Advancing Evidence-Based Medical Research With Wearable Technology

How researchers are using new capabilities in health monitoring to elevate health and wellness

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Introduction:

A Better Way to Collect Physiological Data

In the world of medicine and evidence-based research, data is everything. But collecting this data — and ensuring it's accurate, continuous, and easy to use for study participants — presents challenges for researchers across multiple disciplines.

Among the most notable challenges are inaccuracies in self-reported data and inconvenient methodologies that require participants to stay on-site for long periods of time or make multiple visits.

Even before researchers can begin gathering data for their studies, they need a simple way of collecting participant consent and compliance. This process has often proved cumbersome and inefficient, impeding important research and the progress of medical breakthroughs.

Yet with a reliable, consistent, and streamlined approach to health monitoring and data collection, researchers gain unparalleled insights into understanding and treating diverse therapeutic areas. This method isn't aspirational either — it's already possible.

Wearables-assisted research revolutionizes data collection by taking it out of the lab and into the real world in a much more accurate way. WHOOP, a leader in wearable technology, offers 24/7 health monitoring that measures key biometric data, including sleep duration, sleep quality, heart rate, heart rate variability, skin temperature, and more. WHOOP enables researchers to collect and analyze physiological data at scale by equipping study participants with a non-invasive wearable and simplified consent process, streamlining collection for participants and researchers alike.

Groundbreaking Studies in Core Research Areas

When the world's leading research organizations are equipped with accurate data, they're able to do their jobs more efficiently and at a greater scale — advancing research across a number of critical therapeutic areas and pillars of foundational health and wellness: **Chronic Diseases, Respiratory Health, Mental Health, Women's Health, and Resilience.**

Here, we consider the importance of these research areas, and how a growing community of researchers are leveraging data from WHOOP to improve health and wellness across diverse patient populations.

Chronic Diseases

The research community has long been committed to understanding risk behaviors that lead to chronic disease and developing new opportunities for preventative care. This research is particularly relevant, considering chronic diseases like heart disease, cancer, and diabetes are the leading causes of death and disability in the United States.[1]

Specialist researchers at Penn State Health looked at developing preventative care for those at risk of heart disease. By using WHOOP to assess heart rate and respiratory rate in heart failure patients, they found that sleep monitoring can be a vital tool in early intervention and heart failure management.[2]

Another study conducted by **Penn State Health researchers investigated opportunities for preventative care for patients with inflammatory bowel disease (IBD)**. Using WHOOP data, they found that remote physiological monitoring of factors like resting heart rate, heart rate variability, and sleep could help in the detection of IBD.[3]

By leveraging data from WHOOP, this study reveals remarkable potential for early detection and preventative care. Remote physiologic monitoring with WHOOP, combined with symptom and lifestyle tracking in the IBD population, has the potential to predict individuals' disease severity and potentially lead to earlier interventions.

In the Penn State Health studies, sleep quality and duration have been important metrics in understanding the prevalence and early treatment of chronic diseases. In fact, studies show that the relationship between sleep and physical health is increasingly relevant.

In 2019, patients with a family history of Alzheimer's disease (AD) and minimal-to-no cognitive complaints were recruited from the **Alzheimer's Prevention Clinic at Weill Cornell Medicine & New York-Presbyterian**.[4] Utilizing WHOOP for data collection, researchers looked at sleep cycle, heart rate variability, and activity measures to see if physiological data could help predict an Alzheimer's diagnosis before cognitive changes appeared.

Because Alzheimer's develops over an extended period prior to cognitive symptoms, there is a window of opportunity for doctors to mitigate risk. The study found that wearable technology may be a feasible tool to assess AD-related physiological changes.

Researchers also found that 89% of participants were satisfied with WHOOP after six months, and **85% of participants wanted to continue wearing WHOOP to understand how their daily behaviors continued to impact their health**. This high level of satisfaction opens the door to more proactive conversations between patients and clinicians, as patients are given the tools to monitor their bodies' physiological responses and raise questions or concerns.

Key Takeaway:

Six in ten adults in the U.S. have a chronic disease.[5] Researchers are leveraging data from WHOOP to identify chronic disease earlier on, develop preventative care treatments, and help people understand daily behaviors that may put them at risk of chronic illness.

