroft A. (2007, January). Gender bias in research: how does it affect evidence based medicine? Journal of the Royal Society of Medicine.
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1761670/>
13. Institute of Medicine (US) Committee on Ethical and Legal Issues Relating to the Inclusion of Women in Clinical Studies. (1994). Women's Participation in Clinical Studies. Women and Health Research: Ethical and Legal Issues of Including Women in Clinical Studies: Volume 1.
<https://www.ncbi.nlm.nih.gov/books/NBK236535/>

14. Institute of Medicine (US) Committee on Ethical and Legal Issues Relating to the Inclusion of Women in Clinical Studies. (1999). Women's Representation as Subjects in Clinical Studies: A Pilot Study of Research Published in JAMA in 1990 and 1992. Women and Health Research: Ethical and Legal Issues of Including Women in Clinical Studies: Volume 2: Workshop and Commissioned Papers.
<https://www.ncbi.nlm.nih.gov/books/NBK236566/>
15. Liu K, Mager N (2016, March 15). Women's involvement in clinical trials: historical perspective and future implications. Pharmacy Practice.
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4800017/>
16. Feldman S, Ammar W, Lo K, Trepman E, van Zuylen M, Etzioni O. (2019). Quantifying Sex Bias in Clinical Studies at Scale with Automated Data Extraction. JAMA Network Open.
<https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2737103?widget=personalizedcontent&previousarticle=0>
17. Foley K. (2019, July 3). 25 years of women being underrepresented in medical research, in charts. Quartz.
<https://qz.com/1657408/why-are-women-still-underrepresented-in-clinical-research>
18. Werner B. (2020, May 20). GAO: Women 28 Percent More Likely to Leave Military Service than Men. USNI News.
<https://news.usni.org/2020/05/20/gao-women-28-percent-more-likely-to-leave-military-service-than-men>
19. Holl D. (2022, January 19). Why fitness matters - reviewing history of Army fitness testing. Army Public Health Center.
https://www.army.mil/article/253358/why_fitness_matters_reviewing_history_of_army_fitness_testing
20. Overson D. (2021, March 4). The ACFT is designed for combat - TRADOC shows why. TRADOC Communication Directorate.
https://www.army.mil/article/243931/the_acft_is_designed_for_combat_tradoc_shows_why
21. Novak K. (2020, November 19). A Critical Review of the Baseline Soldier Physical Readiness Requirements Study.
<https://kylenovak29.s3.amazonaws.com/BSPRRS+Assessment.pdf>
22. University of Iowa. (2020, April 1). Baseline Soldier Physical Readiness Requirements Study.
<https://iti.uiowa.edu/sites/iti.uiowa.edu/files/2021-03/Univ%20of%20Iowa%20Review%20Report%20W911SO-19-C-0005%20Baseline%20Soldier%20Performance%20Readiness%20Requirement%20Study%20%28BSPRR%29%20Peer%20Review%20Report%201-Apr2020%20v2.pdf>
23. Mitchell E. (2022, March 23). Army approves reduced physical fitness standards for women, older soldiers. The Hill.
<https://thehill.com/policy/defense/599459-army-approves-reduced-physical-fitness-standards-for-women-older-soldiers/>
24. Ryan M. (2020, September 24). The Army is rolling out a new fitness test: Will it hold back women?. Washington Post.
https://www.washingtonpost.com/national-security/army-fitness-test-women/2020/09/24/20ed51e2-e244-11ea-ade1-28daf1a5e919_story.html
25. Tiron R. (2022, March 23). U.S. Army's New Fitness Test Ditches Gender-Neutral Scoring. Bloomberg.
<https://www.bloomberg.com/news/articles/2022-03-23/u-s-army-s-new-fitness-test-ditches-gender-neutral-scoring?leadSource=uverify%20wall>
26. Novelly T. (2022, September 28). Even More Young Americans are Unfit to Serve, a New Study Finds. Here's Why. Military.com.
<https://www.military.com/daily-news/2022/09/28/new-pentagon-study-shows-77-of-young-americans-are-ineligible-military-service.html>
27. Lee M. (2023, January 11). Army expands program for recruits who don't meet weight and test requirements as recruiting crisis deepens. Fox News.
<https://www.foxnews.com/us/army-expands-program-recruits-dont-meet-weight-test-requirements-recurring-crisis-deepens>

