Can wearable devices reduce burnout by making people aware of stress?

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CAN WEARABLE DEVICES REDUCE BURNOUT BY MAKING PEOPLE AWARE OF STRESS?

by

Rohit Mundayaliyath Mundayadan

A Thesis
Submitted to the Faculty of Purdue University
In Partial Fulfillment of the Requirements for the degree of

Master of Science

Department of Computer and Information Technology
West Lafayette, Indiana
December 2016
THE PURDUE UNIVERSITY GRADUATE SCHOOL
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I dedicate this thesis work to my family. I have a special feeling of gratitude to my loving parents, Damodaran and Girija, whose words of encouragement and love has helped me through a few testing times. My elder brother Rahul, who has been the inspiration for me to pursue a master's degree, supported me from the beginning until the end and ensured that I would have no worries about things that I otherwise would.

I would also like to dedicate this thesis to a few of my friends: Paul, Siddharth, Sushant and Sahithya. Thanks for bearing with me when I grumbled about my thesis for a few semesters. These little talks with you helped me reach a plausible research question.
It has been a long journey working on this thesis. A lot of people have helped me along the way in executing this abstract idea in my mind.

Firstly, I would like to thank my chair, Prof. Harriger, for letting me choose a topic that is of my personal interest. Her constant push and guidance on the technology side have helped me stay on track whenever I hit a dead end with the experiment design.

Also, I have got the most supportive committee members. Prof. Brewer, who had given me critical feedbacks at the right time, ensured a timely completion of this thesis. I will never forget his act of kindness in helping me get the funds for running my experiments.

If it were not for Prof. Dittman, I would not have gotten as many subjects as I did. He had also provided information on a weakness in my literature review with regards to the variables I chose in my study. His feedback helped me in creating a stronger case for the variables I selected for the experiment.

Prof. Bentley let me choose a research topic that went along with my thesis in his class. This helped me greatly during a challenging semester. A lot of the content from that paper helped in assessing the various limitations of this study.

Dr. Mohler had the patience to go through my ever-changing literature review as well as correct my broken grammar every time. Your patience and support as an instructor and also your act of kindness as the Dean will always be remembered.
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LIST OF ABBREVIATIONS

APA – American Psychological Association
HRV – Heart Rate Variability
HR – Heart Rate
MBI - Maslach Burnout Inventory
MBI-SS – Maslach Burnout Inventory – Student Survey
PSS – Perceived Stress Scale
GLOSSARY

Burnout - “Coined by psychologist Herbert Freudenberger in the 1970s, ‘burnout’ is more serious than feeling a bit moody or sad for a few days. It’s a state of chronic stress, resulting in the sufferer feeling powerless to cope with everyday tasks, such as getting out of bed or choosing what clothes to wear” (Koch, 2016, para. 8).

Business Strategy – “It is a document that results from goals established to support the stated mission of the business” (“What is a Business Strategy?”, n.d.).

Role Ambiguity – A lack of clarity about expected behavior from a job or position.

Role Conflict – Lack of compatibility between different expectations from a job or position.

Sleep Apnea - Sleep apnea is a common sleep disorder characterized by brief interruptions of breathing during sleep.

Stressors - The situations and pressures that cause anxiety and strain are known as stressors.

Technostress - According to Tarafdar (2007), “Technostress is the effects of stress created by information and computer technology (ICT).”

Wearable Technology – Beal (n.d.) states that “Wearable technology (also called wearable gadgets or wearable device) is a category of technology devices that can be worn by a consumer and often include tracking information related to health and fitness. Other wearable tech gadgets include devices that have small motion sensors to take photos and sync with your mobile devices.”
Workplace Wellness – The article *Wellness Program* (n.d.) states that “An employer approach to improving employees' health. Wellness programs include activities such as company-sponsored exercise, weight-loss competitions, educational seminars, tobacco-cessation programs and health screenings that are designed to help employees eat better, lose weight and improve their overall physical health. Wellness programs often involve financial incentives for employees, such as lower health-insurance premiums or gift cards” (para. 1).

Work-related stress - Lin, Huang, Shiu & Yeh (2015) explains work related stress as “The long-lasting and negative experiences of workers perceived as uncomfortable. The measurable dimensions include the characteristic of work, interpersonal relationships, career development, organizational structure, and the role of the worker” (p.237).
ABSTRACT

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Degree Received: December 2016
Title: Can Wearable Devices Reduce Burnout by Making People Aware of Stress?
Major Professor: Alka Harriger.

Wearable fitness technology is advancing in its capabilities. Every new sensor collects new health data, and it becomes important to study how effectively this data can be utilized to help people lead healthier lives. The American Psychological Association found that Americans live with stress levels higher than what is considered healthy. Poorly managed stress can lead to burnout, which leads to unproductive workers. Burnout is known to cost businesses considerable money. The goal of this research study was to determine if burnout could be reduced through the use of a consumer wearable device along with smartphone apps that alerted wearers of their stress levels. Thirteen undergraduate students served as research subjects. They each used a wearable fitness band in conjunction with two Android mobile applications that enabled continuous stress monitoring. The data collected from the students was analyzed using a mixed methodology. The results suggested that the experiment was effective in making students more aware of their stress levels. Larger studies are recommended to determine if similar results would be realized.
CHAPTER 1. INTRODUCTION

This chapter provides a simple outline of this research. It provides the scope of the study, the significance, assumptions, limitations and delimitations of the research.

1.1 Research Question
Can Wearable Devices Reduce Burnout by Making People Aware of Stress?

1.2 Background and Significance
The 2014 Work and Well-Being Survey (APA, 2014) found that 31% of employed adults in the United States stated that they felt stressed out during the workday. Another survey, by Higginbottom (2014) in the Forbes magazine, reports the following:
The Global Benefits Attitudes survey found that levels of workplace disengagement significantly increase when employees experience high levels of stress. The study of 22,347 employees across 12 countries including the UK and US, revealed that over half of those employees claiming to be experiencing high-stress levels reported they were disengaged. By contrast, only one in ten employees claiming low-stress levels reported they were disengaged, and half of this group claimed to be highly engaged. The proportion of employees claiming high levels of workplace stress was 30% in the US, slightly lower than the 34% in the UK (para. 2).

Smith (2012) states that “66 percent of employees report that they have difficulty focusing on tasks at work because of stress. Stress has been called the health epidemic of the 21st century by the World Health Organization and is estimated to cost American businesses up to $300 billion a year” (para. 1). Smith (2012) further explains that the employees have difficulties such as focusing on tasks at work, errors and missed deadlines, trouble getting along with co-workers/superiors and missed days.

A recent report, IT Salary Survey 2016: Highlights (2016, March) in the Computerworld magazine, provides info from a survey of 3,301 IT professionals which shows that 45% of the participants felt high-stress levels.
“Students become burned out in their learning process because of academic pressure, homework overload, or other individual psychological factors such as emotional exhaustion, negative attitudes, and the phenomenon of low personal accomplishment” (Lin & Huang, 2012, p. 232).