1 Centers for Disease Control and Prevention, "About Chronic Diseases"
2 U.S. National Library of Medicine, "Wearable Remote Monitoring of Heart Rate and Respiratory Rate for Heart Failure"
3 U.S. National Library of Medicine, "Remote Physiologic Monitoring to Detect Inflammatory Bowel Disease (IBD) Flares: A Feasibility Study"
4 Springer Link, "Feasibility of Using a Wearable Biosensor Device in Patients at Risk for Alzheimer's Disease Dementia"
5 Centers for Disease Control and Prevention, "About Chronic Diseases"

Respiratory Health

The COVID-19 pandemic put respiratory health into the spotlight, as millions of people around the world experienced shortness of breath, coughing, and other symptoms related to the respiratory system. In an urgent effort to anticipate health concerns and develop preventative measures, researchers looked for new tools.

A 2020 **study from WHOOP analyzed how changes in respiratory rate can predict the risk of COVID-19 infection.**[6] The results showed that changes in respiratory rate can in fact be an early predictor of infection.

When pro golfer Nick Watney noticed a sudden rise in his respiratory rate from his WHOOP data, but no other virus symptoms, he decided to get tested for COVID-19 anyway. He tested positive. By paying attention to his data, Nick did his part to help prevent the spread of COVID-19 to others on the PGA Tour.[7]

WHOOP has now become **the official fitness wearable of the PGA Tour** to both optimize training and identify increases in respiratory rate that could indicate infection.[8]

In the interests of supporting public health, **WHOOP also looked at how COVID-19 vaccines affect physiology in a 2022 study**. Information about how bodies respond to COVID-19 vaccines were collected via daily surveys delivered through the WHOOP mobile app to all users. The aim was to examine the effect of the COVID-19 vaccination on cardiovascular, respiratory, and sleep measures at larger scales than would typically be possible in traditional clinical settings.[9] The findings indicate that early stages of infection may be detectable, if people are more aware of changes in their respiratory rate, heart rate variability, and sleep physiology.

And with earlier awareness of physiological changes, individuals can self-isolate, seek testing, or raise concerns with their doctor faster.

Key Takeaway:

Data from WHOOP is helping researchers understand risk behaviors and develop preventative care for respiratory health conditions. This research became increasingly important with the onset of the pandemic, helping users to predict COVID-19 infection by paying attention to changes in their respiratory rate.

6 PLOS One, "Analyzing changes in respiratory rate to predict the risk of COVID-19 infection"
7 WHOOP, "Podcast No. 80: Pro Golfer Nick Watney on How WHOOP Warned Him of COVID-19"
8 WHOOP, "PGA Tour Partnership: Why WHOOP is Golf's Wearable of Choice"
9 Journal of Applied Physiology, "Biometrics from a wearable device reveal temporary effects of COVID-19 vaccines on cardiovascular, respiratory, and sleep physiology"

Mental Health

"Using WHOOP, we found people who had persistently short sleep duration or low sleep consistency had higher odds of adverse mental health symptoms."[10]

—Mark É. Czeisler from the COPE Initiative

The mind-body connection is well established within the medical community. However, progress in this area has often been blocked by the inability to gauge physiological metrics. Wearable technology is dismantling these barriers by providing a way to measure how physiological responses correlate with mental health.

The COVID Resilience Project study, done by WHOOP in collaboration with leading scientists at Harvard University, Austin Health, and Monash University, explored how the COVID-19 pandemic not only impacted American adults' physical health, but also their mental wellness.[11] The results of this report were eye-opening:

- More people are coping with mental health challenges, with American adults reporting 3 to 4 times the prevalence of anxiety and depression symptoms.
- Those who slept sufficiently before the pandemic were less likely to experience a mental health decline, even if they slept less during the pandemic.
- People who slept less than 6 hours a night had 1.8 times the odds of anxiety or depression symptoms and 1.6 times the burnout symptoms compared to those who slept more than 7 hours per night.
- Along with the amount of sleep, research found that sleep consistency (going to bed and waking up at similar times each day) was a better predictor of mental health resilience during the pandemic than sleep duration.[12]

A major takeaway was that people with persistently short sleep duration or low sleep consistency have a higher likelihood of adverse mental health symptoms. This underscores that individuals need sufficient, high-quality sleep to reach optimal mental health on a daily basis. But without the tools to monitor sleep duration or quality, people are left in the dark about their sleep patterns.

The impact of sleep is especially concerning in high-risk, high-stress sectors, such as the military. In 2021, **WHOOP partnered with the U.S. Army to understand the psycho-physiological determinants of resilience** of over 1,000 Army personnel in the Arctic.[13]

The aim was to understand how soldiers' bodies respond to high-stress environments, and the impact of this stress on their mental health and performance. The results showed that extreme temperatures, daytime darkness, and inconsistent sleep schedules take a significant toll on physical and mental wellness.

