

2025

Five Years
of Exploration,
Innovation,
and Impact



Wu Tsai Human
Performance Alliance

Stanford University

Contents

04

Transforming Human Health Through the Science of Peak Performance

06

Digital Athlete Moonshot

08

Molecular Athlete Moonshot

10

Regenerative Rehabilitation Moonshot

11

The Human Performance Laboratory

12

Female Athlete Program

14

Agility Projects: Expanding Our Knowledge and Impact

16

Collaborations Around the World

18

Uniting World-Class Science and Athletics at Stanford

20

Training the Next Generation of Leaders

22

Growing the Human Performance Research Community at Stanford

23

Fueling Human Performance via Open Science

24

Performance for Everyone: Bridging Research and Public Awareness

25

Looking Forward

26

Our Team

Welcome

When we launched the Wu Tsai Human Performance Alliance five years ago, our goal was ambitious: to transform the field of human performance science through rigorous research, transformative education, open collaboration, and global impact.

We've surpassed this goal. Together, we've built an international network of more than 500 world-leading scientists, engineers, and clinicians across six core institutions and dozens of partner institutions worldwide. At Stanford alone, our teams have published groundbreaking discoveries, including new molecules that improve endurance, control appetite, and strengthen muscles. We have developed the first-ever scar-free healing of injuries and created a versatile AI model of movement. Tools we built, like our OpenCap software for smartphone-based biomechanical analysis, are now used by thousands of researchers, coaches, and athletes around the world, advancing scientific discovery and athletic performance worldwide.

What makes the Wu Tsai Human Performance Alliance so distinctive is our commitment to open science and to research that serves people at every level of performance, from Olympic athletes to anyone striving for better health. We're not just advancing performance; we're uncovering the fundamental biology of exercise, sleep, and nutrition and translating that knowledge to help everyone live stronger, healthier lives.

Through the Alliance, we've brought together the world's largest team of researchers focused on understanding female physiology and performance. This year's Female Athlete Research Meeting at Stanford marks a milestone in that work, and it's just the beginning. We're building the foundation for a future where performance science represents all athletes.

We have also invested in training future leaders in human performance science. Through mentorship and cross-disciplinary education, we're equipping early-career scientists and clinicians to carry this field forward—and that investment is already making an impact. Our past trainees are now faculty members who are starting human performance research centers at universities such as Harvard and the University of Washington, and have taken on leadership roles in industry and sport.

None of this would have been possible without the vision and generosity of our partners, Clara Wu Tsai and Joe Tsai. I'm deeply grateful for their partnership and to everyone who has joined us on this journey. Together, we're proving that we can transform human performance and, ultimately, human health.



Scott Delp

Director, Wu Tsai Human Performance Alliance at Stanford



Andrew Brodhead

Transforming Human Health Through the Science of Peak Performance

The Wu Tsai Human Performance Alliance is discovering the biological principles that govern peak performance and translating these discoveries to drive innovations in human health for all. Inspired by the vision of Clara Wu Tsai, the Alliance launched in 2021. At Stanford, the Alliance is a university-wide research initiative that brings together experts from across the campus and is making tremendous progress in advancing human performance.



“The Alliance is building the equivalent of the Hubble telescope to explore the universe of the body.”

Ashton Eaton
Two-time Olympic gold-medal winning decathlete

3

new drugs in pipeline for FDA approval

40

studies in collaboration with Stanford athletics

65

grants, fellowships, and follow-on funding awards

100+

active collaborations around the world

250+

research publications, including in *Nature*, *Science*, and *Cell*

305

Stanford faculty affiliates

400,000+

motion trials collected

Moonshots

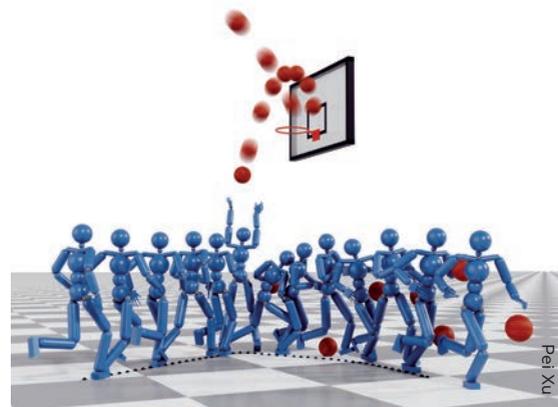
Our moonshots are addressing fundamental scientific and technical challenges and having profound impact on human performance.

Digital Athlete Moonshot Innovations for Rapid, Accurate, State-of-the-Art Digital Twins

The Digital Athlete moonshot is creating “digital twins”—accurate, personalized, and predictive models of how a person moves—to help all people train smarter, recover faster, and achieve their performance goals.

OpenCap Transforms Smartphone Videos into Affordable, Accurate Digital Twins

OpenCap’s [smartphone-based movement analysis](#) matches the detail of gold-standard motion capture at just 1% of the cost and in as little as five minutes, a fraction of the time typically required for data collection. We built the open-source OpenCap platform by combining computer vision, deep learning, and musculoskeletal simulation. OpenCap computes biomechanical quantities, such



A novel AI algorithm generates a sequence of tasks with realistic transitions between them, like shooting a basketball and dribbling.

as joint forces and muscle activity, and is transforming how researchers, clinicians, and coaches assess performance and injury risk.

A Foundation Model for Movement

We developed GaitDynamics, a generative AI model that can predict human gait and joint forces in seconds. Unlike earlier AI models trained to predict a single output, GaitDynamics is a foundation model that can perform multiple tasks, from estimating joint angle changes as someone runs faster to computing how changes in gait affect knee loading. This versatility in generating realistic movements is analogous to how large language models, like those underlying ChatGPT and Claude, generate text, providing a powerful tool to prevent injuries, guide rehabilitation, and optimize performance.

Moving like a Basketball Player: AI Algorithms for Predictive, Human-Like Play

Professor Karen Liu and her lab are pushing the limits of movement prediction. Their latest [AI algorithm](#) is able to generate physics-based simulations of a complex series of tasks—like catching a ball, dribbling, and shooting—with smooth and realistic transitions between them, an achievement that has eluded previous efforts. This flexible algorithm makes it possible to simulate both sequences of movements and cooperation between multiple individuals, a vital step in creating digital twins for team sports that can optimize team strategy, while minimizing injury risk for individual players.

Rapid Medical Imaging for Personalized Models

Professor Akshay Chaudhari is using AI to rapidly collect medical images and use them to create personalized biomechanical models. His imaging tools [reduce MRI scan times](#) from 30

minutes to five minutes, and his freely available software for image analysis replaces commercial services that cost upwards of \$2,000 per patient. It’s a significant advancement, and the resulting FDA-cleared tools are now used in hundreds of hospitals and clinics.

Digital Twins in Action

Precision Training to Prevent Hamstring Injuries

Hamstring injuries account for about 20% of all injuries in sports that feature high-speed running and can bench athletes for weeks, if not months. With Digital Athlete technology, the Alliance is gaining insights into the factors behind injuries and laying the groundwork to prevent them.

As a Digital Athlete postdoctoral fellow at Stanford, Reed Gurchiek used OpenCap to turn smartphone videos into digital twins of athletes running. With this technology, he [discovered that hamstring muscles](#) stretch just as much during acceleration from lower speeds as at top speeds, showing that speed alone may not predict injury risk. These insights can help coaches create algorithms to manage training loads. Gurchiek is now an assistant professor at Clemson University, where he continues the Alliance’s mission to prevent hamstring injuries.