Lewin (2011) states, “The economy has only added to the stress, not just because of financial pressures on their parents but also because the students are worried about their own college debt and job prospects when they graduate” (para. 5).

This research leveraged the features of wearable fitness and smartphone technology to measure stress and see if this data would motivate people to take better steps to reduce stress, which could reduce burnout.

1.3 Scope

This study primarily focused on helping people assess their stress levels continuously by making use of wearable and smartphone technology available in the consumer market. As part of the literature review, areas relevant to this research such as effects of stress, wearable devices, and ways to measure stress were covered which guided the final experiment design. Undergraduate students at one university were used as the subjects of this experiment.

1.4 Assumptions

The study was conducted assuming the following:

- The subjects have answered the questionnaires honestly.
- The wearable device did not malfunction during the experiment. (No malfunctions were reported by any of the subjects.)
- The pre-questionnaire helped in measuring stress and burnout effectively for initial screening of subjects.
1.5 Limitations

The limitations of this research are as follows:

- Factors that induce stress in students, such as course load on subjects, financial stressors, and any personal/family issues the subjects face, cannot be controlled.
- The subjects were not random samples.
- The subjects had to tweak the experiment parameter (average high heart rate notification) according to their personal health accurately.
- The findings may not be generalizable to the entire population.

1.6 Delimitations

The delimitations of the research are as follows:

- The subjects were active full-time undergraduate students.
- The variables considered for alerting individuals for stress were hours of sleep, average high heart rate (at an interval of three minutes) and heart rate variability.

1.7 Chapter Summary

This chapter presented the scope of the research question for this thesis. The research questions significance was discussed. Moreover, the definitions, assumptions, limitations, and delimitations necessary to understand this study and its scope were covered. In the next chapter, existing literature relevant to this research will be covered.
CHAPTER 2. REVIEW OF LITERATURE

This chapter presents information on various topics related to this research. Firstly, literature on stress and burnout are explored, then effects of mental stress are covered. A review of existing wearable devices related to health tracking and their capabilities are explained. Finally, the state of corporate wellness programs is discussed.

2.1 Burnout and Stress in People

Scott (n.d.) states that:
Burnout is a reaction to prolonged or chronic job stress, and is characterized by three main dimensions: exhaustion, cynicism (less identification with the job), and feelings of reduced professional ability. More simply put, if you feel exhausted, start to hate your job and begin to feel less capable at work, you are showing signs of burnout (para. 2).

Lewis (2011) states, “Modern life is full of hassles, deadlines, frustrations, and demands. For many people, stress is so usual that it has become a way of life. For others, they don’t know whether they are stressed or not. Perhaps they’re just in denial” (para. 2).

Pal (2016) says that:
Our stress response system evolved to protect us from danger. However, it cannot distinguish between a saber-toothed tiger in the wild and a harsh email. Each time one of our three primal survival needs are not met – for safety (e.g. a company downsizing), reward (e.g. poor performance feedback) and connection (e.g. working on a team with a cut-throat “each to his own” philosophy), the “fight or flight” stress team of biochemical reactions in the body kicks into gear (para. 5).

A population-based, cross-sectional study at the Research Centre for Prevention and Health, Denmark, conducted by Ebstrup, Eplov, Pisinger, & Jørgensen (2011), aimed to investigate possible associations between perceived stress and the personality trait of a person. While studying a large general population, they found that personality traits are associated with perceived stress, but the degree of association is not equal for all personality traits.
Tarafdar, Tu, and Ragu-Nathan (2010) provides information on stress related with usage of technology (technostress). The study states that various technology changes cause stress in IS personnel, Information Technology (IT) departments in American organizations. They are not as productive as their foreign counterparts because of constant deployment of new technologies. The constant coping and learning required of IS professionals lead to loss of productivity and stress.

Fairbrother and Warn (2003) performed a study to identify workplace associations of stress. They summarized aspects of stress at a workplace by going through six different studies published in 1988 through 2000. They are as follows:

- Parts of the work itself can be stressful, namely, work overload.
- Role-based factors such as lack of power, role ambiguity, and role conflict.
- Quality of the social environment in the office is connected with stress.
- Threats to career development and achievement, feeling undervalued, and uncertain promotion prospects are stressful.
- Physical conditions like high noise levels, overcrowding in the workplace or lack of privacy have been associated with stress.

The article *It’s Just Stress, Right* gives details that any person who feels overworked and undervalued such as a hardworking office worker who has not had a vacation or a raise in two years or an exhausted stay-at-home mom with the heavy responsibility of taking care of kids, and housework is at the risk of facing burnout.

“Stress is a major issue for students as they cope with a variety of academic, social, and personal challenges. When stress is perceived negatively or becomes excessive, it can affect both health and academic performance and can have an adverse effect on students” (Lin & Huang, 2013, p.77). The authors further explain that identifying specific life stresses would make it possible to prevent, or diminish academic burnout.

2.2 Effects of Stress

The article *Stress symptoms: Effects on your body and behavior*, by Mayo Clinic, classifies the effects of stress as follows:

On the body:
• Headache
• Muscle tension or pain
• Chest pain
• Fatigue
• Change in sex drive
• Stomach upset
• Sleep Problems

On the mood:
• Restlessness
• Lack of motivation or focus
• Irritability or anger
• Sadness or depression

On the behavior:
• Overeating or undereating
• Angry outbursts
• Drug or alcohol abuse
• Tobacco use
• Social withdrawal

Although many symptoms of stress are recognizable by the stressed person or others around that person, sometimes, the person may be unaware that s/he is under stress. According to the article Stress management (n.d.), “Sometimes, you can be experiencing stress, but your mind and body are so good at hiding it from you that you are unaware of it” (para. 7). The article further explains that symptoms of hidden stress are subtle and, therefore, difficult to recognize, such as:
• Working endlessly and not feeling tired.
• Having little feeling with occasional outburst of anger.
• Consumption of caffeine, cigarettes or other drugs.
• An inability to relax.
The article *STRESS...At Work.* (2014, June) published by The National Institute for Occupational Safety and Health (NIOSH) explains that health costs are nearly 50 percent higher for highly-stressed employees. The article further summarizes the effects of long-term stress, from the Encyclopaedia of Occupational Safety and Health, as follows:

- **Cardiovascular disease:** Psychologically demanding jobs that give employees little control over work processes increase the risk of heart disease.
- **Musculoskeletal disorders:** Stress is believed to increases the risk of back and upper-extremity musculoskeletal disorders.
- **Psychological disorders:** Studies support that mental health problems varies (such as burnout and depression) with differences in job stress levels.
- **Workplace injury:** Stressful working conditions could interfere with safety practices and the risk of injury at work increases.

2.2.1 Stress vs. Sleep

A survey conducted by Gallup in 2013 states that “Medical studies have related a lack of sleep to health problems and cognitive impairment. Therefore, experts typically recommend seven to nine hours sleep for adults. Currently, 59% of U.S. adults meet that standard, but in 1942, 84% did. That means four in 10 Americans get less than the recommended amount of nightly sleep, compared with the 11% who did so 70 years ago” (Jones, 2013, para. 2).