"The circadian clock is programmed to reset every 24 hours and it's guided by natural light," Kristen Holmes, Vice President of Performance Science, WHOOP Unite™, explained. "So, when you don't get this natural light or you get it at the wrong times, hormone production, mood, appetite, digestion, body temperature, and all sorts of bodily functions just work differently or are not optimized."

10 WHOOP, "Podcast 129: How Sleep Affected Mental Health During COVID-19"
11 MedrXiv, "Prior sleep-wake behavior predicts mental health resilience among adults in the United States during the COVID-19 pandemic"
12 WHOOP, "There's More to Sleep than Sleep Need: The Importance of Sleep Consistency"
13 WHOOP, "Podcast 112: Study with U.S. Army Looks at Alaska Soldiers' HRV and Resilience"

“You never really understand the toll that sleep deprivation takes on your body. This is about American soldiers and about American lives. I think WHOOP has allowed us to do something truly unique and magnificent.”

—Phil Ranck, Army Chief Warrant Officer

For Army Chief Warrant Officer Phil Ranck, this study was a wake-up call about how these extreme environmental factors, most notably insufficient sleep, affect soldiers’ psyches. “We wear sleep deprivation as a badge of honor,” Ranck said of his time in the Army.

WHOOP is empowering Army leaders to leverage personalized data about circadian rhythm, sleep, heart rate variability, and more to mitigate risks in high-stakes situations.

Tracking Mental Health with WHOOP Journal

WHOOP enables users to track their emotional and mental health by monitoring three core psychological needs:[14]

1. **Purpose**: *Do your environment, work, and relationships provide you with an outlet to live your values?*
2. **Efficacy**: *Do you believe that you have the skills and resources to produce a desired or intended result?*
3. **Control**: *Do you feel as though you have autonomy and choice over your day / schedule / life?*

Users can keep track of their emotional needs by recording how they’re feeling in the Journal. Examples include tracking:

- Gratitude
- Irritability
- Motivation
- Social Fulfillment
- Stress
- Therapy Sessions

Key Takeaway:

By understanding how physiological responses like sleep duration, consistency, and quality correlate with mental health, researchers gain key insights into how to cultivate resilience.

14 PLOS One, “Purpose, Efficacy, Control: Track Mental Health in WHOOP Journal”

Women's Health

"There's a lack of basic health education. Women have been pigeonholed into male data and male stats. No one really talks about how these hormones affect every system of our body."[15]

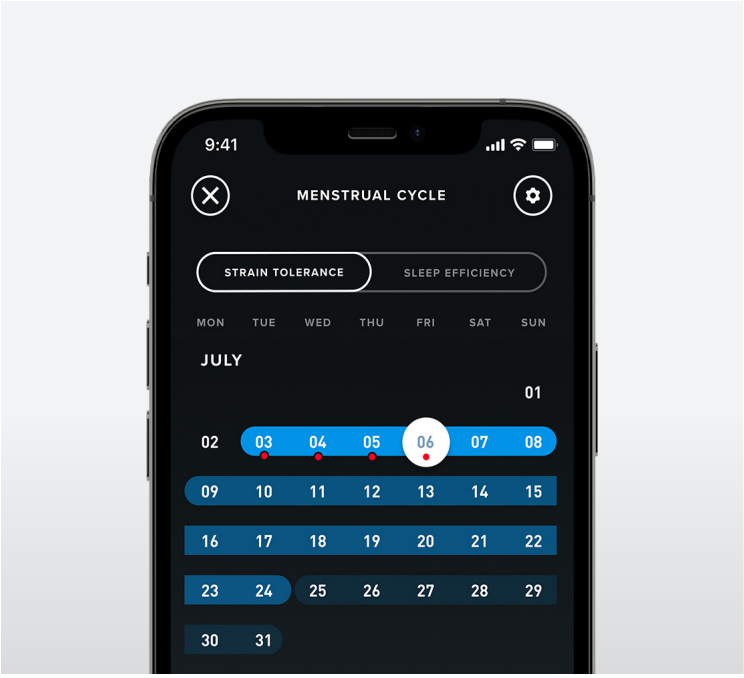
—Dr. Stacy Sims, Female Physiology Expert

A wide research and education gap exists within women's health, as only 3% of sports science research is focused exclusively on women.[16] Prior to the 1970s, women were rarely included in clinical research.

