NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

RESILIENCE AT THE TIP OF THE SPEAR: IDENTIFYING THE MINDFULNESS PRESCRIPTION FOR SPECIAL OPERATIONS FORCES

by

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December 2021

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REPORT DOCUMENTATION PAGE	*Form Approved OMB No. 0704-0188*

1. AGENCY USE ONLY *(Leave blank)*	**2. REPORT DATE** December 2021	**3. REPORT TYPE AND DATES COVERED** Master's thesis

4. TITLE AND SUBTITLE
RESILIENCE AT THE TIP OF THE SPEAR: IDENTIFYING THE MINDFULNESS PRESCRIPTION FOR SPECIAL OPERATIONS FORCES

5. FUNDING NUMBERS

6. AUTHOR(S) Kevin A. Butler and Frank G. Foss

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Postgraduate School
Monterey, CA 93943-5000

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
N/A

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release. Distribution is unlimited.

12b. DISTRIBUTION CODE
A

13. ABSTRACT (maximum 200 words)

After 20 years of combat, continuous deployments have left special operations forces (SOF) searching for ways to improve their holistic health. One evidence-based avenue is mindfulness meditation, shown to decrease stress and improve performance. This research examined how mindfulness techniques affect SOF's ability to downregulate stress from routine, stress-inducing duties.

Researchers conducted a randomized controlled trial to test the efficacy of informal mindfulness practice in reducing stress in SOF operators. Researchers assigned participants to 1 of 2 conditions: (a) an Oura ring-based mindfulness meditation five times a week for six weeks and (b) a no-treatment control group that also wore Oura rings but did not conduct mindfulness meditations.

At the beginning and end of the study, researchers measured stress utilizing a stress event that induced physiological and cognitive stress. Measurements of stress included blood pressure, subjective surveys, and heart rate variability. The experimental group displayed a 28-second decrease in time taken to return to baseline blood pressure levels than the control group's 15-second decrease. Additionally, subjective surveys suggested Oura rings to increase overall health. Data supports the efficacy of informal mindfulness as a practical, portable, and low-cost manner for SOF to improve holistic health across the force; however, research must continue to narrow the prescription.

14. SUBJECT TERMS special operations, resiliency, stress, mindfulness, Oura	**15. NUMBER OF PAGES** 53
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	**18. SECURITY CLASSIFICATION OF THIS PAGE**	**19. SECURITY CLASSIFICATION OF ABSTRACT**	**20. LIMITATION OF ABSTRACT**
Unclassified	Unclassified	Unclassified	UU

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

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RESILIENCE AT THE TIP OF THE SPEAR: IDENTIFYING THE MINDFULNESS PRESCRIPTION FOR SPECIAL OPERATIONS FORCES

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Submitted in partial fulfillment of the
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MASTER OF SCIENCE IN DEFENSE ANALYSIS
(IRREGULAR WARFARE)

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After 20 years of combat, continuous deployments have left special operations forces (SOF) searching for ways to improve their holistic health. One evidence-based avenue is mindfulness meditation, shown to decrease stress and improve performance. This research examined how mindfulness techniques affect SOF's ability to downregulate stress from routine, stress-inducing duties.

Researchers conducted a randomized controlled trial to test the efficacy of informal mindfulness practice in reducing stress in SOF operators. Researchers assigned participants to 1 of 2 conditions: (a) an Oura ring-based mindfulness meditation five times a week for six weeks and (b) a no-treatment control group that also wore Oura rings but did not conduct mindfulness meditations.

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LIST OF ACRONYMS AND ABBREVIATIONS

FM	field manual
GWOT	global war on terror
H2F	holistic health and fitness
HRV	heart rate variability
MBSR	mindfulness-based stress reduction
MBMFT	mindfulness-based mind fitness training
MSPE	mindful sport performance enhancement
NPS	Naval Postgraduate School
PTSD	post-traumatic stress disorder
RCT	randomized control trial
SOF	special operations forces

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ACKNOWLEDGMENTS

We would like to dedicate this thesis to all special operators who have struggled with their mental health. The special operations community is the top 1% of an even smaller subset of the American population; truly remarkable Americans who give and sacrifice so much for their country and their teammates.

Special thanks to our fantastic advisor, Dr. Shannon Houck. Without your guidance and leadership, we would have lost our way. Thanks also to our second readers. Our classmate and friend, Dr. Regan Lyon, proved invaluable in helping us navigate the intricacies of medical-related studies, and Dr. Robert Burks made sure we didn't mess up the math.

Last and most importantly, thank you to our families, especially our wives, who put up with long hours of research and supported us unconditionally.

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I. INTRODUCTION

> There are few people I know on the planet who couldn't benefit more from a greater dose of awareness.
>
> —Jon Kabat-Zinn

A. BACKGROUND

The Global War on Terror—now spanning nearly two decades—has put an untenable mental, physical, and emotional strain on Army soldiers and their families. In response, the Army is prioritizing its human capital.[1] Part of the prioritization of people includes publishing the new Army Field Manual (FM) 7-22 *Health and Holistic Fitness*. FM 7-22 offers multiple techniques to improve soldier readiness and resilience, including mindfulness exercises that help soldiers who have experienced significant stress.[2] However, the FM's mindfulness techniques are often vague or require formal training to conduct, potentially leaving soldiers unable to perform them correctly.

While the Army has prioritized people, it is currently facing difficulty manning the force; Army Special Operations are no exception.[3] Furthermore, special operations forces (SOF) personnel have borne the burden of being the main effort during the last 20-year counterterrorism fight and are being asked to do even more with the national security shift to great power competition.[4] One potential solution is apparent: create healthier, more resilient individuals that are capable of robust adaptation. With potential backfills on the

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[1] "Action Plan to Prioritize People and Teams," U.S. Army, October 13, 2020, https://www.army.mil/article/239837/action_plan_to_prioritize_people_and_teams.

[2] U.S. Army, *Field Manual 7-22 Holistic Health and Fitness* (Washington, D.C.: Department of the Army, 2020), 11–12.

[3] Thomas Spoehr and Bridget Handy, *The Looming National Security Crisis: Young Americans Unable to Serve in the Military*, Backgrounder Research Series 3282 (Washington, DC: The Heritage Foundation, 2018), https://www.heritage.org/defense/report/the-looming-national-security-crisis-young-americans-unable-serve-the-military.