In an article related to wellness, Scott (2016) says that “Most of us have had the experience of losing sleep over a stressful situation at least once or twice. Many people find that sleep is either difficult to come by because they are gripped by rumination, or they even find themselves waking up in the night between sleep cycles, their stress response triggered by rumination that's surfaced, and unable to get back to sleep quickly” (para. 3).

Knudsen, Ducharme & Roman (2007) conducted a study to check the relation between job stress and sleep-related outcomes. The study was conducted by collecting data from full-time American workers. The findings of the study are as follows:
• American workers reported 5.3 days of trouble falling asleep, 6.6 days of trouble in maintaining asleep, and 5.0 days of trouble waking up for work in the past month.
• Positive association was found with the frequency of poor sleep quality and work overload.
• Role conflict was positively associates with difficulty in initiating sleep.
• Repetitive tasks were associated with difficulty initiating and maintaining sleep.

2.2.2 Stress vs. Heart Rate and Heart Rate Variability

Choi & Gutierrez-Osuna (2009) published a research article describing an approach to detect mental stress. They say that “A number of physiological markers of stress have been identified, including electrodermal activity (EDA), heart rate (HR), various indices of heart rate variability (HRV), blood pressure (BP), muscle tension, and respiration.” (p. 219).

“Stressful events suppress your parasympathetic nervous system, which regulates your body at rest, and activate your sympathetic nervous system, which puts you into a state of fight or flight. Your cortisol levels spike, you breathe faster, and your heart rate and blood pressure go through the roof” (Eaves, 2016, para. 8).

“Heart rate variability (HRV), the beat-to-beat variation in either heart rate or the duration of the R-R interval, has become a popular clinical and investigational tool” (Billman, 2011, p. 1).

“Measurements of cardiac activity are robust and, with the advent of consumer-grade heart rate monitors (HRM), relatively unobtrusive and affordable” (Choi & Gutierrez-Osuna, 2009, p. 219).

Several authors have justified that low HRV reading signifies a higher level of mental stress (Billman, 2011; Choi & Gutierrez-Osuna, 2009; Eaves, 2016).
2.3 **Corporate Wellness Programs**

Most of the corporations are aware that keeping their employees healthy is an important aspect of their success. Some corporations do provide a wellness program for their employees, but they have their fair share of backlash for being too intrusive and at times being counterproductive (Brino, 2015).

The article *Corporate Wellness Programs Sprout Up as Companies Face Higher Healthcare Costs* (2010) states that:

Although they have been on the scene for 30-some years, corporate wellness programs are evolving from being a nice, "new agey" thing to do to an increasingly popular business strategy that can drastically reduce a company's healthcare costs and improve employee productivity and retention (para. 1).

According to Mujtaba and Cavico (2013), the focus of wellness programs identifies high-risk employee profiles and offers programs for behavior modification (like diet, smoking cessation, exercise, etc.) to reduce risk and to increase productivity and longevity. These programs were inspired by the high cost of providing benefits to employees. It is recognized that society pays the price for unhealthy personal shortfalls either within the organization or through the citizen-funded welfare systems.

Nield (April 2014) informs us about various companies who are using fitness trackers as part of their corporate wellness programs. The report provides the info on the following companies:

- Buffer (a startup in San Fransisco) encourages its employees to track wellness using Jawbone’s Up wristband.”
- Autodesk issued Fitbit devices as optional extras for its employees in 2011. 50% of the employees signed up when it was initially introduced. Autodesk reported that this move had a real influence on the employees as data prompted changes in their behavior.
- The gas and oil giant BP partnered with StayWell Health Management to offer employees the use of a Fitbit tracker. As part of its wellness program, a challenge called million-step challenge encourages employees to walk in the course of their daily routine.
Erickson (March 2016) reports that “Fitbit works with employers such as Indiana University Health and Emory University in Atlanta to subsidize fitness trackers for their staff” (para. 7).

2.4 Review of Fitness Wearables

Delgado (2014) states that “While it might not be as prevalent as smartphones, wearable technology has gained more mainstream attention thanks to products like Nike’s FuelBand, Samsung’s Gear Fit, and Google Glass. These items and devices are really the first generation of wearable technology, and they only tap into a fraction of the true potential wearable tech has to offer” (para. 1).

“Healthcare technology vendors have taken notice of people's desire to measure their activity. Heart rate monitors are not just for cardiologists anymore. They are being incorporated into consumer devices such as watches, wearable fitness trackers, bracelets and even smartphones” (Kim, n.d., para. 1).

There are different types of wearable devices available for heart rate monitoring. Below are the types along with their pros and cons as per the consumer report magazine (Heart-rate monitor buying guide, April 2013)

2.4.1 Chest-strap

All of these models are worn with a chest strap. Heart rate is continuously displayed on either the wristwatch or a smartphone using Bluetooth.

The pros of a chest-strap are that they provide continuous heart-rate readings. These devices allow individuals to move freely so that they can perform any workout from basketball to Zumba.

The cons of a chest-strap are that a person has to wet the chest strap at least initially to get a reading. It sends the heart rate to an iPhone, which can be convenient, but some panelists worried about dropping their phone while working out.

2.4.2 Touch-type wristwatch

These wrist-only models require an individual to either touch the device on its rim or press a button to get a reading. They are placed in the same spot as your watch.
The pros of a touch-type watch are that these models do not require a chest strap, making them more comfortable regarding usage.

The cons of a touch-type watch are that they are tough to use for certain workouts like running or cycling. There are delays in readings. Also, the wearer may have to wet the back of the watch with water or conductive gel, depending on the model.

2.4.3 Continuous reading wristwatch

These are newer devices that provide continuous heart readings without a chest strap. The wristwatch device must be placed snugly above the wrist bone to get an accurate reading. Putting them in the right spot is crucial to getting an accurate reading since they are not connected to a chest strap.

The pros of using continuous reading smartwatches are that they provide continuous heart rate readings without a chest strap and work well for any workout. Furthermore, they can be read more easily than touch watch models.

The cons are that they are pricier than chest-strap devices and standard touch wristwatch models. Many even lacked some basic features like a calorie counter.

2.4.4 Market Analysis of Wearable Fitness Devices

There are many devices available on the market today at various price ranges. Chest straps can be a bit uneasy to wear on a daily basis. The smartphones do not provide a continuous reading. After analyzing the consumer market on February 2016, from amazon.com, the following devices that can track heart rate from the wrist continuously were found:

- Garmin Vivoactive HR ($250)
- Mio Alpha 2 ($200)
- HeHa Qi Health Manager ($80)
- Mio LINK Heart Rate Monitor ($70)
- Xiaomi Mi Band 1S ($30)

Any of these devices can be easily worn around by students. By going through the reviews of Profis (2014, May) and Vishik (2015, June), it is clear that the chest-worn sensors are more accurate at reading the heart rate compared to the wristband. Profis
(2014, May) also states that for the casual user looking to get a resting heart rate, these wrist-based devices are fine.