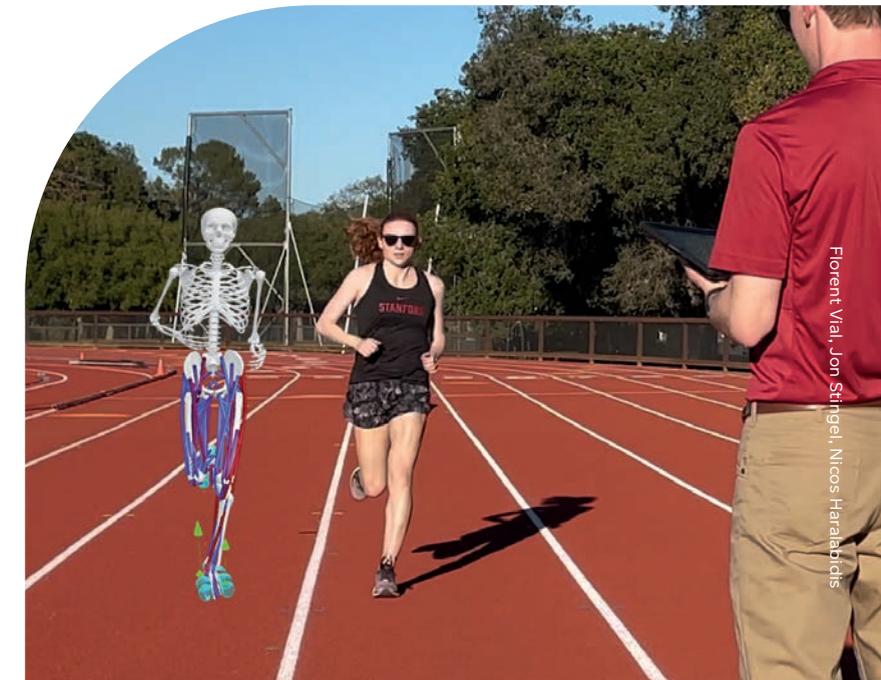
Our research also provides insights into the Nordic hamstring exercise (NHE), a widely used training modality to reduce hamstring injuries that is not well understood at a physiologic level. We used our team’s novel imaging technology to show that the NHE lengthens muscle fibers by about 30%, but these beneficial muscle adaptations can be short-lived without sustained training. Using Digital Athlete software, we discovered that while total muscle work is similar between the NHE and running, the NHE stretches muscles slowly under moderate force for a long duration, while high-speed running applies higher forces but briefly. This suggests NHE and high-speed running are complementary training modalities for injury prevention.

We are partnering with the Stanford football team to translate our findings into practical screening and training programs.

Train Smarter, Sprint Faster

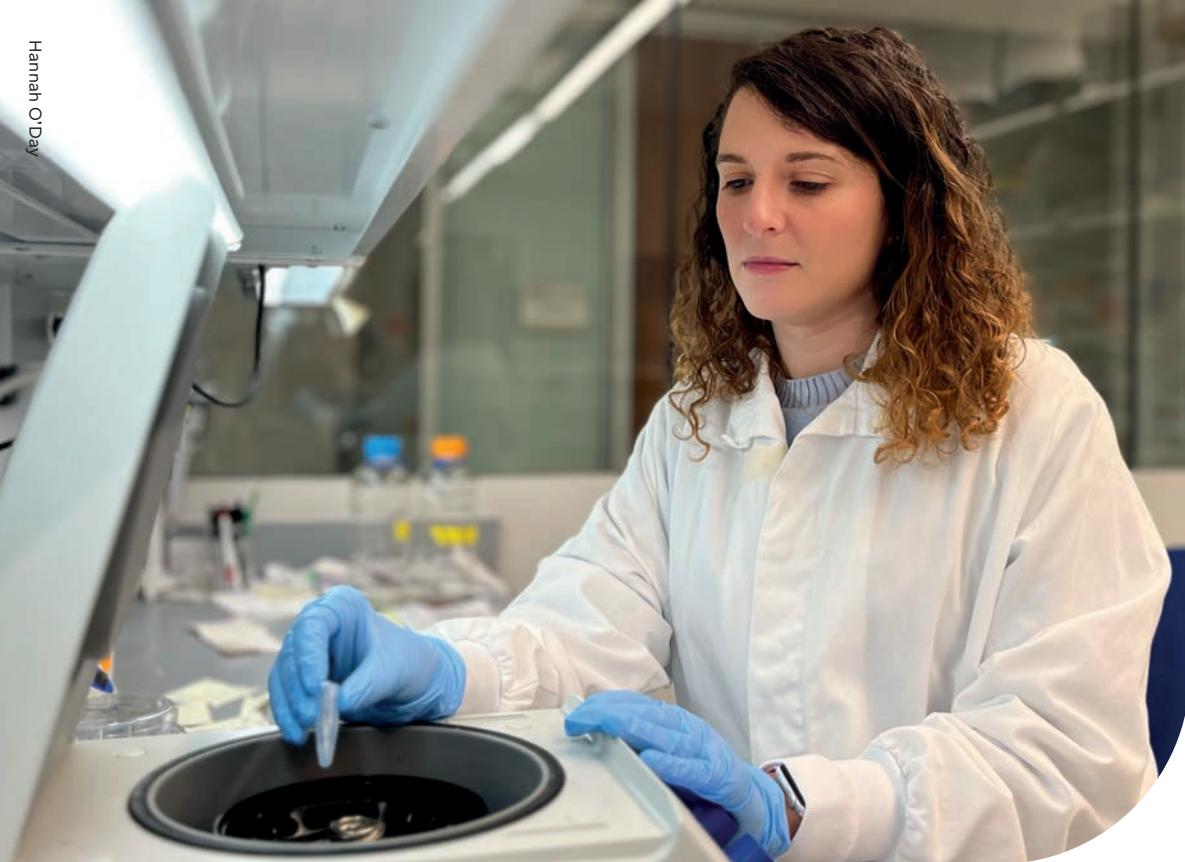
What makes a sprinter just a fraction of a second faster than the competition? Digital Athlete postdoctoral fellow Nicos Haralabidis [conducted simulations](#) that revealed how subtle changes in technique—like where the foot lands—impact sprint speed. A mere 6-centimeter shift in foot placement led to a 7% increase in speed.

A simulation framework developed by Digital Athlete postdoctoral fellow Tom Van Wouwe showed that hip muscle volume is critical for sprint speed, while longer legs improve marathon running economy.



Further Explorations

We have highlighted just a few of our technological advances and discoveries. Visit <https://humanperformance.stanford.edu/research/moonshots> for more about these and other findings, such as our *Nature* publication on using sensor data to guide policy on creating environments that increase physical activity.



Alliance postdoctoral fellow Maria Dolores Moya Garzon investigates a ketosis-related molecular pathway.

Molecular Athlete Moonshot

Creating a Dynamic, Biological Knowledge Base

Exercise and diet trigger profound changes in the body, affecting thousands of molecules in ways we're just beginning to understand. The Molecular Athlete moonshot at Stanford is mapping how genes and molecules respond to physical activity, diet, injury, and recovery, and harnessing this knowledge to improve health and performance.