As a result, researchers are increasingly interested in how changes in health metrics affect women's performance, exercise, and lifestyle in particular. To facilitate these efforts, WHOOP recently established its inaugural Women's Performance Collective (WPC) to foster research, thought leadership, and product development initiatives that specifically benefit women.[17] Members of the WPC's founding class include U.S. Army neuroscientist Dr. Allison Brager, nutritionist and medical doctor Dr. Hazel Wallace, and female physiology expert Dr. Stacy T. Sims.

In an effort to shine a light on reproductive health, **WHOOP, in partnership with Dr. Sims, conducted research addressing the relationship between the menstrual cycle, hormonal birth control, and the impact on sleep and recovery.**[18] One of the study's biggest findings is that the ability to recover changes throughout the natural menstrual cycle differently than when hormonal birth control is used. The effect of hormonal birth control on recovery further varied depending on whether or not the birth control contains estrogen.

In response to these research findings, **WHOOP introduced the Menstrual Cycle Coaching feature to help women understand how their periods affect their bodies, from exercise levels to sleep efficiency**. Menstrual cycles cause dramatic hormonal shifts throughout the month, producing different physiological responses. During the early follicular phase (the start of menstruation), women produce more testosterone than at any other phase of the cycle, allowing them to take on more strain, build more muscle, and recover better. As bodies complete the menstruation cycle in the late luteal phase, research found that women have less capacity to take on strain, and thus should focus on active recovery and increased sleep.[19] Equipped with this information, women can better align their training and recovery schedules with their bodies' natural cycles, yielding optimal physical conditioning and improved recoveries.



15 WHOOP, "Podcast 150: Science of Training & Sleeping Based on Your Menstrual Cycle"
16 Outside, "Where Are the Women in Sports Science Research?"
17 WHOOP, "WHOOP Establishes Women's Performance Collective and Announces Partnership with VOICEINSPORT"
18 BMJ Journal, "Patterns of endogenous and exogenous ovarian hormone modulation on recovery metrics across the menstrual cycle"
19 WHOOP, "New WHOOP Feature: Menstrual Cycle Coaching"

> **"The data we are gathering can help obstetricians to encourage and guide their pregnant patients and also to provide peace of mind to female athletes who prioritize the well-being of their babies during this important stage of life."**[20]
>
> *—Jenna Wallace, WVU Pediatric Psychologist & research team member*

Additionally, the research community is partnering with WHOOP to investigate the link between physiological responses and pregnancy. While recent studies encourage women to continue exercising during pregnancy — with proper attention to risk and surveillance — there has been a historic lack of scientific research in the field. This is largely due to the fact that studying pregnant women with invasive technologies can pose risks to the woman and fetus.

A study led by West Virginia University (WVU) School of Medicine safely used WHOOP to overcome this traditional barrier to studying pregnant women's physiology. The study, led by Dr. Shon Rowan, an associate professor at WVU, and Karen Merryman, a nurse and IVF coordinator with the Department of Obstetrics and Gynecology, used WHOOP to monitor 12 pregnant patients' physiological data from conception to delivery.[20]

Barbells for Boobs is a non-profit working to improve the quality of life and overall outcomes associated with breast cancer. Launched in 2020, **the partnership between Barbells for Boobs and WHOOP explores how breast cancer impacts physiological factors** like strain, sleep, recovery, heart rate variability, resting heart rate, and more — to find interventions that can improve health.[21]

Key Takeaway:

Women's health has long been overshadowed by male-dominated research. The WHOOP research community is shifting the paradigm by exploring how women's physiological responses are affected by hormones, menstrual cycles, pregnancy, and more.

20 WHOOP, "WVU School of Medicine Study Uses WHOOP to Track Health Trends of Pregnant Women"
21 WHOOP, "Podcast 104: WHOOP Partners with Barbells for Boobs for Groundbreaking Breast Cancer Research"

Resilience

“Sleep is critical to recovery. Too many of us neglect sleep and try to perform our daily tasks after spending far less time than we should in bed the night before … WHOOP helps monitor on-the-fly adjustments to things like switching between working days and nights at the hospital, changing time zones due to travel, and other major changes in life.”

—Dr. Alexander Hajduczok, MD

Now more than ever, the research community is determined to address burnout and exhaustion by understanding what builds resilience.