The devices in the current market are not designed to measure the stress levels directly. These devices, on the contrary, have the ability to measure the symptoms of stress such as sleeplessness. Also, Newell (2015) specifies that stress can cause elevated heart rate. Irregular physical activities can cause negativity. The existing devices can measure these readings which can provide an estimation of stress. Few apps in the Android app store have been designed to measure stress levels, using heart rate variability, which could be utilized in conjunction with these devices to get a better understanding of stress levels of an individual.

2.5 Summary

The literature review provided information on the effects of stress on an individual. It gave an insight of different stressors faced by various people like working people, students, and even stay-at-home moms. A review of wearable devices feasible for this study was done. Some corporations already have programs set up for the wellness of their employees. This study examined if certain features of wearable devices can be leveraged to make people aware of their stress levels. The next chapter will describe the theoretical framework for this study and explain the setup which may be able to notify high stress continuously using wearable devices. Awareness of stress might drive better management of it, which can, in turn, reduce burnout.
CHAPTER 3. METHODOLOGY

This chapter covers the experimental setup for stress detection, types of data collected for the study, the methods used for data collection and finally the data analysis strategy. It also discusses how the framework for the experiment has developed and the reliability of this research.

3.1 Research question

Can Wearable Devices Reduce Burnout by Making People Aware of Stress?

3.2 Qualitative Framework

The literature review had provided info on various stressors faced by people and the effects of it. Figure 3.1 shows those variables from the literature that are in scope for this study. They are shaded in green. Sleep and heart rates have confounding variables. For example, heart rate may vary due to physical activity and also due to medications or pacemakers. In section 3.4 of this chapter, the subject selection criteria would be explained which prevents few confounding variables related to heart rate. Sleep is also affected by other conditions (e.g. Sleep apnea), but this would still contribute to stress. Hence, subjects were not filtered based on sleeping disorders. The literature also showed that personality traits of a person are a predictor of stress. Due to limited resources (access to students), the personality traits of an individual were not considered while choosing the subjects. The literature also showed that low heart rate variability (a byproduct from heart rate) could be used to measure stress levels reliably.
3.3 Experimental Setup

The Xioami Mi Band 1S was selected for this experiment. The selection of this device was based on its low cost and the fact that it does not have a screen. This study required the subjects to wear the device at all times for continuous monitoring. Few instructors may not be happy to see a digital device on the wrist of students during exams. Hence a screen-less device was chosen which could measure the required variables in the scope of this study.

The subjects had to install three apps on their phone. One was the stock Mi-Fit app, which automatically measured the subjects hours of sleep. The second was the ‘Mi Fit Tools’ app, which provided continuous heart rate monitoring and notification.
for high heart rate. The third was the StressCheck app, which can assess stress levels, by reading heart rate variability, when a finger is placed on the phone's camera with flash.

The setup was designed to work on an Android smartphone with a flash camera as the ‘Mi band Tools’ app, which provided continuous heart rate monitoring, was only compatible with Android. Subjects were provided with instructions for setting up this experiment (Appendix A). Using funds supplied by the researcher, the subjects purchased the “Mi Band Tools” app, which provided the continuous heart monitor, a feature that was critical for the needed notifications of high heart rates.

A heart rate chart was provided in the instructions to inform subjects how to configure the alert parameter (average high heart rate) as per the subject’s age and health status (Appendix A). The subjects used the “StressCheck” app, whenever notified of high heart rate, which assessed the stress level on their smartphone by measuring the heart rate variability. They were also encouraged to make an effort to try and reduce their stress level if they could. The subjects were instructed to tweak the high heart rate notification value (usually incremented by five units) until they had an optimal notification setting. This configuration is crucial to notify subjects of stress effectively and to avoid any false alarms.

This study had three rounds. First round required the willing subjects to take a pre-questionnaire. This questionnaire collected data on the stress and burnout levels of the willing subjects. It also determined what kind of smartphone the subjects had along with demographic info (Appendix C) which would help in understanding the background of the students who took part in the study.

For round two, subjects were first filtered out based on having any heart conditions or not having an Android smartphone. From the remaining set of subjects, subjects who fell into the high-stress group or the ones who fell into the low-stress group were selected. This selection was done to see how subjects in the different stress level groups responded to this experiment. The chosen subjects were provided with a fitness band (Xiaomi Mi Band 1S) and funds to purchase required apps that tracked their sleep and provided continuous heart rate monitoring. Round two lasted for three weeks.
In the final round, subjects had to respond to a post-study questionnaire (Appendix D), which was used to gain insights on the setup and its effectiveness.

3.4 Sample

A selective sample was used for this research. Students were recruited from a senior undergraduate class. Willing participants signed the IRB approved consent form (Appendix B). They were invited to take a screening questionnaire (Appendix C) which provided an estimate of their stress and burnout level. Based on the responses in the pre-questionnaire, 14 subjects were chosen to participate in the entirety of this study based on their stress rating, burnout rating and the ones with no heart condition. Among the 14, seven subjects belonged to the high-stress group, and the other seven were in the low-stress group. One subject from the high-stress group dropped out of the study after one week due to an allergic reaction around the wrist while wearing the Mi-Band for 24hrs. Finally, 13 students completed all the rounds of this study.

3.5 Data collection procedures

The data were collected online via pre-questionnaires (Appendix C) and post questionnaires (Appendix D). The pre-questionnaires collected data on demographics, burnout and stress. The instrument used in formulating the questions for assessment of burnout is the Maslach Burnout Inventory (MBI). “MBI has been recognized for more than a decade as the leading measure of burnout, incorporating the extensive research that has been conducted in the more than 25 years since its initial publication.” (Maslach Burnout Inventory (MBI) - Statistics Solutions). A version of MBI aimed at students (MBI – Student Survey) was used in the questionnaires for this study. Yavuz & Dogan (2014) conducted a study to access the validity of the modified MBI-SS. The scale was applied to 9th, 10th, 11th and 12th-grade students, and the data obtained from 1,020 high school students were analyzed. Results show that the reliability of this scale is satisfying. Hu & Schaufeli (2009) conducted a multi-group analysis to test the invariance between three groups of students from high school, university and nursing in China. The study had been carried out on a large sample of students (N=1,499) and concluded that the MBI-SS was consistent in assessing burnout among the students of all the different groups.
In order to evaluate the stress levels of the subjects, the Perceived Stress Scale (PSS) instrument was used. Andreou et al. (2011) conducted a validity study of PSS. 941 individuals completed anonymously questionnaires comprising of PSS. They found a satisfactory Cronbach’s alpha values (0.82 for the full scale) for PSS.

The five-point Likert scale was used for collecting the responses of the MBI and PSS questions. The post questionnaire had additional open-ended questions assessing the effectiveness of the experiment along with the same set of MBI, PSS questions in a randomized order.

Both the stress and burnout questions were modified to accommodate the timetable for this research. For example, the question “In the last month, how often have you felt nervous or stressed?” was changed to “In the last semester, how often have you felt nervous or stressed?” This study was conducted right after the summer break. The period of ‘last month’ would not help in assessing the true stress or burnout levels of the students which they would normally face.