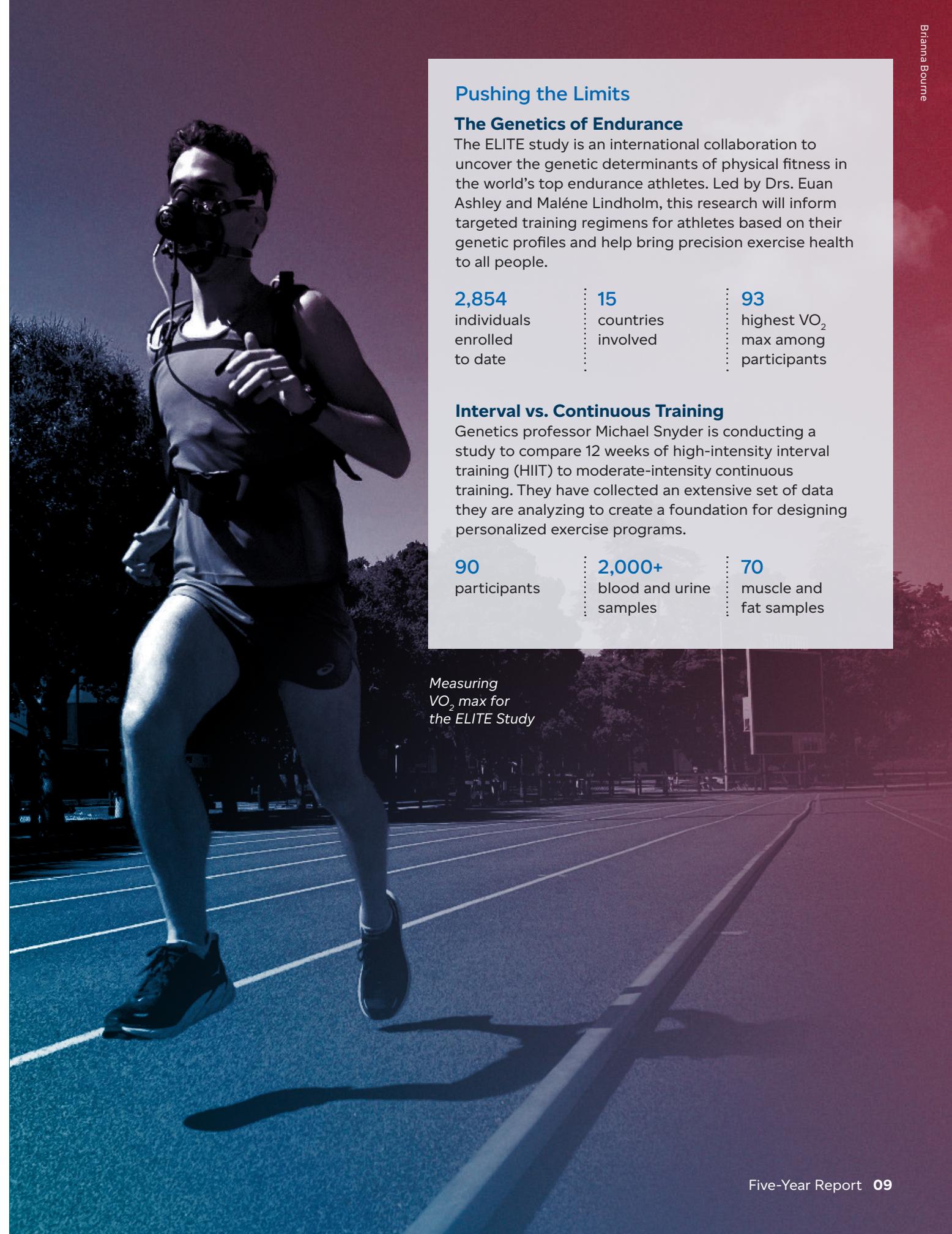
Molecules that Shape Health

What if better metabolic health begins with the same molecules that power your workout? In the last few years, Professor Jonathan Long has discovered molecules that link exercise, diet, and metabolism, including a new metabolite [Lac-Phe](#). Long and his team's experiments revealed that Lac-Phe spikes after exercise—whether endurance, sprint, or resistance training—and leads to appetite suppression and weight loss in mice.

Interestingly, many cell types secrete Lac-Phe, indicating that different cell types sense and respond to exercise. His lab also discovered the [BHB shunt pathway](#), which is linked to ketosis, and the [taurine-PTER pathway](#). These discoveries have led to a clinical trial for new therapies and several patent applications.

Molecular Changes During Physical Activity

In partnership with the U.S. National Institutes of Health's MoTrPAC program, our Molecular Athlete faculty are mapping how more than 35,000 biological molecules adapt to exercise in humans and animals. Our Alliance team discovered that male rats lose more fat than females post-exercise, but the fat that stays in females is more resistant to diabetes and other diseases. We are now studying how these molecular responses translate to human participants, which could help doctors personalize exercise recommendations for men and women. Results appeared in *Nature*, *Nature Metabolism*, *Nature Communications*, and *Physiology*.



Pushing the Limits

The Genetics of Endurance

The ELITE study is an international collaboration to uncover the genetic determinants of physical fitness in the world's top endurance athletes. Led by Drs. Euan Ashley and Maléne Lindholm, this research will inform targeted training regimens for athletes based on their genetic profiles and help bring precision exercise health to all people.

2,854

individuals enrolled to date

15

countries involved

93

highest VO₂ max among participants

Interval vs. Continuous Training

Genetics professor Michael Snyder is conducting a study to compare 12 weeks of high-intensity interval training (HIIT) to moderate-intensity continuous training. They have collected an extensive set of data they are analyzing to create a foundation for designing personalized exercise programs.

90

participants

2,000+

blood and urine samples

70

muscle and fat samples

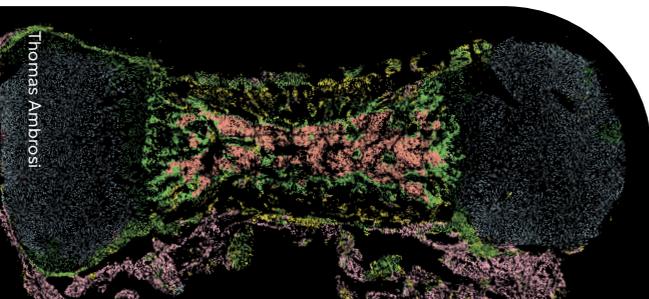
Measuring VO₂ max for the ELITE Study

Regenerative Rehabilitation Moonshot Accelerating Healing and Optimizing Recovery

The Regenerative Rehabilitation moonshot at Stanford is discovering new ways to restore the health of skeletal and muscle tissues—the framework that supports every movement we make. We're developing therapies to repair cartilage, bone, tendon, and muscle to accelerate healing and prevent injuries, work that is already improving people's health and performance.

A Drug for Scar-Free Healing

For billions of people, scars are more than skin-deep. They can limit movement, function, and daily life. Dr. Michael Longaker, a plastic surgeon, has repurposed verteporfin, an FDA-approved drug for eye disease, to transform chronic skin scars into healthy skin. Published in *Science*, this was the first-ever scar-free regeneration of adult wounds in mice. Subsequent preclinical trials have yielded similarly promising results. Longaker is currently working with the FDA to make verteporfin available for preventing scarring in children and adults.



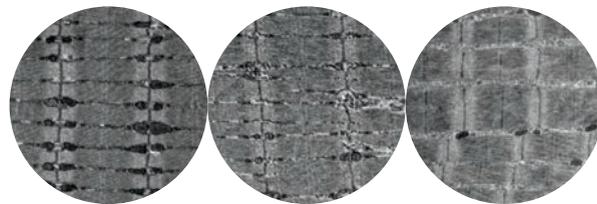
Speeding Up Bone Healing After Menopause

More than 250,000 hip fractures occur each year in adults aged 65 or older in the United States. Seventy-five percent of them are female. The late Professor Charles Chan and his colleagues discovered a reason for the sex difference: female human skeletal stem cells rely on estrogen to regenerate bone. By [delivering estrogen to fracture sites](#) in

postmenopausal female mice, they were able to restore stem cell function and speed healing while simultaneously avoiding the side effects of systemic estrogen therapy. These findings could transform care for women with fractures, osteoporosis, and other bone disorders.

Rejuvenating Muscle in Older Adults

Muscle mass and strength decline as we age. While exercise can help, older adults often struggle to rebuild muscle once it's lost, creating a pressing need for therapies that regenerate muscle. Professor Helen Blau discovered a small molecule to block the enzyme 15-PGDH, which limits stem cells' ability to repair and regenerate muscle as we age. When administered to aged mice, the small molecule increased muscle stem cell activity and improved muscle strength. Epirium Bio has used this knowledge to create a muscle-strengthening drug called MF-300, an oral compound that recently successfully completed Phase 1 clinical trials.