A 2019 study from **Houston Methodist Orthopedic and Sports Medicine utilized WHOOP to measure the prevalence of burnout in orthopedic surgeons.**[22] The goal was to determine if there was a correlation between clinician-specific variables (like age, gender, total hours worked, average sleep) and burnout.

The study found that female clinicians experience higher rates of burnout, while the number of overnight calls put professionals of all genders at higher risk of burnout. This is due in large part to working long hours without adequate sleep. If frontline staff have the tools to take care of themselves first, however, they could show up better for their patients, resulting in more positive health outcomes.

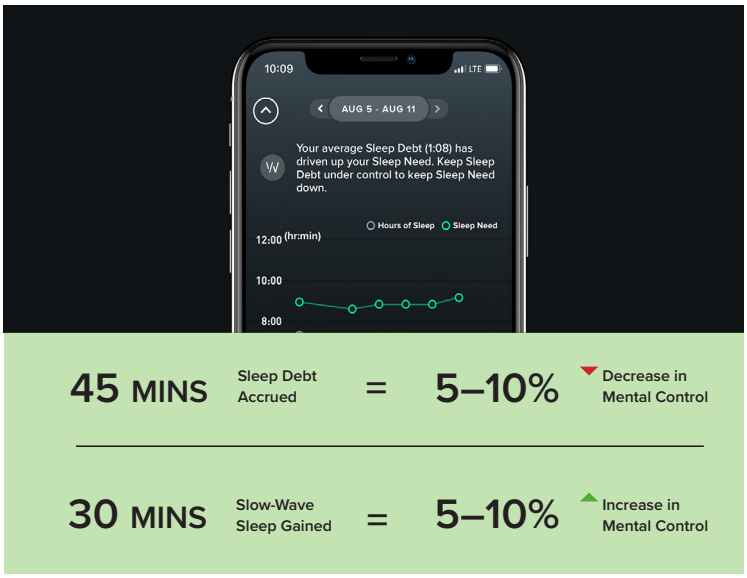
In the same vein, a 2020 study by researchers at **Penn State College of Medicine tapped WHOOP to measure wellness and predict burnout among resident physicians**. Led by Dr. Alexander Hajduczok, MD, the study was designed to increase awareness around burnout in residency, and identify the warning signs of burnout earlier on. Hajduczok explained that “Everyone across the medical education spectrum, from medical students to residents to attendings, experiences stress.”[23]

While this study is ongoing, the potential impact is tremendous. If leaders can identify the warning signs of burnout early on, they can take appropriate action to optimize resident schedules, transform policies, and promote resilient behaviors such as self-reflection and exercise.

22 WHOOP, “The Measurement of Orthopaedic Surgeon Burnout Using a Validated Wearable Device”
23 WHOOP, “Researchers Use WHOOP to Measure Resident Wellness, Prevent Burnout”

In 2021, **WHOOP and McKinsey's Executive Leadership Program in Australia partnered to investigate the relationship between sleep and executive function in the workplace.**[24] While it's no secret that humans need enough sleep to operate at their peak potential, the results from this research were particularly revealing. Data shows that cognitive function is significantly impaired when people sleep less than 7 hours per night for an extended period of time. WHOOP discovered that:

- For every 45 minutes of sleep debt accrued, people experienced a 5-10% decrease in mental control the following day.[25]
- Conversely, for every 30 minutes of slow wave sleep gained, people saw a 5-10% increase in mental control the next day.[26]



"The idea that just 45 minutes of sleep is going to have a massive influence on your ability to make decisions the next day is remarkable," notes Kristen Holmes. For leadership, this insight could translate into making positive organizational changes, like sleep incentives that actually reward teams for resting.

Additional research from **The University of Queensland Australia reveals that sleep correlates to feelings of psychological safety**, or the absence of interpersonal fear. In other words, employees feel safe to express work-related ideas and opinions. By leveraging WHOOP data, researchers found that:

- Leaders who have higher sleep debt the day they have team meetings have subordinates who report lower levels of psychological safety.
- Leaders who get more sleep the night before they have team meetings have subordinates who report higher levels of psychological safety.

Key Takeaway:

WHOOP not only helps individuals understand how work-related stressors and personal behaviors influence their risk factors and performance — at an aggregate level, it demonstrates to leadership and administrators how they can support staff that may be suffering from unmanageable work conditions. Identifying the predictors of burnout allows teams and their leaders to address these risk factors, reduce burnout, and ensure short and long-term health.