3.6 Data analysis strategy

A mixed methodology was used to answer the research question. The pre-questionnaire collected data on the demographics, stress, and burnout. The post questionnaire contained the same set of questions that were used for measuring the perceived stress and burnout as in the pre-questionnaire.

The initial responses and the post responses were used to perform a comparative analysis in a quantitative way. Two-way ANOVA was used to check the difference in changes of stress and burnout between the high stress and low-stress group. Additionally, a paired t-test was used to check differences in stress and burnout score individually before and after the experiment. Responses to the open-ended questions in the post-questionnaire helped in driving the discussion for this study. A thematic analysis was used for the qualitative analysis.
3.7 Trustworthiness

This study was reviewed by a committee who have expertise in the area of wearable technology, project management, and organization management. Their inputs and directions along the way have helped in formulating a reliable research study.

3.8 Summary

This chapter provided the qualitative framework which describes the variables used for stress measurement for this study. Sample selection and data collection procedure were discussed. The next chapter describes the implementation and challenges faced while running the experiment.
CHAPTER 4. DISCUSSION

This chapter presents details on the process, challenges, and outcomes while executing the various stages of this study as described in the methodology.

4.1 Subjects Recruitment Process

Students from CNIT 480 were approached to take part in this study. This study was introduced to the class by giving a short presentation. 43 students had signed the consent form (Appendix B) to take part in this study. The screening pre-questionnaire (Appendix C) was created in Qualtrics, and the links were distributed via email to the willing subjects. These links were private and specifically bound to each subject's email address. Each link could be used only once. Out of the 43 students, 37 students responded to the screening questionnaire. The remaining six students were categorized as unresponsive.

4.2 Demographic Information

Out of the 37 students who responded, 31 were male, and six were female. Figure 4.1 represents this data on a pie chart.

Figure 4.1 Sample Gender Ratio
Figure 4.2 represents the age distribution. 34 subjects fall in the age group of 18-24 years, and the remaining three subjects were above 25 years.

![Sample Age Distribution](image)

None of the students indicated that they take any medication that might influence their heart rate. Hence none of the subjects were screened out based on this condition in the sample.

Figure 4.3 represents the year in the undergraduate program to which the subjects belong. Not surprisingly, 34 out of 37 were seniors, since the class was a senior level course. Two students were juniors, and one was a freshman. Due to the lack of distribution between school years, the burnout comparison between students at different years was not made.
4.3 Stress and Burnout Assessment of the Sample

The PSS (Stress) and MBI-SS (Burnout) questionnaires consisted 28 questions with responses recorded on a scale of 1 to 5. The candidate's mental state was assessed based on the cumulative score (StressBurnoutScore) obtained from their responses to all the 28 questions. Hence, the StressBurnoutScore could range from 28 to 140. The distribution of the StressBurnoutScore of the 37 subjects is shown in Figure 4.4. The StressBurnoutScore of the complete sample is normally distributed. The mean score is 74 (2.63 out of 5), which is an optimal score for good performance.

The correlation analysis of stress scores (PSS) and burnout scores (MBI-SS) shows a positive correlation of 60.54% which is a moderately strong relationship. Hence, the data is consistent with the theoretical framework that stress is a good predictor of burnout.
In the qualitative framework of this study, having a heart condition was considered to have a confounding effect on this experiment. The screening questionnaire checked if anyone had any heart condition. None of the subjects indicated to have any such conditions. Hence none of the 37 candidates were filtered out based on these criteria.

This experiment can only be tested with subjects who owned an Android smartphone which had a flash camera. Among the 37 subjects, 22 subjects owned an Android smartphone and the remaining 15 subjects did not. All the 22 Android phones had a flash camera. Hence, the 15 candidates without an Android device were eliminated from taking any further part in this study. Figure 4.6 shows the stress and burnout distribution of the 22 subjects with the Android phone. The distribution of the
StressBurnoutScore of the subjects with Android phones is skewed to the left. The normality is lost compared to the distribution in Figure 4.4.

Figure 4.5 StressBurnoutScore of Subjects with an Android smartphone

Initially, seven subjects with lowest ratings and seven subjects with the highest ratings were invited to take part in the second round via email.

Most of the subjects agreed to participate apart from one subject from the high-stress group and one from the low-stress group. Both the candidates were not comfortable with a device continuously monitoring their data. The next lowest and highest rated subjects were approached to take part instead, and they agreed. Finally, 14 subjects agreed to take part in round 2, which lasted for three weeks.
4.5 Challenges During the Experiment Setup

The researcher met with all 14 subjects in person to set up the round 2 experiment. During the setup, it was observed that a single Mi-Band took a long time to pair with the smartphone of the subjects. When one Mi-Band was charged and given to the subject, the time to pair the device ranged from 30 seconds to 45 minutes. To avoid delays, the researcher charged multiple Mi-Bands (up to 5 bands at times) and put them all on the table for pairing. Whichever device had paired first was given to the subject (the researcher termed this methodology as fishing). Figure 4.6 shows the fishing technique.

Even though the pairing issues were resolved, two subjects had found it difficult to set up the continuous heart rate monitoring. The continuous heart rate monitoring was provided by the ‘Mi Band Tools’ app. This app usually syncs up with the stock Mi-Fit app and then performs the required operations with the Mi-Band. For those two subjects,
when the Tools app tried to sync with Mi-Fit automatically, their Bluetooth kept turning off for an unknown reason. This issue was resolved by manually entering the MAC address of the Mi-Band into the Tools’ app. This issue occurred on HTC phones, which were under contract with Verizon. The contracting companies generally modify the Android operating system on contracted phones. This info should help anyone trying to replicate this study. Finally, all the 14 subjects had the experiment setup and running by following the instructions given by the researcher. Not all subjects had this experiment setup on the same day. Hence, the three-week time frame for round two was not on the same days for all 14 subjects. There was a week gap between the first subject and the last subject while completing round two.

During the experiment, one of the subjects pointed out that the continuous heart rate was not working properly on the phone. The heart rate was only being monitored when the phone was unlocked and being used actively. When the phone was locked, and no active apps were running, the heart rate monitoring was freezing up. After some analysis, it was discovered that the subject had tweaked a power saving setting which turned Bluetooth off when the phone goes into locked mode. By restoring the power settings back to the default setting, this issue was fixed.

One subject from the high-stress group decided to drop out after having an allergic reaction while wearing the band. This subject did not take part any further in this study.

Once the 3-weeks were completed, all 13 subjects responded to the final post questionnaire.

4.6 Data Analysis

A mixed methodology was used to get meaningful insights from the data. Some insights were derived quantitatively by using two-way ANOVA and paired T-test. Then a thematic analysis was performed on the open-ended questions that gave insights into the experiences of subjects who took part in this experiment.

4.6.1 Two-way ANOVA

A two-way ANOVA was performed on the data. The two factors that were considered for this analysis were Group with levels as HIGH and LOW (which is stress level), and Time, BEFORE and AFTER (which were the responses from pre and post
questionnaires). This analysis was done with 95% confidence to check if there is any significant variance between the StressBurnoutScore of subjects in High and Low burnout levels before and after the experiment. The three null hypotheses are as follows:

$H_{01}$: All GROUPS have the same StressBurnoutScore on average.