28. Michaelis P. (2022, August 4). Fort Jackson's Future Soldier Preparatory Course. US Army.
https://www.army.mil/article/259078/fort_jackson_s_future_soldier_preparatory_course
29. BenZvi M. (2022, June 23). Congress Eyes Gender-Neutral Fitness Standards for Combat Roles. Coffee or Die Magazine.
<https://coffeedie.com/gender-neutral-fitness/>
30. O'Halloran K. (2023, January 10). Elite athletes are no longer ashamed of their periods - and tracking their menstrual cycles may even be a secret weapon. ABC News.
<https://www.abc.net.au/news/2023-01-11/menstrual-tracking-cycle-coaching-fitness-performance/101296512>
31. Bandyopadhyay A, Dalui R. (2012). Endurance capacity and cardiorespiratory responses in sedentary females during different phases of menstrual cycle. Kathmandu University Medical Journal.
<https://pubmed.ncbi.nlm.nih.gov/23575048/>
32. Chidi-Ogbolu N, Baar K. (2019 January 15). Effect of Estrogen on Musculoskeletal Performance and Injury Risk. Frontiers in Physiology.
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6341375/>
33. Saner E. (2019, July 10). How period tracking can give all female athletes an edge. The Guardian.
<https://www.theguardian.com/lifeandstyle/shortcuts/2019/jul/10/how-period-tracking-can-give-all-female-athletes-an-edge>
34. KCH Nutrition (2020, October 31). Female Athletes - The Hidden Power of your Hormones and How to Harness them.
<https://kchnutrition.co.uk/female-athletes-hidden-powers-hormones-harness/#>
35. Meignie A, Duclos M, Carling C, Orhant E, Provost P, Toussaint J-F, Antero J. (2021, May 19). The Effect of Menstrual Cycle Phase on Elite Athlete Performance: A Critical and Systematic Review. Frontiers in Physiology.
<https://www.frontiersin.org/articles/10.3389/fphys.2021.654585/full>
36. Romero-Moraleda B, Del Coso J, Guterrez-Hellin J, Ruiz-Moreno C, Grgic J, Lara B. (2019, August 21). The Influence of the Menstrual Cycle on Muscle Strength and Power Performance. Journal of Human Kinetics.
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6724592/>
37. Bull J, Rowland S, Scherwitzl E, Scherwitzl R, Danielsson K, Harper J. (2019). Real-world menstrual cycle characteristics of more than 600,000 menstrual cycles. npj Digital Medicine.
<https://www.nature.com/articles/s41746-019-0152-7>
38. WHOOP. (2021, November 22). New WHOOP Feature: Menstrual Cycle Coaching.
<https://www.whoop.com/thelocker/whoop-feature-menstrual-cycle-coaching/>
39. Oura. (2021, June 22). Training According to Your Cycle? Wild.AI Now Integrates with Oura.
<https://ouraring.com/blog/wild-ai-integration/>
40. Orreco. Female Athlete Program.
<https://www.orreco.com/products/female-athlete-program>
41. Schram B, Canetti R, Orr R, Pope R. (2022, July 25). Injury Rates in female and male military personnel: a systematic review and meta-analysis. BMC Women's Health.
<https://bmcmenshealth.biomedcentral.com/articles/10.1186/s12905-022-01899-4>
42. Arendt E, Dick R. (1995). Knee injury patterns among men and women in collegiate basketball and soccer. NCAA data and review of literature. AM J Sports Med.
<https://pubmed.ncbi.nlm.nih.gov/8600737/>
43. Ireland M, Gaudette M, Crook S. (1997). ACL Injuries in the Female Athlete. Journal of Sport Rehab.
http://www.marylloydireland.com/PDFSCANS/Rehabilitation/1997_Journal_of_Sport_Rehab_ACL_Injuries_in_the_Female_Athlete.pdf