[4] *Special Operations Culture and Climate: The Future of the Force*, Committee on Armed Services United States House of Representatives (2021) (statement of Mark E. Mitchell, Former Acting Assistant Secretary of Defense for Special Operations/Low-Intensity Conflict).

decline, soldiers will need to increase their ability to overcome stressors and problem sets in all spectrums of conflict and subsequently downregulate to recover the mind, body, and spirit. Increasing resilience has multiple individual and organizational level benefits. The Army may increase the longevity of their service members, improve operational effectiveness, and decrease the vast amount of money spent annually on retiree disability.

B. PURPOSE

This study examines how mindfulness meditation affects SOF operators' stress levels as measured through blood pressure, subjective surveys, and heart rate variability (HRV). Previous studies have already shown mindfulness techniques as an effective way to increase awareness and working memory.[5] The unique contribution of this study is its focus on low-cost and portable ways SOF operators can effectively downregulate stress to improve longevity, operational effectiveness, and overall quality of life. Oura rings provide users with biometric feedback and guided mindfulness meditations that do not require formal training. As such, they offer a unique and underexplored human-enhancement capability for the SOF formation at a low cost.

C. RESEARCH QUESTION

This experiment sought to answer the primary question: To what degree does informal mindfulness meditation affect SOF operators' ability to downregulate stress from routine occupational duties and specifically stressful events?

[5] Walt Piatt, "Why The Army Is Training in Mindfulness," *Mindful* (blog), November 12, 2019, https://www.mindful.org/why-the-army-is-training-in-mindfulness/.

II. LITERATURE REVIEW

A. U.S. ARMY'S HOLISTIC HEALTH AND FITNESS CONCEPT

As of 2018, the U.S. had deployed an estimated four million American service members in support of the Global War on Terror (GWOT), resulting in 970,000 veterans with a recognized disability.[6] While all military branches participated in the GWOT, the operational tempo of special operations forces left America's elite military organizations stretched thin and overused.[7] Continuous deployments contributed to a disproportionate mental burden on special operators as compared to conventional counterparts. For example, SOF experienced suicide rates of 39.3 per 100,000 from 2007 to 2015 compared to 22.9 per 100,000 from the American armed forces writ large.[8] These suicide rates drastically contrast to the overall U.S. Army suicide rates from 1946–2005, which hovered between 10 to 15 per 100,000.[9] Special Operations Command and the American military continue to fight terrorism and simultaneously look for solutions to aid service members dealing with mental health issues. However, retired Brigadier General Donald Bolduc, an Army special forces veteran, may have summed it up best by saying, "if you want to keep people at war for 18 years, you better come up with something better than we have right now."[10]

Fortunately, the military is moving in the right direction regarding service members' health. In October 2020, the U.S. Army changed its long-standing top priority from readiness to people.[11] Shortly following the shift in priorities, the Army introduced

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[6] "US Veterans & Military Families Costs of War," Watson Institute, August 2021, https://watson.brown.edu/costsofwar/costs/human/veterans

[7] Richard Sisk, "Mattis Looks to Ease Strain on Special Forces in 2018," *Militar*y, January 2, 2018, https://www.military.com/daily-news/2018/01/02/mattis-looks-ease-strain-special-forces-2018.html.

[8] Nick Turse, "U.S. Commandos at Risk for Suicide: Is the Military Doing Enough?" *New York Times*, June 30, 2020, https://www.nytimes.com/2020/06/30/magazine/special-operations-suicide-military.html.

[9] Jeffrey Allen Smith et al., "A Historical Examination of Military Records of U.S. Army Suicide, 1819 to 2017," *JAMA Network Open* 2, no. 12 (December 2019): https://doi.org/10.1001/jamanetworkopen.2019.17448.

[10] Turse, "U.S. Commandos at Risk for Suicide."

[11] U.S. Army, "Action Plan to Prioritize People and Teams."

the Holistic Health and Fitness (H2F) Operating Concept. This new framework attempts to optimize physical and non-physical readiness through the domains of mental, nutritional, spiritual, and sleep, in addition to the standard readiness component of physical fitness. While the H2F concept is a welcome change in the Army's approach to mental health, the idea offers vague means to improve Soldier resilience. H2F defines resilience as the ability to recover, learn, and grow from setbacks, a critical factor in leveraging mental skills and behaviors and optimizing long-term health.[12] While many of H2F's recommendations to improve resilience are vague, it does recommend mindfulness, defined as "a process of openly attending, with awareness, to one's present moment experience."[13] According to the H2F concept, mindfulness is essential to H2F and can increase relaxation, improve focus, and reduce stress, among other benefits.[14]

B. MINDFULNESS HISTORY

While mindfulness may be a relatively new concept for the U.S. Army, it has been widely researched and frequently utilized for its propensity to reduce stress.[15] The roots of mindfulness and meditation in Western society can be traced back to the Indus Valley in present-day Pakistan.[16] Interwoven within Eastern religions of Buddhism and Hinduism, mindfulness and other meditation practices such as yoga are now well-known in Western society. Over the last 50 years, meditation practices have grown in popularity in the United States.[17] However, within the previous few decades, interest in mindfulness interventions as a means of medical treatment has grown exponentially as scientific reports have

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[12] U.S. Army, *Holistic Health and Fitness*, Field Manual 7-22 (Washington, DC: Department of The Army, 2020), https://armypubs.army.mil/epubs/DR_pubs/DR_a/ARN30714-FM_7-22-000-WEB-1.pdf.

[13] J. David Creswell, "Mindfulness Interventions," *Annual Review of Psychology* 68, no. 1 (January 2017): 494, https://doi.org/10.1146/annurev-psych-042716-051139.

[14] U.S. Army, *Holistic Health and Fitness*, 13–3.

[15] Brian Chin et al., "Mindfulness Training Reduces Stress at Work: A Randomized Controlled Trial," *Mindfulness* 10, no. 4 (April 2019): 627–38, https://doi.org/10.1007/s12671-018-1022-0.

[16] Joaquin Selva, "History of Mindfulness: From East to West and Religion to Science," Positive Psychology, June 21, 2021, https://positivepsychology.com/history-of-mindfulness/.