$H_{02}$: The average StressBurnoutScore is the same BEFORE and AFTER the experiment.

$H_{03}$: There is no interaction between GROUP and TIME.

<table>
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<tr>
<th>Source</th>
<th>DF</th>
<th>Anova SS</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Pr &gt; F</th>
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</thead>
<tbody>
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<td>3076.821429</td>
<td>21.94</td>
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<tr>
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<td>183.115385</td>
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</tr>
<tr>
<td>GROUP*TIME</td>
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<td>35.539377</td>
<td>35.539377</td>
<td>0.25</td>
<td>0.6197</td>
</tr>
</tbody>
</table>

$H_{01}$ is rejected as the p-value 0.0001 < 0.05. Alternatively, it can be concluded with 95% confidence that the high and low-stress group have statistically significant differences in their StressBurnoutScore. This is obvious since the sample was chosen for this study accordingly.

$H_{02}$ is accepted as the p-value 0.2645 > 0.05. Hence, with 95% confidence, it is concluded that there is no significant variance in the StressBurnoutScore before and after the experiment. Further analysis on this data was done using a Paired T-Test in the next section.

$H_{03}$ is accepted as the p-value 0.6197 > 0.05. Hence, with 95% confidence, it is concluded that there is no interaction between the GROUP and TIME. This means that there was no significant difference in the StressBurnoutScore between LOW and HIGH-stress groups, before and after the experiment was concluded.

4.6.2 Paired T-Test

The two-way ANOVA showed no significant variance in the scores between HIGH and LOW-stress group. So, considering the StressBurnoutScore collected from the pre-
questionnaire of all the subjects as control data and the StressBurnoutScore collected from the post-questionnaire as the treatment data, a Paired T-test was performed to see if there was any significant change in the StressBurnoutScore of the subjects before and after the experiment at 90% confidence. Hence the null hypothesis:

\[ H_0: \text{There is no difference in StressBurnoutScore.} \]

Table: 4.2 Paired T-Test on StressBurnoutScore

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Std Err</th>
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<th>Maximum</th>
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<tbody>
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<td></td>
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<td>9.7073</td>
<td>2.6923</td>
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</table>

<table>
<thead>
<tr>
<th></th>
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<th>Std Dev</th>
<th>90% CL Std Dev</th>
</tr>
</thead>
<tbody>
<tr>
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<td>-10.1062</td>
<td>-0.5092</td>
<td>9.7073</td>
</tr>
</tbody>
</table>

|                      | DF   | t Value | Pr > |t| |
|----------------------|------|---------|-------|
|                      | 12   | -1.97   | 0.0722|

The null hypothesis is rejected as the p-value 0.0722 < 0.10. Alternatively, it can be concluded, with 90% confidence, that there is a significant difference in StressBurnoutScore of subjects. The mean value of differences from after and before is negative (-5.3077), which implies an average reduction in StressBurnoutScore score after the final round completion.

A limitation of this analysis is that the control and treatment readings were not taken in a well-controlled environment (the workload on subjects, duration of assessment were not consistent while assessing the StressBurnoutScore before and after the treatment). Although a significant reduction at 90% confidence is shown, it may or may not be due to the awareness provided by the wearable device.

4.6.3 Qualitative Analysis

In the post-questionnaire (Appendix D), the subjects answered four questions (Q29 to Q32) that helped in assessing the effectiveness of this experiment in a qualitative way.
The subjects were asked how effective the experimental setup was in making them aware of stress (Q29) and if they took any steps to reduce stress (Q31). The responses were collected on a 5-point scale. The summary is shown below:

![Figure: 4.7 Effectiveness of Stress Notification](image)

Out of the 13 subjects who tested this setup for three weeks, nine subjects responded with a rating of 4 and two with a 5 rating for the effectiveness of stress. Only two subjects felt that the setup was not effective at notifying them about their stress (Figure 4.7). The mean for effectiveness comes to 3.92 out of 5. Hence, this setup was 78.4% effective at making people aware of stress.

Regarding the intent to reduce stress when notified, seven subjects rated their intent as 4 and two subjects rated 5. Three subjects did not show much intent to reduce stress while notified (Figure 4.8).
Two open-ended question were asked as a follow up to better interpret the ratings above (Q30 and Q32). A thematic analysis was performed on the responses (Appendix G, Appendix H). A color coding technique was used to summarize the various patterns within the replies. Responses that answer the questions positively were coded in green, and the ones that responded negatively to the question were coded in red. The responses coded in yellow do not respond to the question directly but provides additional insights about the setup.

The summary of the replies for the effectiveness of stress (Q30) are as follows (ranked by frequency):

1. The device notified of high stress appropriately. (4)
2. Helped in being more cautious of stress even when not aware of it. (4)
3. Only a few times it notified of stress while resting. (2)

The summary of the responses for the intention to reduce stress (Q32) are as follows (ranked by frequency):

1. Took steps to reduce stress (Breathing, Mindfulness training, stop thinking about stressors). (7)
2. Cannot control stress unless completing the stressful activity (Deadline). (2)
3. When notified too much, would give up and accept that it was a bad day. (1)
4. Did not feel the notification was accurate so did not do anything. (1)
5. Could have put in more efforts but did not. (1)

The additional insights obtained from the various responses are as follows (ranked by frequency):

1. Unwanted notifications while doing physical activities. (5)
2. Setting the right high heart rate notification setting was essential for effective notification. (4)
3. Took a while to get the heart rate notification correct. (2)
4. Helped in de-stressing throughout the day rather than just at the end of the day (2).
5. Stress analyzer app struggles to assess stress while resting just after a workout. (1)
6. Notified while sleeping and disrupted sleep. (1)
7. Was annoying while taking exams (1)
8. The setup may benefit from more accurate readings. (1)
9. Heart rate is a good indicator of mood. (1)
10. Heart rates are very high after drinking. (1)
11. Notified during presentations. (1)

4.7 Conclusion

The majority of the responses state that the setup was effective and also, the additional insights provided by subjects (being notified during the exam, presentation) shows that the setup effectively notified of stress during stressful events.

The paired t-test showed a reduction in burnout at 90% confidence, but there is no consensus if it was the setup that caused the reduction, due to the lack of control in the environment. The two-way ANOVA concluded that there are no significant changes in the burnout between the high and low-stress group, before and after the experiment.

Subjects also responded that they took active measures to reduce their stress whenever it was possible, but there was no data on how effective the measures they took were on reducing their stress. Few subjects did not seem to like the device going off at
odd times. The experiment could be further improved to have proper monitoring hours as per the requirements of the person using it. The “Mi-Band Tools” app has the option of setting the period during which the heart rate should be monitored which can be used to resolve these issues. Having the correct high heart rate notification parameter is critical to getting efficient notifications, and this, according to some subjects, would take some time.

From all these data it can be concluded that the setup was successful in making people aware of stress.