15-PGDH limits muscle repair. Muscles in aged mice with inhibited 15-PGDH (left) show increased numbers and improved morphology of mitochondria compared with those with typical levels of 15-PGDH (middle). The mitochondria are also more similar to those in muscles of young mice (right), suggesting enhanced muscle regeneration.

Adelaida Palla
and Science

“The Wu Tsai Human Performance Alliance has been a tremendous resource for the development of clinical therapeutics and for the initiation of highly productive collaborations across Wu Tsai partner universities.”



Michael Longaker
Deane P. and Louise Mitchell Professor
in the Stanford School of Medicine

The Human Performance Laboratory

The Human Performance Laboratory (HPL) at Stanford is an innovation hub linking athletics, medicine, engineering, and the sciences. It provides shared resources and expert support in biomechanics, musculoskeletal modeling, machine learning, and wearable technology. Over the past five years, the HPL has enabled research projects ranging from ACL injury prevention to the development of at-home measures of muscle strength.

Step by Step: Personalized Exoskeletons Help Restore Independence in Everyday Life

Assistive exoskeletons have great potential to increase mobility for those with movement impairments, whether from injury, disease, or age, and to help athletes recover from injury or enhance their training. Though exoskeleton research has shown promise in the lab, translating these devices to real-world use has remained a challenge. Mechanical engineering professor Steve Collins created the first untethered, portable [ankle exoskeleton](#) that personalizes assistance as people walk. Using an inexpensive wearable sensor system and a machine-learning model—both built and tested in the HPL—the device measures ankle motion and adjusts torque in real time, providing assistance that complements the wearer's calf muscles. Tests show that the exoskeleton enables people to walk up to 9% faster while using 17% less energy—equivalent to removing a 30-pound backpack—and the largest improvement of any exoskeleton for real-world walking to date.



Kurt Hickman

The Body Clock of Female Athlete Performance

Little research has examined how sleep, circadian rhythms, and hormonal cycles influence neuromuscular function in female athletes. Supported by the HPL, Professor Jamie Zeitzer led a study of 48 young women and found that performance metrics such as jump height varied with both time of day and menstrual cycle phase, and that balance measures also shifted with time of day, revealing windows of increased injury risk. These timing effects are especially relevant for traveling athletes, including those on college and professional sports teams. The project resulted in an NIH fellowship and valuable data for new grant proposals.



Julie Mucchi

Female Athlete Program

The Alliance's commitment to advance female athlete health and performance permeates all aspects of our work. It impacts our research, our educational fellowships, and our community-building efforts, including our inaugural Female Athlete Research Meeting. It was the impetus for our Female Athlete Science and Translational Research Program (FASTR), which provides the latest science to coaches and athletes. Read on for examples of our research and educational impact.



John Lozano/ISI Photos

The Menstrual Cycle and Performance

Despite growing interest in the menstrual cycle's influence on performance, we still don't fully understand how hormonal fluctuations influence sleep, recovery, digestion, injury risk, and endurance. We're addressing this gap by creating an unprecedented foundation of data. The Digital Athlete moonshot, in partnership with the wearables company WHOOP, is mapping relationships between menstrual phases, vital signs, and sleep across thousands of active individuals. One early finding: Sleep deprivation negatively impacts vital signs, and these effects were consistent across menstrual cycle phases, running counter to the popular concept of "cycle syncing," at least when it comes to sleep patterns.

Complementing these insights, Professors Todd Coleman and Zhenan Bao are developing wearable gut trackers that record electrical patterns of digestion to determine whether they shift with hormonal changes. They have filed a patent and established new collaborations with sleep researchers to explore the brain-gut connection.

Injury Prevention in Female Athletes

Female athletes face a higher risk of anterior cruciate ligament (ACL) tears and bone stress injuries than men, yet many prevention strategies stem from research on male athletes.

We are closing that gap. Using OpenCap, the Human Performance Lab at Stanford developed the ACL Injury Resilience Score to measure how movement patterns influence injury risk—all from a smartphone video. This rapid, real-world approach is enabling us to measure injury resilience in thousands of female athletes, from youth sports to Stanford collegiate teams.

In parallel, our FASTR team, led by Dr. Emily Kraus, is redefining how we detect and treat Relative Energy Deficiency in Sport (REDs) and bone stress injuries in female runners. Using advanced imaging, they recently identified new markers of compromised bone microarchitecture in athletes at risk for REDs. Coupled with hormonal data, these markers could enable earlier detection and treatment.

Improving Female Athlete Health and Performance Through Education

We bring the latest science directly to coaches and athletes. Our educational resources reach thousands through clinics and online platforms. We meet with girls' and women's teams to discuss critical aspects of health and performance. And through workshops at community gatherings and coaching clinics, we ensure the knowledge extends beyond athletes to the coaches and communities that support them.

Using Big Data to Protect Athletes

When Sarah Johnson joined the Wu Tsai Human Performance Alliance, she set out to answer a question that had followed her since her early days as a competitive runner: How can we train and recover in ways that protect the body?

Now a bioengineer and Alliance postdoctoral scholar, Johnson leads a project analyzing more than 240,000 Garmin-recorded activities from 210 endurance runners, most logging more than 60 kilometers a week. By pairing training data with athletes' self-reported injuries

and illnesses, she's building predictive models to identify when performance tips into overtraining or injury and investigating the connections between menstrual cycle phases and physiological and performance changes.

"If you can get training and recovery correct, then the likelihood is that you're going to keep improving your performance," says Johnson. She also emphasizes the broader impact of her work: "As there is more opportunity for women in sports, we should also make sure we have the knowledge to protect them."



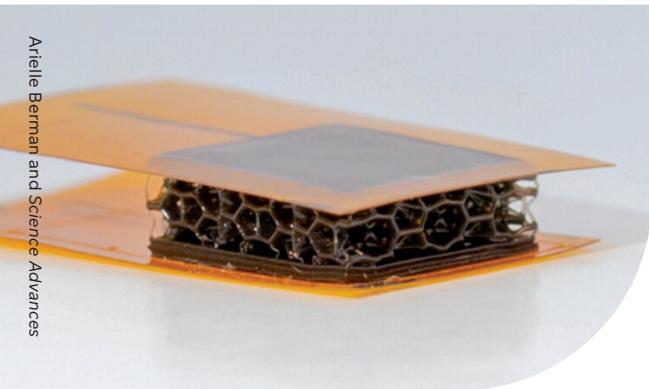
@standersonia



A research study participant performs a drop jump task on different surfaces to test the robustness of our smartphone-based ACL Injury Resilience Score.

Agility Projects: Expanding Our Knowledge and Impact

Our Agility Project programs fund early-stage, cross-disciplinary research at Stanford and other institutions to advance human performance. We have funded 29 projects at Stanford from among hundreds of applications, reflecting the program's effectiveness in stimulating new collaborations and interest in human performance across the university.



Arielle Berman and Science Advances

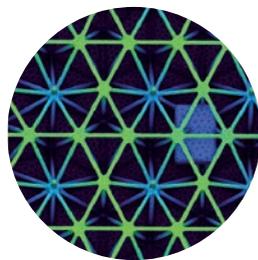
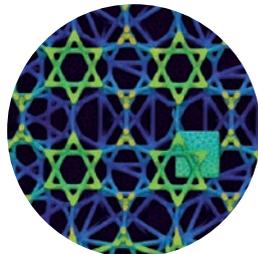
Traumatic Brain Injury: From Impact to Insights

Professor Joe DeSimone has a track record of putting state-of-the-art materials science into the hands of athletes, with his company Carbon's innovative 3D printing technology used for football helmet liners, cricket pads, and golf putter grips.

Now his team at Stanford, in collaboration with Professor Zhenan Bao, has developed 3D-printed soft sensors that detect pressure and shear forces with remarkable precision. Using continuous liquid interface production (CLIP), they can create flexible, lattice-like materials that capture real-time impact data and are readily customized for different sensitivities. The research was published in [Science Advances](#).