[17] Stephen Batchelor, *The Awakening of the West: The Encounter of Buddhism and Western Culture* (Berkeley, CA: Parallax Press, 1994).

demonstrated its efficacy.[18] In the mid-20th century, Jon Kabat-Zinn, an American professor emeritus of medicine, was vital in adapting mindfulness as a scientifically tested stress intervention method to modern Western culture. A student of Zen Buddhism, Kabat-Zinn integrated mindfulness with Western science to create the Mindfulness-Based Stress Reduction (MBSR) program.[19]

C. EVOLUTION OF MINDFULNESS

Kabat-Zinn created MBSR to treat chronic pain,[20] but it also offered a structured program imitated for other target populations, such as treating depression, drug addiction, and diet.[21] Mindfulness interventions also evolved from Kabat-Zinn's eight-week model, with new methods ranging from well-controlled mindfulness retreats, multiple-day lab-based interventions, and now user-regulated interventions through smartphone applications and other biometric feedback devices.[22] While the target population and the design may vary between interventions, mindfulness has often been proven as an effective prescription to create healthier people. Of the targeted populations, one commonality stands out: a high amount of mindfulness interventions have target populations in high-stress jobs or situations.[23]

D. MINDFULNESS IN HIGH-STRESS PROFESSIONS

Because mindfulness research has shown a direct correlation with reducing stress, multiple studies have targeted the effects of mindfulness in high-stress occupations. One

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[18] J. David Creswell, "Mindfulness Interventions," *Annual Review of Psychology* 68, no. 1 (January 3, 2017): 492, https://doi.org/10.1146/annurev-psych-042716-051139.

[19] Selva, "History of Mindfulness."

[20] Jon Kabat-Zinn, Leslie Lipworth, and Robert Burney, "The Clinical Use of Mindfulness Meditation for the Self-Regulation of Chronic Pain," *Journal of Behavioral Medicine* 8, no. 2 (June 1985): 163–90, https://doi.org/10.1007/BF00845519.

[21] "Mindfulness Interventions," 495.

[22] Creswell, 495.

[23] "Lab Directors," Health & Human Performance Laboratory, accessed January 13, 2021, https://www.healthandhumanperformancelab.com/lab-director.

such study included over 100 elementary and middle school teachers. Not only did mindfulness improve the teachers' attention and focused memory, but it also indicated lower levels of occupational stress and burnout.[24] Mindfulness may also act as a buffer against post-traumatic stress disorder (PTSD) for individuals in high-risk and high-stress occupations. A 2011 study assessed 124 urban firefighters for the presence of PTSD symptoms, depression, substance abuse, mindfulness, resilience resources, social support, and several other related variables. The study identified a negative correlation between mindfulness and PTSD and its depressive symptoms; those firefighters with increased resilience resources and coping mechanisms were less likely to turn to substance abuse or be affected by PTSD.[25]

In addition to reducing stress in teachers and firefighters, mindfulness's positive impacts have not gone unnoticed in elite athletes' stressful and demanding world. One of the first attempts to incorporate mindfulness into sports was conducted with the U.S. Olympic rowing team in the 1980s and reported positive effects on performance.[26] In the proceeding decades, more mindfulness interventions were designed and tested on athletes, including the four-week mindfulness intervention developed in the early 2000s, mindful sport performance enhancement (MSPE). MSPE was initially introduced to archers and golfers and resulted in immediate and long-term (one year) improvements in both performance, enjoyment, and relaxation.[27] Unsurprisingly, various mindfulness

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[24] Robert W. Roeser et al., "Mindfulness Training and Reductions in Teacher Stress and Burnout: Results from Two Randomized, Waitlist-Control Field Trials," *Journal of Educational Psychology* 105, no. 3 (April 29, 2013): 787–804, https://doi.org/10.1037/a0032093.

[25] Bruce W. Smith et al., "Mindfulness Is Associated with Fewer PTSD Symptoms, Depressive Symptoms, Physical Symptoms, and Alcohol Problems in Urban Firefighters," *Journal of Consulting and Clinical Psychology* 79, no. 5 (October 2011): 613–17, http://dx.doi.org.libproxy.nps.edu/10.1037/a0025189.

[26] J. Kabat-Zinn, B. Beall, and J. Rippe, "A Systematic Mental Training Program Based on Mindfulness Meditation to Optimize Performance in Collegiate and Olympic Rowers." (Presented at the World Congress in Sport Psychology, Copenhagen, Denmark, June 1985).

[27] Rachel W. Thompson et al., "One Year Follow-Up of Mindful Sport Performance Enhancement With Archers, Golfers, and Runners," *Journal of Clinical Sport Psychology* 5, no. 2 (June 2011): 99–116, https://doi.org/10.1123/jcsp.5.2.99.

adaptations have increased in professional sports and are now commonplace in the National Football League.[28]

While many known effects of mindfulness, such as being more attentive to the moment and not dwelling on the past, appear to translate well to competitive sports, one potential pitfall is the time needed to practice mindfulness consistently. Many sports mindfulness studies resulted in inconclusive findings and noted lack of flexibility and brevity of the mindfulness interventions as critical limitations.[29] In simpler words, many athletes, especially collegiate student-athletes, did not have the time to conduct mindfulness practices in an already demanding profession. While mindfulness is not yet perfect in sports and other high-risk jobs, the effectiveness of mindfulness interventions amongst high-stress occupations signals a potential analog in an even more demanding profession: the U.S. military.

E. MINDFULNESS IN THE MILITARY

The U.S. military began testing and implementing mindfulness nearly a decade into the GWOT. One of the first people to introduce mindfulness interventions was Dr. Amishi Jha, professor and leading expert on cognitive neuroscience. Dr. Jha partnered with an Army infantry unit preparing for combat deployment and introduced mindfulness training to investigate its effects on working memory capacity.[30] A portion of the Army unit received eight weeks of mindfulness training and logged the time spent outside of class practicing mindfulness techniques. Compared to a control group that did not receive mindfulness training, soldiers demonstrated improved working memory capacity during a

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[28] Jen Christensen, "For Greatness on the Gridiron, NFL Teams Turning to Mindfulness," CNN, November 23, 2017, https://www.cnn.com/2017/11/23/health/nfl-football-mindfulness/index.html.