44. Adachi N, Nawata K, Maeta M, Kurozawa Y. (2007, October 2). Relationship of the menstrual cycle phase to anterior cruciate ligament injuries in teenaged female athletes. Arch Orthop Trauma Surg. <https://pubmed.ncbi.nlm.nih.gov/17909824/>
45. Mirabile B. (2019, March 5). Female Athletes Compete Against Higher Risk of ACL Injuries Than Males. Biomechanics in the Wild. <https://sites.nd.edu/biomechanics-in-the-wild/2019/03/05/female-athletes-compete-against-higher-risk-of-acl-injuries-than-males/>
46. Parsons J, Coen S, Bekker S. (2021). Anterior cruciate ligament injury: towards a gendered environmental approach. British Journal of Sports Medicine. <https://bjsm.bmj.com/content/55/17/984>
47. Howie L. (2022, May 17). Hopes menstrual cycle can help in post-surgery recovery. 1 News. <https://www.1news.co.nz/2022/05/17/hopes-menstrual-cycle-can-help-in-post-surgery-recovery/>
48. Sanderson K. (2021, August 3). Why sports concussion are worse for women. Nature. <https://www.nature.com/articles/d41586-021-02089-2>
49. McGroarty N, Brown S, Mulcahey M. (2020, July 16). Sport-Related Concussion in Female Athletes: A Systematic Review. Orthopaedic Journal of Sports Medicine. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7366411/>
50. Nazem T, Ackerman K. (2012, July). The Female Athlete Triad. Sports Health. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3435916/>
51. Henderson G. (2023, January 3). How Under-Fueling can Lead to RED-S - Relative Energy Deficiency in Sport. Dance Magazine. <https://www.dancemagazine.com/under-fueling-and-red-s/>
52. O'Leary T, Wardle S, Greeves J. (2020, August 25). Energy Deficiency in Soldiers: The Risk of the Athlete Triad and Relative Energy Deficiency in Sport Syndromes in the Military. Frontiers in Nutrition. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7477333/>
53. Naval Medicine Female Force Readiness Clinical Community. Relative Energy Deficiency in Sport (RED-S) Provider Guide. https://www.med.navy.mil/Portals/62/Documents/NMFA/NMCPHC/root/Health%20Promotion%20and%20Wellness/Women's%20Health/Documents/Musculoskeletal/RED_S_Provider_Guide_vF.pdf
54. Hauck Z. (2020, January 31). How Your Hormones Affect Athletic Performance and Why You Need to Start Testing. The ZRT Laboratory Blog. <https://www.zrtlab.com/blog/archive/how-your-hormones-affect-athletic-performance#B14>
55. Helm M, McGinnis G, Basu A. (2021, June 10). Impact of Nutrition-Based Interventions on Athletic Performance during Menstrual Cycle Phases: A Review. International Journal of Environmental Research and Public Health. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8296102/>
56. Epstein Y, Fleischmann C, Yanovich R, Helped Y. (2015, November). Physiological and Medical Aspects That Put Women Soldiers at Increased Risk for Overuse Injuries. Journal of Strength and Conditioning Research. <https://pubmed.ncbi.nlm.nih.gov/26506172/>
57. Iowa Technical Institute. Santos: The Virtual Human. University of Iowa: College of Engineering. <https://iti.uiowa.edu/santos-virtual-human>
58. Druga M. (2020, January 28). Legislation would ensure proper-fitted body armor for female service members. Homeland Preparedness News. <https://homelandprepnews.com/stories/43286-legislation-would-ensure-proper-fitted-body-armor-for-female-service-members/>

59. Army News Service. (2022, February 7). DEVCOM leads effort to make warfighter footwear more inclusive. APG News.
<https://apgnews.com/inside-the-innovation/devcom-leads-effort-to-make-warfighter-footwear-more-inclusive/>
60. KADRI Clothing. <https://www.kadriclothing.com/>
61. Sims S, Ware L, Capodilupo E. (2021). Patterns of endogenous and exogenous ovarian hormone modulation on recovery metrics across the menstrual cycle. BMJ Open Sport and Exercise Medicine.
<https://bmjopensem.bmj.com/content/7/3/e001047>
62. Teng Q, Liu Z, Song Y, Han K, Lu Y. (2022, June 25). A survey on the interpretability of deep learning in medical diagnosis. Multimedia Systems.
<https://link.springer.com/article/10.1007/s00530-022-00960-4>
63. Leavy S. (2018). Gender Bias in Artificial Intelligence: The Need for Diversity and Gender Theory in Machine Learning. 2018 ACM/IEEE 1st International Workshop on Gender Equality in Software Engineering.
https://www.researchgate.net/profile/Susan-Leavy-4/publication/326048883_Gender_bias_in_artificial_intelligence_the_need_for_diversity_and_gender_theory_in_machine_learning/links/5bce138aa6fdcc204a001d87/Gender-bias-in-artificial-intelligence-the-need-for-diversity-and-gender-theory-in-machine-learning.pdf
64. Clubb J. (2022, December 7). Illuminating the Black Box in Search of Greater Transparency in Sports Science. Global Performance Insights.
<https://www.globalperformanceinsights.com/post/illuminating-black-box-greater-transparency-sports-science>
65. Niethammer C. (2020, March 2). AI Bias Could Put Women's Lives At Risk - A Challenge For Regulators. Forbes.
<https://www.forbes.com/sites/carmenniethammer/2020/03/02/ai-bias-could-put-womens-lives-at-risk-a-challenge-for-regulators/?sh=2c4cbf38534f>

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