The group is now developing smart, sensorized equipment that delivers real-time insights into body mechanics and impact forces, opening new pathways for personalized health monitoring and performance optimization. "The Wu Tsai grant has been instrumental in advancing our work," says DeSimone. "It has supported not only scientific progress but also the development of the next generation of researchers and leaders in interdisciplinary science."

Simulations of the continuous liquid interface production (CLIP) sensor's deformation for a (top right) kagome lattice design vs. (bottom right) tetrahedral lattice design.



240

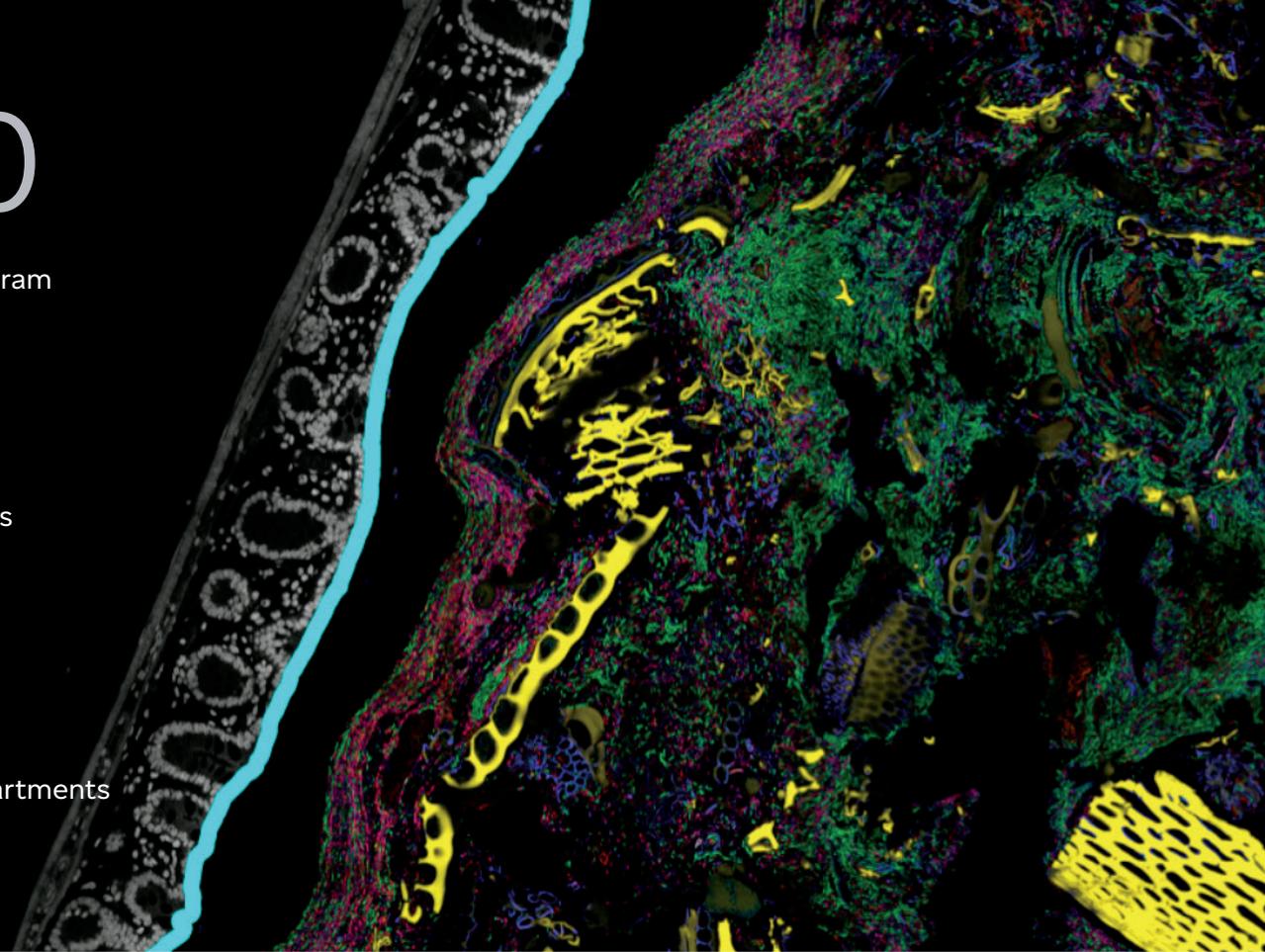
applicants to Stanford program

55

Agility Projects awarded

36

Stanford departments represented



The Gut-Performance Connection

For Professor KC Huang, the Agility Project award "has been transformative" for his research program and trainees. His team is exploring how the gut microbiome responds to endurance exercise and thermal stress. "We generated the first integrated dataset linking controlled thermal regulation, exercise physiology, and gut microbiome sampling," Huang explains.

Early findings show that controlling core temperature during strenuous activity can alter performance and lactate buildup, revealing temperature as a powerful, manipulable variable in endurance. "The funding catalyzed a truly interdisciplinary collaboration between the Huang, Sonnenburg, and Heller labs, and provided students and postdocs with a rare opportunity to bridge fundamental microbiology with human performance science."

Several trainees have since launched independent projects and careers exploring host-microbiome interactions under physical stress. "For me, the award emphasized the power of cross-disciplinary science, and it has created a solid framework for mentoring students at this exciting interface."

Above: The gut lining of a mouse colon, depicting (white) the epithelium—the tissue layer separating the interior and exterior of the body; (cyan) the epithelial boundary; (red, green, blue) different bacterial types; and (yellow) debris.

Learn More

Explore Stanford's 29 agility projects at <https://humanperformance.stanford.edu/research/agility-projects>.

Collaborations Around the World

The Wu Tsai Human Performance Alliance has cultivated a collaborative network that now spans more than 80 academic institutions, sports teams, non-profit organizations, and industry partners—all united in the mission to advance human performance science.

At the heart of the Alliance’s network are the core partnerships among the founding public and private institutions: Stanford University; the Salk Institute; the University of California, San Diego; the University of Kansas; the University of Oregon; and the Women’s Health, Sports & Performance Institute (WHSP). Centered at Stanford, the Alliance works closely with its network to identify real-world needs, uncover new possibilities for research, and accelerate the translation of scientific discoveries. Learn more about some of our collaborations below.

Cross-Alliance Bone-Stress Injury Project

A [multi-site](#) collaboration among Alliance institutions, including Stanford, WHSP, and the University of Oregon, is working to better understand how stress fractures heal in the

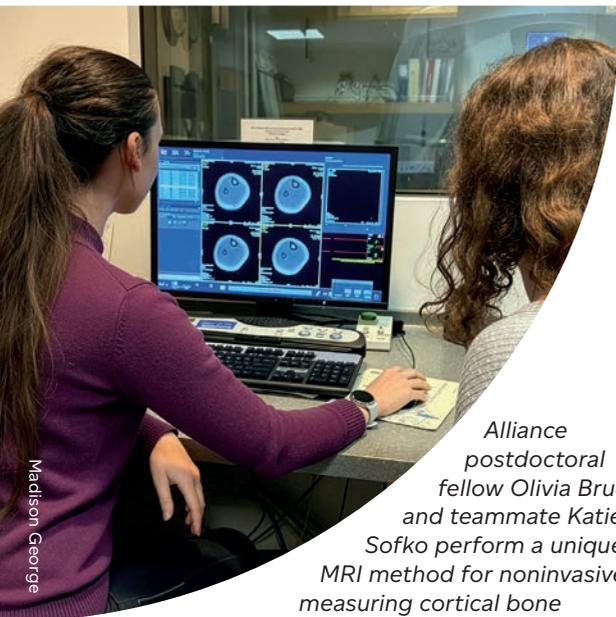
year following diagnosis. By integrating MRI scans, blood biomarkers, movement analyses, and a return-to-run protocol, we will enhance our ability to anticipate future stress fractures and create a baseline and precision outcome metrics to measure the efficacy of new drugs designed to accelerate healing.