[29] Zelijka Vidic, Mark St. Martin, and Richard Oxhandler, "Mindfulness Meditation Intervention with Male Collegiate Soccer Players: Effect on Stress and Various Aspects of Life," *The Sport Journal,* 22 (May 2018), https://thesportjournal.org/article/mindfulness-meditation-intervention-with-male-collegiate-soccer-players-effect-on-stress-and-various-aspects-of-life/.

[30] Amishi P. Jha et al., "Examining the Protective Effects of Mindfulness Training on Working Memory Capacity and Affective Experience.," *Emotion* 10, no. 1 (2010): 54–64, https://doi.org/10.1037/a0018438.

high-stress pre-deployment training. This result suggests that mindfulness interventions may keep soldiers more alert and aware of their surroundings during high-stress events.[31]

Mindfulness continues to be used to help military members respond more appropriately to highly stressful situations. Mindfulness-Based Mind Fitness Training (MBMFT) was developed in 2014, specifically for the military, to incorporate a mindfulness practice to improve autonomic nervous system regulation.[32] The method allows service members to better prepare their autonomic nervous system for a dynamic response during stressful events. While the military has proven successful in stress inoculation to prepare service members for stressful situations, MBMFT intends to help service members avoid burnout during prolonged stress exposure. After implementation, the Marines who received the mindfulness training reported decreased perceived stress levels and demonstrated faster heart rate recovery following a stress inoculation event. This result indicates that mindfulness might provide an effective means to downregulate both physical and psychological stress among members of the military community.[33]

In addition to individual mindfulness, military organizations' collective mindfulness can play a crucial role in reliable success. In a 2017 longitudinal study on high-reliability organizations, U.S. Navy SEALs were interviewed and followed through the various rigors of SEAL training. The study found that individuals possessed a certain level of mindfulness, enabling comfort with uncertainty and chaos in addition to grit, emotional intelligence, and resilience.[34] Furthermore, the SEAL organization itself possessed a level of collective mindfulness that allowed the SEALs to perform in an environment that permitted failure for the sake of growth and development. This "mindfulness in action" synchronized mindfulness effects across the entire organization to

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[31] Jha et al.

[32] Judson Brewer, "Mindfulness in the Military," *American Journal of Psychiatry* 171, no. 8 (August 2014): 803–6, https://doi.org/10.1176/appi.ajp.2014.14040501.

[33] Brewer.

[34] Amy L. Fraher, Layla Jane Branicki, and Keith Grint, "Mindfulness in Action: Discovering How U.S. Navy Seals Build Capacity for Mindfulness in High-Reliability Organizations," *Academy of Management Discoveries* 3, no. 3 (September 2017): 256, https://doi.org/10.5465/amd.2014.0146.

enable learning without the standard preoccupation with failure.[35] While neither the SEALs nor the collective organization underwent formal training in mindfulness, the study highlights the importance of mindfulness in high-reliability organizations, particularly within special operations forces.

F. MINDFULNESS TECHNOLOGY AND APPLICATIONS

As research and practice of mindfulness have blossomed in the past twenty years, so too has technology. Wearable technology, capable of monitoring individuals' biometric and health information, increases popularity, comfort, and accuracy.[36] These devices, available at progressively low entry costs, are worn on the wrist, arm, or finger and pair seamlessly with omnipresent smartphones and applications. Such technological innovation allows everyday users to monitor the effects of life choices and stimuli on biometric markers and, in this way, make positive changes in areas such as sleep, exercise, nutrition, and even mindfulness.

Wearable technology has not gone unnoticed by the Department of Defense, testing wearables across different military branches. The U.S. Air Force recently began using the Oura ring, a wearable technology worn on your finger, to more accurately determine pilots' flight readiness based on the previous night's overall sleep score. The standard for flight readiness is determined by hours in bed rather than the quality of sleep. However, Oura rings can measure sleep quality and potentially improve sleep, making pilots fitter to fly.[37] The U.S. Navy regularly tests various wearable devices at the Naval Postgraduate School Human and Systems Integration laboratory to study and improve crew rest. The U.S. Army also tries wearables to check soldiers' ability to buttress resiliency in harsh winter

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[35] Fraher, Branicki, and Grint, 257.

[36] Alicia Phaneuf, "Latest Trends in Medical Monitoring Devices and Wearable Health Technology," Business Insider, January 11, 2021, https://www.businessinsider.com/wearable-technology-healthcare-medical-devices.

[37] Tyler McQuiston, "435th FTS Pilots Test New Wearable Technology," 12th Flying Training Wing, July 28, 2021, https://www.12ftw.af.mil/News/Article-Display/Article/2711506/435th-fts-pilots-test-new-wearable-technology/.

conditions.[38] As wearable technology continues to progress, so do the applications and opportunities to improve service members' sleep, fitness, and overall health. Specifically, wearable technology may utilize informal mindfulness techniques to target mental and emotional health as well.

Wearables, such as the Oura ring and their respective smartphone applications, can guide the user through mindfulness practices and subsequently provide feedback on the session's effects on resting heart rate, heart rate variability, and skin temperature.[39] Though relatively new, the combination of smartphones and mindfulness has seen efficacy. One recent randomized control trial (RCT), published in 2017, utilized smartphone-based cognitive training to reduce stress and categorize the significance of acceptance in successful mindfulness practice. Overall, 156 stressed adults were studied in a three-arm parallel trial, utilizing different mindfulness components across the subjects in addition to 15 smartphone-based lessons. The study demonstrated that brief smartphone-based mindfulness interventions could positively affect individuals' stress biology along with successful stress reduction.[40] While the study did not use wearable technology, such feedback may present the next evolution in delivering increasingly practical mindfulness training.

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[38] Rebecca Hoag, "Crew Endurance Team Explores Innovative Sleep Solutions Onboard USS Paul Hamilton," Naval Postgraduate School, February 3, 2020, https://nps.edu/-/crew-endurance-team-explores-innovative-sleep-solutions-onboard-uss-paul-hamilton; Rob Verger, "The Army Put Fitness Trackers on Paratroopers in Alaska to Fine-Tune Its Training," Popular Science, March 21, 2021, https://www.popsci.com/story/technology/whoop-strap-used-in-army-study/.

[39] Oura Team, "Managing Stress: The Mind Body Connection," The Pulse Blog, February 12, 2020, https://ouraring.com/blog/mind-body-managing-stress/.