4.8 Future Research

There are numerous directions this research can go. This study was primarily focused on using wearable technology to make people aware of stress and tried to apply this setup to reduce burnouts. There should be many other applications of this setup in other fields. From the technology standpoint, the setup got a score of 3.92 out of 5 at making people aware of stress, but the sample size was quite small. A larger study would require much more wearable devices. The researcher believes that the setup can be improved further by adding more variables into the mix, which would require more sensors on the wearable device. Advancements in the wearable field should enable this requirement. This setup could be extended further by adding in effective stress management techniques when people are notified of stress.
APPENDIX A: SUBJECT INSTRUCTION SHEET

Please follow the below instructions below to set up the experiment:

1) Attach the MI-head to the charger as shown below and charge the MI completely (until three LEDs on the head are lit).

2) Attach the head to the band provided and put it on your wrist firmly (any wrist is fine).

3) Download and install the ‘Mi-Fit’ app on your Android smartphone from the play store.

4) There is an issue registering an account for ‘Mi-Fit’ app through the app. Please create an account through the link https://account.xiaomi.com/pass/register on a web browser separately.

5) Open Mi-Fit app on the phone and log in with the new account.

6) Turn on Bluetooth and pair the device with the Mi-Fit app by following instructions on the screen.

7) It can now actively measure your steps, calories burnt and sleep automatically.

8) To read your heart rate continuously, purchase the app ‘Mi Band Tools’ and install it on your smartphone. (The amount of the app purchase was already provided to you while handing over the MI band).

9) From the Main Menu (left swipe menu) of the Mi Band Tools app, select Heart Rate.

10) In the Heart Rate dashboard, go to the settings tab (On the very right).

11) Enable the option “Heart Rate Monitor”.

12) Set the “Monitor Interval” option value to 1.
13) In the notification section of the settings screen, set the “Number of Readings” option to be 3. The setting will fire a notification for an average heart rate reading for last three readings.

14) Please check the chart below first and select the poor heart rate (as per your health and gender) as the value for the setting “High Heart Rate Notification.” This is just a reference point to start.

<table>
<thead>
<tr>
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<th>18-25</th>
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<th>36-45</th>
<th>46-55</th>
<th>56-65</th>
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</thead>
<tbody>
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<td>50-57</td>
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</tr>
</tbody>
</table>

15) Now install another app called ‘StressCheck’ by Azumio Inc on the phone. You need to put a finger on the camera and press the play button to check your stress level with this app. It will take a couple of minutes to get the reading.

16) The set up for the study is complete.
17) Check the sleep data after you wake up every day. Sleep time less than 7 hours could indicate that you are facing some level of stress.

18) Every time you get a high heart rate notification (while resting and not doing any physical work), please use the StressCheck app to check your stress level.

19) If the current high heart rate setting seems to notify you regularly and the StressCheck app doesn't show high or medium level of stress, please increment the High Heart Rate Notification setting by 5 and repeat until you feel that the notifications are consistent with StressCheck.

20) The reports in apps are displayed as follows:
21) Whenever you have to perform an activity where the device would come in contact with water (swimming, shower), take the device off and stop the continuous monitoring in the MI band tools app. Put the device back on and continue the heart rate monitoring once completing the activity.

22) The device runs for approximately 10 days after a single charge. Remember to charge the devices whenever required.

23) Finally, and most importantly, when you have been notified of high heart rate and the stress check shows high stress levels, try your best to follow one of the steps provided in the following article to relieve stress: https://www.verywell.com/top-school-stress-relievers-for-students-3145179

Different individuals have different ways of relieving stress. If you know any activity that helps you and is not on the list provided, please do it. You don’t have to restrict yourself to the activities on the list.
APPENDIX B: RESEARCH PARTICIPANT CONSENT FORM

Can Wearable Devices Reduce Burnout by Making People Aware of Stress?
Alka Harriger, Professor and Rohit Mundayaliyath Mundayadan, Graduate Student
Department of Computer and Information Technology
Purdue University

What is the purpose of this study?
This research focuses on leveraging the features of wearable fitness devices and smartphone technology to make people aware of their stress levels. The researcher needs to conduct a test to evaluate if the experimental setup can notify elevated stress in humans. Students can have stress for various reasons like assignments, exams, coursework, etc. Hence, ten students will be invited to take part in this study.

What will I do if I choose to be in this study?
This study has three rounds. First round is to answer an online questionnaire which would determine if you are the right candidate for this study. The researcher will inform you regarding the selection outcome. If you have been chosen to be part of the study, you will proceed to round two. For round two, you would be provided with a fitness device (Xiaomi MI Band 1S) and $2 cash to purchase a smartphone app. An instruction sheet for setting up the experiment would be provided. Once you have setup the device and apps, carry on with your daily activities. Finally, in round three another online questionnaire needs to be answered.

How long will I be in the study?
- The initial screening questionnaire will take about 30 minutes to complete.
- If you meet the criteria for selection and agree to participate in further rounds, you will meet the researcher and setup the experiment. The setup takes around 35 min to complete.
You will continue with daily routines with the device on for three weeks. Each day you may spend around 10-15 min looking at reports and checking stress levels using the apps on your phone.

In the final round, you will have to take the final online questionnaire which will take about 30 min to complete.

**What are the possible risks or discomforts?**

- During the experiment, your heart rate is continuously monitored every minute. Remember that this is a new technology and at times, it would show spikes in heart rate erroneously. Do not be alarmed if you see spiked readings when you are feeling alright.
- If you feel like you have high rate heart on average and ever feel like you need help, please use the services provided at PUSH to get it check out by a doctor.
- This experimental setup only alerts for stress. If you are too stressed and ever feel you need help, make use of the Purdue stress management programs. Please check the following link:
  https://www.purdue.edu/recwell/programs/wellnessPrograms/wellnessClasses-services/wellnessWorkshops/stressManagement-wellBeing.php
- Breach of confidentiality is a possible risk associated with research.

**Are there any potential benefits?**

You will get reports of your sleep, heart rate and physical activity by using the wearable device. It may help you lead a healthier life.

**Will I receive payment or other incentive?**

- You will be awarded with the extra credits in CNIT 48000 after successfully completing round one.
- If you were selected for further rounds and you complete all the rounds, the wearable device and apps are all yours. You will get some more extra credits after completing all rounds.
(Note: You have the right to quit the study at any point. You must return the device if you choose to quit after the devices were provided. The extra credits for completing round 3 will not be provided. You will still have alternative ways to attain those extra credits in other ways)

Will information about me and my participation be kept confidential?

- The research records will be stored in a locked storage in a private place to avoid a leak. The research records will be de-identified after finishing the analysis.

- The research records may be reviewed by the researcher and by departments at Purdue University responsible for regulatory and research oversight.

Note: The health data collected by the fitness devices will remain on your phone. They will not be recorded in the research records. Only the responses from the questionnaires are collected.

What are my rights if I take part in this study?

- Your participation in this study is voluntary. You may choose not to participate, or if you agree to participate, you can withdraw your participation at any time without penalty.

- You will require contacting the researcher directly if you decide to withdraw from the study at any point.

- You will need to return the wearable device if you choose to withdraw between round 2 and 3 of this study.

Who can I contact if I have questions about the study?