USOPC: Co-Creating a Research Agenda with Female Athletes

In collaboration with the U.S. Olympic & Paralympic Committee (USOPC) and other Alliance institutions, Stanford researchers partnered with 40 Team USA female athletes to co-create a sports medicine and exercise science research agenda based on their lived experiences. The [first-of-its-kind study](#) established the most pressing topics affecting their health and performance, with menstrual cycle symptoms, recovery, birth control, mental health, and fueling topping the list.

UNESCO: Developing a Global Sport Policy

UNESCO’s Fit for Life initiative, with support from the Wu Tsai Human Performance Alliance, launched the first-ever Global Sport Policy Survey to capture baseline data on inclusion, equity, and safety in sport and physical education. This information, which will be shared in a public digital data dashboard, will accelerate research and enable countries to compare how their policies drive change in investment, participation, and human capital. This foundational knowledge will shape new global policy standards.



Alliance postdoctoral fellow Olivia Bruce and teammate Katie Sofko perform a unique MRI method for noninvasively measuring cortical bone porosity in the tibia.

Brianne Connizzo: Tendon Strength Over the Menstrual Cycle

An Agility Project award enabled Boston University professor Brianne Connizzo to explore an outstanding question regarding tendon injuries: Do intrinsic tissue structure or sex hormones account for the sex differences we observe in tendon injury rates and healing outcomes? Connizzo developed an *ex vivo* model capable of isolating the factors and discovered that the proteins important for tendon strength increase and decrease in sync with hormone levels, suggesting there may be optimal times during the menstrual cycle for strengthening tendons.

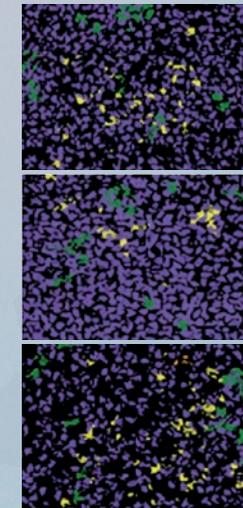
“The financial support of the Alliance has given me the freedom to deepen my research initiatives in female athletic performance and go after more innovative and high risk ideas.”



Brianne Connizzo
Assistant Professor,
Boston University
Agility Project Awardee

Silvia Blemker: How Estrogen Shapes Healing

With the support of an Alliance Agility Project grant, University of Virginia professor Silvia Blemker developed the first multiscale computational model of muscle regeneration that includes estrogen, revealing that muscle regeneration and recovery time are sensitive to estrogen levels. The agility funding led to an NIH R21 award and provides a foundation for designing hormone-aware rehabilitation strategies—particularly for postpartum athletes, individuals with Relative Energy Deficiency in Sport (REDs), or those going through menopause.



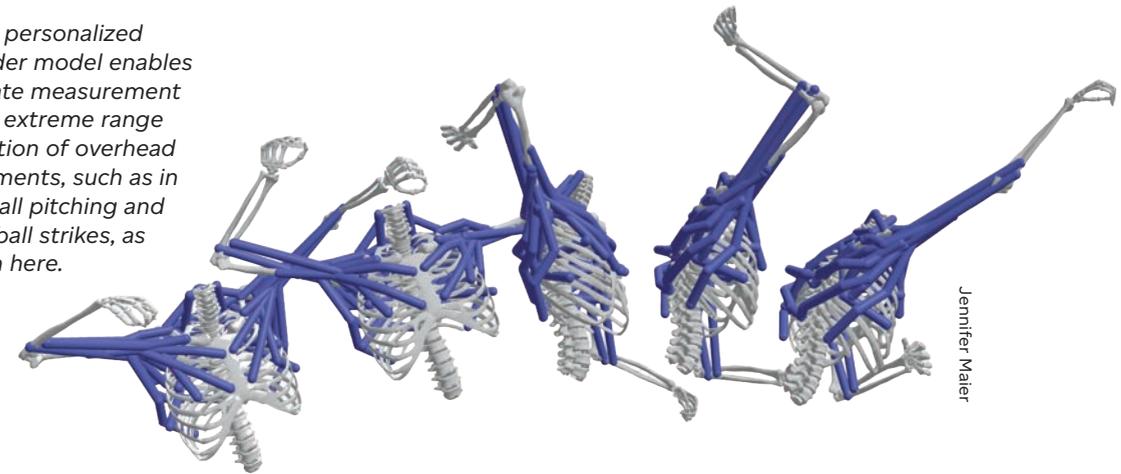
Novel multi-scale simulations of the muscle now allow us to study how estrogen levels impact satellite stem cells, shown in purple, and healing post-injury. (middle) Moderate levels of estrogen support the most effective healing, corresponding with larger numbers of stem cells, while both (top) low and (bottom) high estrogen can slow recovery.

Uniting World-Class Science and Athletics at Stanford

Stanford's world-class science and preeminent athletics each excel on their own, but new collaborations enabled by the Wu Tsai Human Performance Alliance are advancing human performance research and supporting student-athletes.



A new personalized shoulder model enables accurate measurement of the extreme range of motion of overhead movements, such as in baseball pitching and volleyball strikes, as shown here.



Stanford Athletics stands as a beacon of collegiate sports achievement. With 137 NCAA team championships—the most in the nation—Stanford has set a standard of excellence across a diverse array of sports. Stanford-affiliated athletes have also left their mark on the world stage, earning 335 Olympic medals. Academically, Stanford boasts a similar record with 20 living Nobel laureates and 44 recipients of the MacArthur “genius grant.” Working together, we are pushing the boundaries and discovering new insights in both the world of sports and science. Just a few of the 40 collaborative projects between the Alliance and Athletics are outlined below.

Modeling Shoulder Movements at the Extremes

Digital Athlete postdoctoral fellow Jennifer Maier developed a process to personalize computer models of the shoulder and accurately measure the extreme range of motion needed by elite athletes. We are using this model with Stanford's beach volleyball team, analyzing their overhead strikes to improve performance and minimize injury risk.

Researchers on the Water and on the Field

Postdoctoral fellow Morgan Smith collaborated with the women's rowing team to study recovery using biomarkers and wearables data. Graduate student Kristen Steudel is embedded with Stanford Football, learning about the team's needs and applying our tools to reduce hamstring injuries.

Learning About Performance On and Off the Field

We support student-athletes in deepening their knowledge and developing research skills to become the next generation of leaders in human performance. Jason Kaul, BA '23, a football player, and Brielle Smith, BS '23, a track and field athlete, are just two of the 40 student-athletes we have mentored. Kaul conducted research on mental resilience in collegiate athletes and is now a mental performance and leadership consultant at Premier Sport Psychology. Smith investigated the effects of aerobic exercise on memory as a Wu Tsai Human Performance Undergraduate Scholar and is now a research associate at WHOOP, leading research on wearable health devices.

“The Wu Tsai Human Performance Alliance is an extraordinary asset to Stanford Athletics. I'm eager to expand our partnership and apply cutting-edge science to help our student-athletes stay healthy and keep Stanford at the forefront of collegiate sports.”



John Donahoe
Jaquish & Kenninger Director
and Chair of Athletics
Stanford University

Training the Next Generation of Leaders

Our training programs attract Stanford's top talent, from college freshmen to experienced clinicians. We're also bringing in people from outside traditional sports science who offer fresh perspectives to the field. We've supported 160 scholars, including 40 student-athletes. Our fellows are expanding human performance research beyond Stanford with faculty positions at institutions like Harvard, Duke, and the University of Washington, and taking on leadership roles in industry and sport.

The Wu Tsai Human Performance Alliance Undergraduate Research Program trains Stanford students to conduct groundbreaking research in the field of human performance. They design and conduct research on a range of topics from biomechanics to molecular physiology with close mentorship from experienced faculty members in the Alliance. Launched in 2022, the program has become the first step for many young scholars on the path to a research career.