[40] Emily Lindsay et al., "Acceptance Lowers Stress Reactivity: Dismantling Mindfulness Training in a Randomized Controlled Trial," *Psycho-neuro-endocrinology* 87, no. 2018 (October 15, 2017): 67–73, https://doi.org/10.17632/bx2gvkty4c.2.

III. METHODS

A. RESEARCH APPROACH

To investigate the question "to what degree do brief mindfulness techniques affect SOF operators' ability to downregulate stress from routine occupational duties and specifically stressful events?" this thesis will use a field experiment to test the effect of a brief mindfulness intervention on stress reduction, as measured by physiological responses from SOF participants. Based on a literature review, it is apparent that mindfulness interventions have efficacy in changing human behavior, including addiction, working memory capacity, and even stress reduction. However, previous studies focused on formal mindfulness training, ranging from three days to eight weeks in duration. In modern times, the ubiquity of smartphone technology and the increase in wearable devices that boast mindfulness applications necessitates research in the efficacy of short, informal mindfulness interventions provided by wearable technology.

To study the efficacy of shorter duration mindfulness training on stress reduction, this study recruited volunteer participants with backgrounds in SOF to conduct daily, ten-minute mindfulness meditations using the Oura ring for a period of six weeks. Participants completed an entry and exit stress event to determine the effects of the Oura ring's mindfulness meditations that measured physiological and perceived psychological stress levels.

B. STUDY DESIGN

This study sought to measure the effectiveness of brief mindfulness uses and differentiate it from formal resident instruction programs. To this end, this study established the following parameters: the mindfulness program must be accessible on a smartphone, the interventions must take no more than 10 minutes per day, and the instructions must not be separate from the intervention. Increased accessibility to mindfulness meditations made a clear delineation from more extended mindfulness immersion programs.

To determine the efficacy of brief mindfulness meditation on SOF, researchers used Oura rings as the means to conduct mindfulness meditations. No training was required. Researchers recruited SOF personnel to conduct an eight-week study. Researchers established an eight-week study length because more formal mindfulness training programs, such as the MBSR and Dr. Jha's mindfulness study with the Army, were both eight weeks long.[41] To measure how stress levels changed from the beginning to the end of the study, participants conducted two separate stress events that included physiological and cognitive stressors. Researchers chose a stress event with physical and mental stress to mimic best some of the complex stressors experienced by SOF. The Naval Postgraduate Institutional Review Board approved this study.

C. RECRUITMENT AND PARTICIPANTS

Participants were recruited from the Naval Postgraduate School (NPS) SOF student population, with a minimum of 40 participants. Using the ClinicCalc program, a power analysis determined this sample size (https://clincalc.com/stats/samplesize.aspx), indicating a minimum total sample of 38 people needed to detect a small effect with 80% power using a *t*-test between means with alpha at .05. To best recruit SOF participants, a flyer was designed and sent via email to all students within the Defense Analysis program and posted on the NPS campus. The flyer (posted below) recruited participants by advertising increased individual performance, improved sleep awareness using the Oura ring, and edification on mindfulness and its practice. In addition to self-improvement through mindfulness, the study's incentives included testing the famous wearable Oura ring at no cost to participants.

[41] Kabat-Zinn, Lipworth, and Burney, "The Clinical Use of Mindfulness Meditation for the Self-Regulation of Chronic Pain."

Figure 1. Recruitment Flyer

Ultimately, 33 of the 38 participants completed the study. Four voluntarily withdrew after reading the consent form and medical waiver of the five who did not complete the study. One participant withdrew after two weeks of the study due to discomfort from the Oura ring. The participants' study numbers were entered into an excel spreadsheet and randomly assigned to either experimental or control conditions. All participants in both conditions were issued an Oura ring. In the experimental condition, researchers asked participants to perform a mindfulness meditation using the Oura ring smartphone application a minimum of five times per week. The mindfulness meditations through the Oura ring smartphone application allowed participants to conduct the meditations discretely and at their convenience. The Oura ring mindfulness mediation used

by the participants was guided, 10 minutes long, and required no training. In the control condition, participants were instructed *not* to perform mindfulness meditations using the Oura rings.

D. DATA COLLECTION MEASUREMENTS

Researchers utilized multiple data points to determine the effects of brief, informal mindfulness interventions. In addition to providing the mindfulness meditations, the Oura ring collected data from users such as heart rate variability (HRV), heart rate, and skin temperature. Researchers were particularly interested in HRV, which stress impacts, and an objective assessment of psychological health and stress powerfully.[42] In addition to HRV provided by the Oura ring, researchers utilized blood pressure, which is also associated with stress, to measure stress during stress events.[43] Before each stress test, researchers measured systolic blood pressure to determine baseline levels and compare them to immediately after stress events. A commercial-off-the-shelf blood pressure cuff was utilized and tested for accuracy by a medical doctor before the stress event (Large Cuff Easy@Home Digital Upper Arm Blood Pressure Monitor). Lastly, participants were given a standard subjective stress measurement after the stress events. Similar surveys were used to measure the long-term effectiveness of mindfulness in collegiate athletes and included questions regarding participants' frequency and intensity of feelings of anxiety and stress.[44]

E. OURA RING AND MINDFULNESS TRAINING

After the initial stress event, researchers issued participants an Oura ring. During the issue, researchers measured another blood pressure measurement from the participants

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[42] Hye-Geum Kim et al., "Stress and Heart Rate Variability: A Meta-Analysis and Review of the Literature," *Psychiatry Investigation* 15, no. 3 (March 2018): 235–45, https://doi.org/10.30773/pi.2017.08.17.

[43] Talma Rosenthal and Ariela Alter, "Occupational Stress and Hypertension," *Journal of the American Society of Hypertension* 6, no. 1 (January 1, 2012): 2–22, https://doi.org/10.1016/j.jash.2011.09.002.

[44] Thompson et al., "One Year Follow-Up of Mindful Sport Performance Enhancement (MSPE) With Archers, Golfers, and Runners."

to establish a baseline further. Researchers conducted the Oura ring issue stress events at the same time of day to attempt to negate any circadian influences on the blood pressure measurement. Participants signed the Oura consent form, and researchers assigned participants a generic NPS email account (e.g., NPSMindfulnessStudy39@nps.edu) to establish an Oura account. After being sized for a ring, participants linked their ring to their smartphone using the Oura smartphone application. Researchers instructed participants not to allow sharing of any data with either Apple or Google health. Additionally, participants entered their height, weight, and birth year into the Oura application, which allows Oura to adjust each participant's amount of needed activity and sleep accordingly.