24 WHOOP, "Podcast 131: Understanding Stress and How it Affects Sleep Performance & Cognitive Functioning"
25 WHOOP, "The Optimal Sleep Playbook: Managing Sleep Debt with WHOOP"
26 WHOOP, "Understanding Sleep Cycles and the Stages of Sleep"

WHOOP Validation From the Research Community

Sound analysis and recommendations rely on sound data. As a leader in wearable technology and the source of key biometrics used for pioneering studies, WHOOP takes that responsibility seriously and has worked with accredited third parties to validate the accuracy of our analytics and algorithms.

One of the most compelling validation studies comes from researchers at **The University of Arizona**, who analyzed sleep staging data from WHOOP.[27] In this study, researchers looked at participants' sleep using both polysomnography (PSG), the gold standard of sleep tracking, and WHOOP. **The study overwhelmingly showed that the WHOOP data accuracy was on par with PSG**, demonstrating WHOOP is a highly reliable and non-invasive method for sleep tracking.

To summarize the study's key findings:[28]

- The WHOOP sleeping respiratory rate algorithm was shown to be within 1 breath per minute of gold standard truth.
- The WHOOP sleeping heart rate was shown to be within 1 beat per minute of EKG.
- Using WHOOP was shown to be associated with improvements to sleep quality.
- WHOOP sleep staging had high levels of agreement with polysomnography testing.

Another impactful study conducted on **eight NCAA Division 1 athletic teams looked at how WHOOP data offers valuable insights about athletic performance, preparedness, and health**.

The study conclusively showed that when given the tools to monitor their behaviors and patterns, the athletes were able to make immediate changes that, in as little as one month, had tangible benefits including:[29]

BETTER SLEEP

- 41 minutes more sleep per night
- 10% increase in high-quality sleep

IMPROVED PERFORMANCE

- Reduced rate of injury by 60%
- Reduced rate of self-reported illness by 53%

HEALTHIER HABITS

- 10% reduction in alcohol consumption before bed
- 3 more workouts completed every month
- 50% reduction in late night caffeine consumption

Key Takeaway:

Researchers who are leading studies across diverse therapeutic areas, patient populations, and geographies validate WHOOP as a trustworthy and reliable health monitoring platform.

27 National Institutes of Health, "Effect of wearables on sleep in healthy individuals: a randomized crossover trial and validation study"
28 WHOOP, "How Does WHOOP Measure Sleep, and How Accurate Is It?"
29 WHOOP, "The Impact of WHOOP on User Behavior"

Why WHOOP Unite is Purpose-Built for Research

Historically, data collection methods have either been cumbersome or impractical for large-scale studies. But the wearability of WHOOP, paired with the quality and granularity of the data it yields, gives researchers a precise method for advancing scientific research.

"HRV during pregnancy had been looked at a few times in other ways. It's been 24 hour Holter monitors once per trimester or just kind of random, 15 minute blocks here and there throughout the pregnancy. But we saw things that we were unable to see before because of the ability to continually monitor with WHOOP."[10]

—Dr. Shon Rowan, OBGYN & Assistant Professor at West Virginia University

Researchers note that using WHOOP Unite alleviates multiple pain points, offering:

- The ability to continuously monitor health
- Reliable and consistent access to key health metrics
- Simplified patient compliance
- The ability to capture data during field events
- The ability to scale clinical trials and research studies
- Seamless management of large groups of patients

Equipped with an unprecedented level of insight into heart rate variability, sleep stages, sleep sufficiency and consistency, and other physiological responses to environmental demands, researchers can accelerate the development of new treatments, preventative care measures, and more.

Key Takeaway:

WHOOP wearable technology enables researchers to do their job more effectively and at scale with a continuous, non-invasive, and accurate data collection method.

Conclusion

As a leader in personalized health, WHOOP is at the intersection of science, technology, and performance. Our comprehensive, continuous data collection meets rigorous standards of measurement by some of the world's top research organizations, including **Stanford School of Medicine, Cornell University, and Oregon Health & Science University**. Gaining this level of affirmation doesn't just come from our work in the WHOOP engineering labs; it is founded on partnerships with leading researchers and institutions around the globe.

At WHOOP Unite, data is in our DNA — and we're here to support researchers on the forefront of groundbreaking work. We've already seen incredible progress as researchers around the world are better equipped to elevate understanding and develop breakthrough treatments across key research areas: chronic illness, respiratory health, mental health, women's health, and resilience. And we're just getting started.

Learn more about the platform that is dedicated to understanding and elevating health and wellness. Get started with WHOOP Unite today.