The Wu Tsai Human Performance Alliance Research Fellowship is an interdisciplinary program that supports doctoral students and postdoctoral fellows in becoming leaders in the field of human performance. The two-year program has attracted great interest, with application numbers increasing year after year. Our fellows represent 14 departments, from genetics to mechanical engineering, and this year we announced the first awardees of our Postdoctoral Fellowship for Female Athlete Research.



Roy Collins (left), Sydney Barta (right), Morgan Smith (top, opposite page)

Clinicians see athletes' needs firsthand and are uniquely positioned to translate the latest research into practice. Our **Clinician-Scientist Program** provides a formal training program at Stanford to support clinicians in advancing our understanding of human performance through innovative, clinically relevant research. This opportunity allows clinicians to dedicate significant time to research and has supported seven outstanding individuals to date. This year we launched a clinician-scientist fellowship focused on sports and performance psychiatry, in conjunction with Stanford's first-of-its-kind clinical fellowship in the field (see Roy Collins' story).



John Lozano/istphotos.com

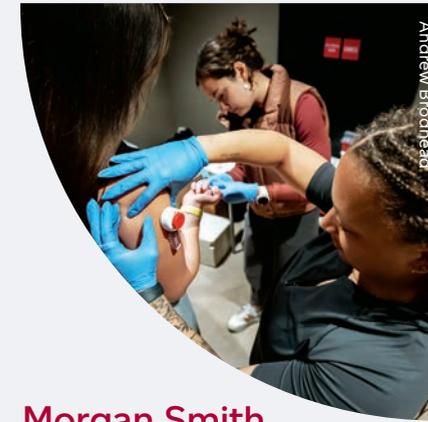
Roy Collins Shaping the Future of Athlete Mental Health

Roy Collins, a former Yale varsity football letterman, often asked himself: What separates an athlete who thrives under pressure from one who struggles? As a psychiatrist at Stanford, he focused on helping Stanford student-athletes stay resilient and perform at their best, but he quickly realized that he lacked the framework to advance the science behind performance and mental health.

That changed with the Wu Tsai Human Performance Alliance Clinician-Scientist Fellowship. "The decision to apply was one of the most positively consequential career decisions I've made," says Collins. The fellowship gave him the training, mentorship, and research support to move from a clinician to a physician-scientist shaping an emerging field.

Building on this work, Collins helped launch the first-of-its-kind [Sports and Performance Psychiatry Fellowship](#) in the U.S., offering specialized training in athlete mental health and performance-based psychiatry. As a former college athlete, he knows firsthand the challenges of balancing sports, academics, and life, giving him a unique perspective in designing a program to meet athletes' real-world needs.

"This program has caught the attention of the international athlete mental health community," he says, "and will set the standard for sports and performance psychiatry training for years to come."



Andrew Brodhead

Morgan Smith Making a Difference for Female Athletes

Morgan Smith has a clear mission: Understand what helps female athletes recover and perform at their best, and then share what she's learned with the community.

As a postdoctoral fellow with Michael Snyder at Stanford, Smith received the Wu Tsai Human Performance Alliance Research Fellowship and led several performance-related studies, including research to identify molecular biomarkers of Relative Energy Deficiency in Sport (REDs) to support early detection and prevention, and to investigate [recovery with Stanford's women's rowing team](#).

"I'm incredibly grateful to have received the fellowship," Smith says. "This work allowed me to expand my skills and collaborate with brilliant minds across campus."

Smith's work didn't stop in the lab. She promoted female athlete health and performance throughout the community, launching a workshop series on strength training basics for women and educating female athletes through the FASTR Team Talks program. Her new role as the senior performance coach for U.S. Soccer's Women's Youth National Teams will leverage her expertise in sport science and female athlete health to support players and coaches.

Sydney Barta From Paralympian to Biomechanics Scholar

Sydney Barta, a U.S. National Champion Paralympic track and field athlete, credits the Wu Tsai Human Performance Alliance with shaping her journey as a scholar and future physician. "I did the Wu Tsai Undergraduate Research Program after my freshman year, and I had no experience with formal research at all at the time," she recalls.

Now a senior bioengineering student with several years of research under her belt, Barta is working on a project with the Digital Athlete team to quantify balance across ages and abilities, in athletes and non-athletes. This will be the basis of her honors thesis.

She's headed to the University of Oxford next year as a Rhodes scholar and ultimately wants to be an orthopedic surgeon, translating her biomechanical knowledge into patient care. "Just knowing biomechanics from a qualitative point is vital as a doctor," she says. "It's super important to recognize how movement patterns influence people's musculoskeletal health."



Thien-An Truong/Ethnography

Meet all Alliance trainees at Stanford: <https://humanperformance.stanford.edu/education/alumni>

Growing the Human Performance Research Community at Stanford

Stanford offers an unparalleled environment for advancing human performance research: With 14 interdisciplinary institutes and seven schools, the campus fosters collaboration across the life sciences, medicine, engineering, physical sciences, social sciences, and the humanities. Over the past five years, the Wu Tsai Human Performance Alliance has strengthened those connections.



We have organized events that expanded awareness of our mission and encouraged new collaborations, such as our cross-disciplinary research seminar series, symposia that attracted hundreds, and an innovation expo that featured hands-on research demonstrations.

Meeting the Moment: Stanford's Inaugural Female Athlete Research Meeting

The inaugural Female Athlete Research Meeting (FARM) we held on November 5, 2025, exemplified the vibrant community we are cultivating at Stanford around human performance. The event demonstrated the tremendous demand for research focused on female athletes, bringing together more than 400 attendees for a full-day event. The five expert panels covered ACL injury prevention, menstrual cycle physiology, nutrition, molecular drivers of performance, and mental resilience.

Attendees included undergraduate students, coaches, clinicians, distinguished researchers, and athletes of all levels, including recreational,

collegiate, and professional. The same diversity was reflected in the speakers, including Tara VanDerveer, Stanford's basketball coach for 38 seasons and second all-time in NCAA wins; Carolyn Bertozzi, Stanford professor and Nobel laureate in chemistry; Mary Cain, professional middle-distance runner and Stanford medical student; and Clara Wu Tsai, Alliance founding partner.

The event made a lasting impression, as expressed by one of the attendees:

"The meeting had incredible energy, from beginning to end. I have never been in a room with such powerful female voices, and I am eager to see the change that is possible with this collection of brilliant minds, shared vision, and focus."

View FARM 2025 Recordings

Visit <https://humanperformance.stanford.edu/farm2025/highlights/>

"Working with the Alliance has opened entirely new avenues for our research. Our expertise at eWEAR-X is in biosensors and wearables, but the Alliance connects us to the questions that matter most in human performance."



Zhenan Bao
K. K. Lee Professor
of Chemical Engineering
Founder and Faculty Director, eWEAR-X
Stanford University

Fueling Human Performance via Open Science

The Wu Tsai Human Performance Alliance fosters a culture of open science, where knowledge, software, data, and resources are shared freely to amplify our impact. With thousands of users in the research and sports communities, our tools are catalyzing research and practical applications in human performance across the Alliance and beyond.

World's Largest Movement Dataset

Our [AddBiomechanics Dataset](#) is the world's largest dataset of human motion dynamics, including more than 24 million frames from 70+ hours of motion data collected from 273 participants. It is a rich, ever-growing dataset that fills the critical gap in data needed to develop AI models of human movement.

Molecular Data for Endurance Exercise

We share thousands of files of molecular-level data from 20 tissue types in rats as they adapt to endurance training as part of the NIH's [MoTrPAC](#) project. The dataset reveals millions of genomic and epigenomic changes, offering a powerful resource for future research. The MoTrPAC data hub has attracted approximately 11,000 unique visitors from 99 countries.