Lastly, the participants accepted a link to Oura Teams, which allowed researchers to visualize all gathered Oura data. If any participants failed to upload their Oura ring data for a period of two days, researchers emailed that participant reminding them to upload their data to remain in the study. Lastly, participants conducted a pre-study questionnaire to understand why service members are interested in using wearable devices and beliefs about mindfulness; the questionnaire also included a self-assessment of stress levels. At this time, researchers informed participants whether they were in the experimental or control condition for the duration of the study.

1. Experimental Condition

Researchers instructed participants within the experimental condition to conduct a specific mindfulness exercise offered by Oura a minimum of five times per week for the duration of the study. The mindfulness exercise specified was the "mindfulness meditation" and is ten minutes long. Using the Oura smartphone application, guided audio leads users through a meditation that focuses on their breathing during the exercise. The mindfulness meditation required no prior training by the study participants.

2. Control Condition

Participants in the control condition were instructed not to utilize the Oura ring's mindfulness meditation feature. Still, they received feedback from the Oura ring regarding their sleep patterns, activity levels, and readiness score. Some of the data provided by Oura included estimated calories burned per day, amounts and types of sleep from the previous

night, resting heart rate, body temperature, and HRV. Additionally, the Oura smartphone application offers recommendations, such as taking naps and altering bedtime, improving sleep, and readiness of its users.

F. STRESS EVENTS

In the experiment's first phase, participants completed a stress event designed to elicit physiological stress through physical exercises and psychological stress through multiple mental challenges. The stress event provided the researchers with baseline performance metrics and stress levels of the participants. The stress event was conducted with one participant and began with a blood pressure measurement to determine baseline blood pressure. Next, researchers administered a concentration grid to determine a baseline concentration level before the stress event. Sports psychologists frequently utilize concentration grids within the SOF formation to assess and train SOF operators to maintain concentration while under duress.[45] The concentration grids used (pictured below in Figure 2) included numbers from 00 to 99. Researchers gave participants one minute to identify as many numbers as possible, starting with 00 and continuing chronologically. Participants annotated a found number by drawing an X over the number. Researchers collected the concentration grid scores.

[45] Seth Haselhuhn, personal communication with 5th Special Forces Group's Mental Performance Specialist, March 2021; "Mental Skills Training Exercise," Concentration Grid, September 18, 2021, https://concentrationgrid.com/.

CONCENTRATION GRID

8	83	2	91	93	16	69	51	5	88
26	53	89	30	20	67	94	63	71	56
24	64	42	18	87	10	73	92	70	57
29	12	95	90	35	1	54	31	52	28
7	47	72	17	61	48	23	100	3	11
21	82	46	59	77	68	41	44	4	99
43	25	58	85	97	22	60	27	98	45
86	9	65	76	96	19	36	74	62	79
13	37	14	33	50	38	6	55	32	75
66	81	80	40	78	34	15	84	39	49

Figure 2. Example Concentration Grid Used during the Stress Test [46]

After the concentration grid was complete, researchers briefed participants on all subsequent activities. Researchers then led the participants through a series of warmup exercises to prepare for physical exertion and reduce the risk of injuries. Researchers administered a 30-second Stroop color-word interference test on a smartphone application to each participant to induce psychological stress before the two 300m shuttle runs. The

[46] Source: "Mental Skills Training Exercise." accessed October 21, 2021, https://concentrationgrid.com.

Stroop Test has been shown to increase heart rate levels and is a safe and efficient means to induce stress.[47]

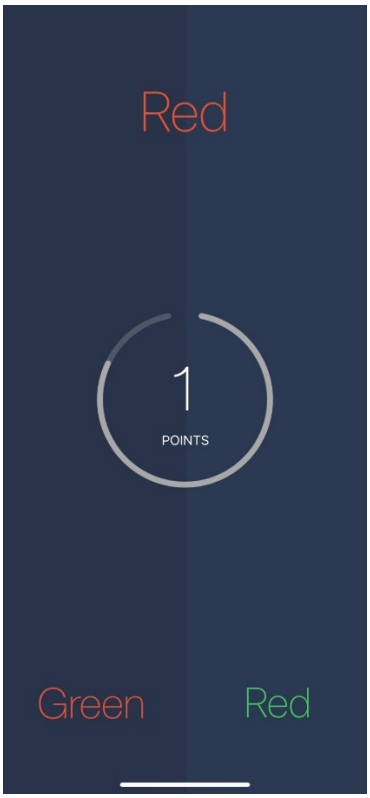

Figure 3. Image of Stroop Test [48]

After the Stroop Test, researchers gave participants a three-digit code (example 136), and the physical portion of the event began. The workout was timed and included two 300m shuttles (25m down and back, six times) with a one-minute break between 300m shuttles. Throughout the shuttle runs, researchers instructed participants four separate times to add or subtract from their respective three-digit code, e.g., researchers ask a participant

[47] Patrice Renaud and Jean-Pierre Blondin, "The Stress of Stroop Performance: Physiological and Emotional Responses to Color–Word Interference, Task Pacing, and Pacing Speed," *International Journal of Psychophysiology* 27, no. 2 (September 1, 1997): 87–97, https://doi.org/10.1016/S0167-8760(97)00049-4.

[48] Source: "Brain Test - Stroop Effect," App Store, accessed October 21, 2021, https://apps.apple.com/us/app/brain-test-stroop-effect/id791503877.

to add 1 to each digit of their code (example answer: 247). Researchers administered this number game to measure performance and working memory while under physical stress.[49] As the participants finished the second shuttle run, they reported their final three-digit code answer to researchers.

Immediately following completion of the workout, participants conducted a second concentration grid for one minute. After completion of the concentration grid, researchers instructed participants to sit and rest for 10 minutes. During this time, researchers measured participants' blood pressure levels every two minutes to determine how quickly blood pressure levels returned to baseline.

Following the 10-minute rest, researchers gave participants a survey to determine perceived stress levels. Researchers asked participants to rate the following statements on a scale of one (low) to five (high): "Overall I feel [stressed; emotionally drained; cognitively drained; physically depleted; agitated]." Additionally, the survey asked participants to circle words that described their current stress levels. These words included: relaxed, calm, stressed, buried, anxious, and anxious. The surveys completed the initial stress event. The second stress event conducted at the end of the eight weeks was identical to the first with one exception. During the 10-minute rest period at the end of the test, participants from the experimental group conducted a mindfulness meditation using the Oura ring smartphone application while there was no change to the control group.

[49] Haselhuhn, Personal communication with 5th Special Forces Group's Mental Performance Specialist.

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IV. FINDINGS AND RESULTS

A. RESULTS FROM STRESS TEST DATA

During the stress event, researchers collected data on participant concentration grid scores, Stroop test scores, 300m shuttle times, number memory game scores, baseline blood pressure, and post-event blood pressure trends. In blood pressure trends, the experimental population displayed an average of 4.58 minutes to return to baseline systolic blood pressure (+/- 5 mmHg) in the initial stress event and an average of 4.11 minutes in the second stress event. The control population displayed an average of 3.87 minutes to return to baseline blood pressure (+/- 5 mmHg) in the initial and 3.62 minutes in the second. Therefore, the experimental group showed an approximate 0.47 minute or 28-second decrease in the average time taken to return to baseline systolic blood pressure (+/- 5 mmHg). In comparison, the control population showed an approximate 0.25 minute or 15-second decrease in the same measurement. These results indicate the potential efficacy of mindfulness interventions in reducing stress, particularly immediately following a stressful event. Researchers utilized a t-test using two samples, assuming unequal variance with the additional metrics collected to determine statistically significant differences between initial and secondary stress event data and between the experimental and control group data. After comparing initial and secondary stress event data, using a 95% certainty level, the critical two-tail t value did not fall within the rejection. (see Table 1. Stress Test Results) Therefore, there was no other statistically significant difference measured in stress event data in the control or experimental population.

Table 1. Stress Test Results

Measurement	Population	Mean score from initial stress test	Mean score from final stress test	*p*
Pre-Stress Test Concentration Grid				
	Experimental	11.23	13.82	.067
	Control	9.75	12.44	.13
Stress Test Concentration Grid				
	Experimental	10.29	11.18	.51
	Control	9.81	13	.08
Numbers Game				
	Experimental	2.41	1.94	.34
	Control	1.5	1.75	.25

B. RESULTS FROM SUBJECTIVE STRESS SURVEY

Following each stress test, researchers gave participants a written survey to determine their subjective stress levels. Researchers asked participants to rate the following statements on a scale of one to five, one being strongly disagree and five being strongly agree: overall I feel stressed, I feel emotionally drained, I feel cognitively drained, I feel physically depleted, and I feel agitated. Researchers conducted a t-test using two samples assuming unequal variances to determine the differences between the experimental and control group responses. The corresponding P values for each test were statistically insignificant at a 95% certainty level, prohibiting rejecting the null hypothesis. (See Table 2. Subjective Stress Survey Results) Therefore, this study did not demonstrate significant differences between the experimental and control populations subjectively rated personal stress levels.

However, this study did demonstrate that the stress test did not significantly, or perhaps sufficiently, stress the participants. For the questions listed above, the highest average response was a 2.44 to the statement "Overall, I feel stressed," indicating participant responses averaged between strongly disagree and neutral. Because the rest of the questions averaged an even lower response score, researchers assumed that the stress test did not induce enough stress for the participants to feel subjectively stressed.

Table 2. Subjective Stress Survey Results

Question / Statement	**Population**	**Mean Initial stress test**	**Mean Final stress test**	***p***
"Overall, I feel stressed."				
	Experimental	2.06	2.12	.84
	Control	2.44	2.19	.42
"I feel emotionally drained."				
	Experimental	1.53	1.59	.8
	Control	1.38	1.56	.3
"I feel cognitively drained."				
	Experimental	1.94	1.76	.52
	Control	1.5	1.75	.25
"I feel physically depleted."				
	Experimental	2.06	1.88	.58
	Control	2	2.19	.53
"I feel agitated."				
	Experimental	1.65	1.47	.52
	Control	1.69	1.63	.82

C. RESULTS FROM THE OURA RING DATA

The data collected by the Oura ring on each participant was analyzed using Oura Teams. HRV, resting heart rate, and sleep score were utilized to study participants' health in the experimental and control groups for this study.

When analyzed for the duration of the study from 27 September 2021 through 10 November 2021, both the experimental group and the control group showed slight decreases in average HRV, slight increases in resting heart rate, and almost no change in sleep score. As a powerful indicator of stress, a slight reduction in HRV indicates that neither the use of an Oura ring nor mindfulness meditation decreased either group's stress.