Knee Analysis Tools and Data

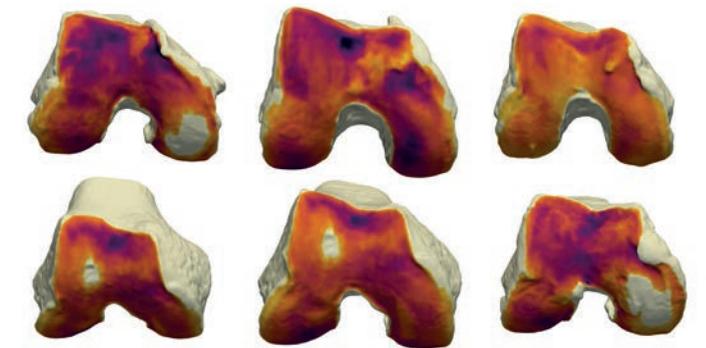
We developed a new shape modeling approach and [benchmark dataset](#) to extract 3D shapes of the femur and cartilage in the knee from medical images, providing a foundation for improved knee diagnostics and clinical decision making. Referred to as [ShapeMed-Knee](#), the 3D shapes and dataset have been downloaded more than 4,700 times since their release in May 2024.

OpenCap: Smartphone-Based Motion Capture

[OpenCap](#) is making motion capture and biomechanical analysis accessible to anyone worldwide. The smartphone-based platform has already empowered more than 5,000 individuals to collect more than 400,000 movement trials.

Explore Other Resources

Visit <https://humanperformancealliance.org/resources>



Anthony Gatti

Examples of 3D femur bone surfaces from the ShapeMed-Knee dataset. Colors show the thickness of the cartilage covering the bone, with darker colors indicating thicker cartilage.

Analyzing Movement and Injury in 170 Elite Volleyball Players

Christina Frese, a researcher at the Institute for Sport and Movement Science at the University of Stuttgart, has been using OpenCap to study knee injury in elite volleyball players, and has collected data for 170 players already.

"Her study would be practically impossible with conventional tools," says her colleague Matthew Millard. He credits OpenCap with making rigorous, large-scale motion analysis accessible to researchers, enabling real-world movement studies that were previously out of reach. "You did something really special when you put OpenCap together."

Performance for Everyone: Bridging Research and Public Awareness

When it comes to public knowledge about human performance, there are gaping holes in understanding and prevailing “wisdom” that is often divorced from the evidence. The Alliance is distilling and sharing our findings to counter this and help individuals, across all ages and abilities, optimize their physical and mental performance.

Team Talks

Our Female Athlete Science and Translational Research Program (FASTR) Team Talks have sparked informed conversations with more than 1,000 female athletes and coaches, including multiple Stanford Athletics and high school sports teams. The discussions, held in person and virtually, are increasing awareness and combating misinformation around topics like menstrual cycle and performance, sports nutrition, and energy availability.

Outreach to Policymakers

We have connected with members of the U.S. Congress and their staff and presented at the 7th International Conference of Ministers and Senior Officials Responsible for Physical Education and Sport (MINEPS VII), a

global conference to increase investment in sport, physical education, and health.



Educational Handouts

Our one-page [educational handouts](#) provide easy-to-digest information on fueling, the menstrual cycle, and other important topics for athletes to perform at their peak. They dispel common myths, such as carbohydrates being “empty calories” when in fact they are the primary energy source during activity. These handouts are frequently cited as valuable resources by coaches and athletes.

Human Performance Playbook

The [Playbook](#) is an online resource to empower individuals with evidence-based insights about human performance from world-leading scientists and athletes. Topics range from the optimal timing of caffeine for physical performance to strategies for overcoming jet lag. Featured athletes include U.S. Olympian Kate Grace; Katie Lamb, the first woman to climb V16; and Ashton Eaton, a decathlete and two-time Olympic champion.

In the Media

The Wu Tsai Human Performance Alliance and its members have received wide media coverage. Highlights include Dr. Emily Kraus speaking with [CNN](#) on ultra athletes, pregnancy, and wellness; Professor Scott Delp in [Runner's World](#) discussing efficient running mechanics; and coverage of our sleep study in [The Washington Post](#).

Looking Forward

We will continue to push advances and foundational science, and accelerate the translation of discoveries from the lab into real-world impact. At Stanford, this means partnering with student-athletes, coaches, and clinicians to integrate insights from our moonshots and innovation hub into training, recovery, and injury prevention programs. From digital twins that predict injury risk to molecular research revealing how exercise and diet shape metabolism, our work will transform how we think about human performance and thriving across the lifespan.

“Our cutting-edge digital tools are making advanced movement analysis accessible to everyone. This is just the beginning. Over the next five years, we will partner with diverse groups, from youth teams to professional sports leagues, to make our tools even more powerful and deliver insights for precision training.”



Jennifer Hicks
Executive Director, Wu Tsai Human Performance Alliance at Stanford

“The power of mindset and mental resilience is transformative for athletes and anyone seeking to reach their full potential. The Alliance’s investment into this research and related fellowships will produce the people and knowledge to boost resilience and performance on and off the field.”



Alia Crum
Associate Professor of Psychology
Stanford University

“Exercise transforms the whole body, far beyond any single organ or disease. We’re only beginning to measure its effects. Our ambitious plan to collect and analyze the genetics of 10,000 of the world’s top endurance athletes will paint a richer picture of exercise’s impact, contributing to the development of precision exercise health.”



Euan Ashley
Roger and Joelle Burnell Professor
of Genomics and Precision Health
Stanford University

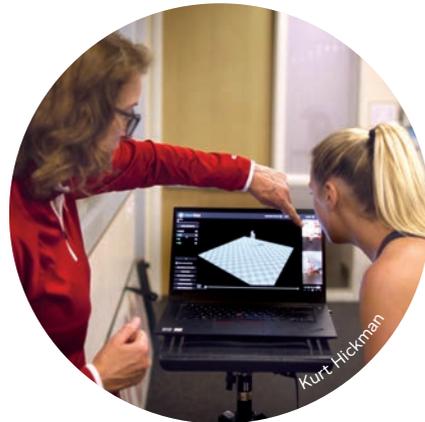
Our Team

The achievements of the Wu Tsai Human Performance Alliance at Stanford would not be possible without the dedication of our executive committee, our incredible staff, and the outstanding faculty and trainees who are constantly pushing the boundaries of human performance.

Executive Committee

Scott Delp, PhD

Director, Wu Tsai Human Performance Alliance at Stanford; James H. Clark Professor in the School of Engineering; Professor of Bioengineering, Mechanical Engineering, and Orthopaedic Surgery



Garry Gold, MD

Co-Director, Wu Tsai Human Performance Alliance at Stanford; Professor of Radiology



Euan Ashley, MD, PhD

Roger and Joelle Burnell Professor of Genomics and Precision Health; Arthur L. Bloomfield Professor and Chair, Department of Medicine; Professor of Genetics and Biomedical Data Science



Todd Coleman, PhD

Associate Professor of Bioengineering

Jennifer Hicks, PhD

Executive Director, Wu Tsai Human Performance Alliance at Stanford

Joy Ku, PhD

Senior Director, Wu Tsai Human Performance Alliance at Stanford



Ellen Kuhl, PhD

Catherine Holman Johnson Director of Stanford Bio-X; Walter B. Reinhold Professor in the School of Engineering; Professor of Mechanical Engineering



Jacquelyn Kulgevich, JD

Deputy Athletics Director

Meet all 490+ members of our team:

<https://humanperformance.stanford.edu/team>



Opposite (clockwise from top left) Julie Muccini and graduate student Kirsten Seagers review OpenCap data; Hannah O'Day and Maléne Lindholm staff a booth promoting the Alliance; Ryan Shiba checks in FARM 2025 attendees; Alex Tolas and Brianna Bourne recruit for studies at the New York City Marathon; Jacqueline Tran, along with trainees Michelle Joyce and Anoosha Pai Shirvanthe, welcome symposium attendees.

Above The Wu Tsai Human Performance Alliance at Stanford is based at the Clark Center.