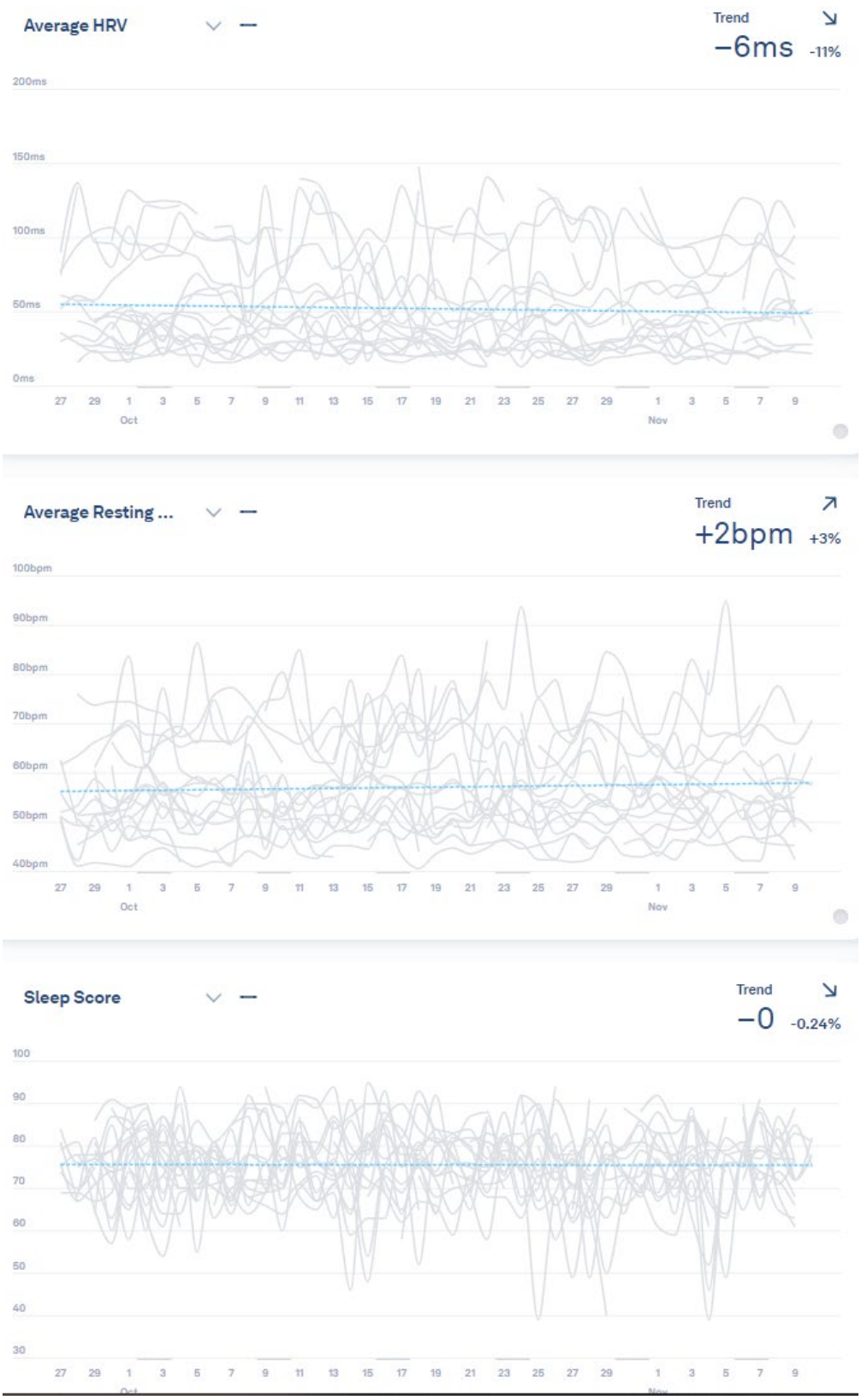

Figure 4. Experimental Group Oura Data 27 SEP–10 NOV

Figure 5. Control Group Oura Data 27 SEP–10 NOV

D. RESULTS FROM THE POST-STUDY SURVEY

After the study, researchers asked participants to take a survey to determine the effectiveness of the Oura ring and mindfulness meditations. Overall, participant responses indicated that the use of the Oura ring was effective in improving health and lowering stress. Additionally, most of the participants from the experimental group indicated that mindfulness meditations helped reduce stress. (See Table 3.)

Table 3. End of Study Survey Results

Question / Statement				
"How accurate do you believe the Oura ring was in assessing your stress levels."	Slightly accurate	Moderately accurate	Very Accurate	Extremely Accurate
	5.88%	44.12%	41.18%	8.82%
How much do you think the Oura ring helped you improve your health and lower stress?	It was detrimental to my health	It did not improve my health	It slightly improved my health	It strongly improved my health
	0%	8.82%	73.53%	17.65%
Do you trust wearable devices to measure your stress more or less?	Much less or somewhat less	About the same	Somewhat more	Much more
	0%	14.71%	67.65%	17.65%
Do you trust your intuition to accurately assess your stress more or less?	Somewhat less	About the same	Somewhat more	Much more
	20.59%	41.18%	29.41%	8.82%
How much would the continued use of a wearable improve your ability to assess your personal stress?	Not at all	Slightly	Significantly	
	0%	52.94%	47.06%	

Question / Statement				
How effective do you believe the mindfulness meditations were in decreasing your stress?	Increased my stress	Did not affect my stress	Decreased my stress	
	11.76%	11.76%	76.47%	

V. CONCLUSION AND RECOMMENDATIONS

A. CONCLUSION

This study aimed to identify a mindfulness prescription for SOF. The tested prescription was a guided mindfulness meditation using the Oura ring, without any formal training, five times a week over eight weeks. Due to time constraints, the study only lasted 45 days, and the goal sample size of 40 participants fell short.

Despite these constraints, this mindfulness prescription demonstrated that mindfulness meditation might provide an effective way for SOF to downregulate stress. Not only did systolic blood pressure return to baseline levels at a faster rate for the experimental group, but most participants indicated that the Oura ring was beneficial to their overall health and stress. Moreover, the experimental population stated that they believed mindfulness meditations decreased their stress. This reduction in perceived stress is essential to lowering physiological stress, as discussed in the literature review. Even if the perceived stress reduction results from a placebo effect, continuous mindfulness intervention may reduce psychological and physiological stress.

Additionally, none of the participants who completed the study indicated any issues with either wearing the ring, conducting mindfulness meditation, or allowing researchers to evaluate their objective and subjective stress levels. While participation was voluntary, the buy-in and use of the Oura ring, a device aimed at increasing physical and mental health, may signal a pathway through the stigma often associated with seeking help with such issues from professionals.

As discussed in the literature review, mindfulness and meditation continue to be highly beneficial to holistic health. SOF, and the U.S. military, writ large, have a need and are searching for different ways to improve holistic health. While sample size and duration limited this experiment, mindfulness meditation and wearables may still be cost-effective to enhance holistic health, increase readiness, and enhance lethality.

B. RECOMMENDATIONS FOR FUTURE RESEARCH

Research on Oura rings and their guided mindfulness applications should continue. However, the mindfulness prescription tested during this study may be too informal. Future research should include more training or orientation on mindfulness, even if that training is brief. Future research should incorporate more frequent meditations (for example, two times every day, seven days a week), a variety of meditation lengths, more consistency in the conduct of the intervention concerning the time of day, and a more comprehensive study (minimum eight weeks recommended). A study population larger than 40 participants would also allow better statistical analysis. Moreover, additional stress indicators, specifically cortisol level trends, should be corroborated with HRV and blood pressure trends. Finally, a more potent stress-inducing event, such as military airborne operations, should be explored to determine mindfulness's efficacy in downregulation of stress following significantly stressful events experienced by SOF personnel in training and combat.

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