If you have questions, comments or concerns about this research project, you can talk to one of the researchers. Please contact Rohit Mundayaliyath Mundayadan at rmundaya@purdue.edu or Alka Harriger at harrigea@purdue.edu
If you have questions about your rights while taking part in the study or have concerns about the treatment of research participants, please call the Human Research Protection Program at (765) 494-5942, email (irb@purdue.edu) or write to:

Human Research Protection Program - Purdue University
Ernest C. Young Hall, Room 1032
155 S. Grant St.,
West Lafayette, IN 47907-2114

**Documentation of Informed Consent**

I have had the opportunity to read this consent form and have the research study explained. I have had the opportunity to ask questions about the research study, and my questions have been answered. I am prepared to participate in the research study described above. I will be offered a copy of this consent form after I sign it.

__________________________________________ _________________________
Participant’s Signature Date

__________________________________________
Participant’s Name

__________________________________________ ___________________________
Researcher’s Signature Date
APPENDIX C: PRE QUESTIONNAIRE

Q1 What is your gender?
☐ Male (5)
☐ Female (6)

Q2 What is your age?
☐ Under 18 (1)
☐ 18 - 24 (2)
☐ 25 - 29 (3)
☐ 29 or older (4)

Q3 What is your race?
☐ White/Caucasian (1)
☐ African American (2)
☐ Hispanic (3)
☐ Asian (4)
☐ Native American (5)
☐ Pacific Islander (6)
☐ Other (7)

Q4 What type of school are you enrolled in?
☐ 2-Year College (1)
☐ 4-Year College (2)
☐ Graduate School (3)
☐ Other (4)
Q5 What is your current Class Year?
- Freshman (1)
- Sophomore (2)
- Junior (3)
- Senior (4)
- Graduate Student (5)

Q6 What is your current or intended major?

Q7 Do you own an Android smartphone?
- Yes (1)
- No (2)

Q8 Does the phone have a camera with flash?
- Yes (1)
- No (2)

Q9 Do you have any heart condition?
- Yes (1)
- No (2)

Answer only if you have any heart condition

Q10 Do you take any medication for any heart ailment?
- Yes (1)
- No (2)
Q11 In the last semester, how often have you been upset because of something that happened unexpectedly?
- Never (1)
- Almost Never (2)
- Sometimes (3)
- Fairly Often (4)
- Very Often (5)

Q12 In the last semester, how often have you felt that you were unable to control the important things in your life?
- Never (1)
- Almost Never (2)
- Sometimes (3)
- Fairly Often (4)
- Very Often (5)

Q13 In the last semester, how often have you felt nervous and "stressed"?
- Never (1)
- Almost Never (2)
- Sometimes (3)
- Fairly Often (4)
- Very Often (5)

Q14 In the last semester, how often have you dealt successfully with day to day problems and annoyances?
- Never (5)
- Almost Never (4)
- Sometimes (3)
- Fairly Often (2)
- Very Often (1)
Q15 In the last semester, how often have you felt that you were effectively coping with important changes that were occurring in your life?
- Never (5)
- Almost Never (4)
- Sometimes (3)
- Fairly Often (2)
- Very Often (1)

Q16 In the last semester, how often have you felt confident about your ability to handle your personal problems?
- Never (5)
- Almost Never (4)
- Sometimes (3)
- Fairly Often (2)
- Very Often (1)

Q17 In the last semester, how often have you found that you could not cope with all the things that you had to do?
- Never (1)
- Almost Never (2)
- Sometimes (3)
- Fairly Often (4)
- Very Often (5)

Q18 In the last semester, how often have you been able to control irritations in your life?
- Never (5)
- Almost Never (4)
- Sometimes (3)
- Fairly Often (2)
- Very Often (1)
Q19 In the last semester, how often have you felt that you were on top of things?
- Never (5)
- Almost Never (4)
- Sometimes (3)
- Fairly Often (2)
- Very Often (1)

Q20 In the last semester, how often have you been angered because of things that happened that were outside of your control?
- Never (1)
- Almost Never (2)
- Sometimes (3)
- Fairly Often (4)
- Very Often (5)

Q21 In the last semester, how often have you found yourself thinking about things that you have to accomplish?
- Never (1)
- Almost Never (2)
- Sometimes (3)
- Fairly Often (4)
- Very Often (5)

Q22 In the last semester, how often have you been able to control the way you spend your time?
- Never (5)
- Almost Never (4)
- Sometimes (3)
- Fairly Often (2)
- Very Often (1)
Q23 In the last semester, how often have you felt difficulties were piling up so high that you could not overcome them?
- Never (1)
- Almost Never (2)
- Sometimes (3)
- Fairly Often (4)
- Very Often (5)

Q24 In the last semester, I felt emotionally drained by my studies.
- Strongly disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q25 In the last semester, I felt used up at the end of a day at university.
- Strongly disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q26 In the last semester, I felt tired when I get up in the morning, and I have to face another day at the university.
- Strongly disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)
Q27 In the last semester, I felt studying or attending a class was a strain for me.
- Strongly disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q28 In the last semester, I felt burned out from my studies.
- Strongly disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q29 In the last semester, I had become less interested in my studies since my enrollment at the University.
- Strongly disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q30 In the last semester, I had become less enthusiastic about my studies.
- Strongly disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)
Q31 In the last semester, I had become more cynical about the potential usefulness of my studies.
- Strongly disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q32 In the last semester, I doubted the significance of my studies.
- Strongly disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q33 In the last semester, I could effectively solve the problems that arise in my studies.
- Strongly agree (1)
- Agree (2)
- Neither agree nor disagree (3)
- Disagree (4)
- Strongly disagree (5)

Q34 In the last semester, I believe that I had made an active contribution to the classes that I attend.
- Strongly agree (1)
- Agree (2)
- Neither agree nor disagree (3)
- Disagree (4)
- Strongly disagree (5)
Q35 In the last semester, I felt that I am a good student.
- Strongly agree (1)
- Agree (2)
- Neither agree nor disagree (3)
- Disagree (4)
- Strongly disagree (5)

Q36 In the last semester, I felt stimulated when I achieve my study goals.
- Strongly agree (1)
- Agree (2)
- Neither agree nor disagree (3)
- Disagree (4)
- Strongly disagree (5)

Q37 In the last semester, I had learned many interesting things during my studies.
- Strongly agree (1)
- Agree (2)
- Neither agree nor disagree (3)
- Disagree (4)
- Strongly disagree (5)

Q38 During classes in the last semester, I felt confident that I was effective in getting things done.
- Strongly agree (1)
- Agree (2)
- Neither agree nor disagree (3)
- Disagree (4)
- Strongly disagree (5)
APPENDIX D: POST QUESTIONNAIRE

Q1 In the past 3 weeks, how often have you been upset because of something that happened unexpectedly?
   - Never (1)
   - Almost Never (2)
   - Sometimes (3)
   - Fairly Often (4)
   - Very Often (5)

Q2 In the past 3 weeks, how often have you felt that you were unable to control the important things in your life?
   - Never (1)
   - Almost Never (2)
   - Sometimes (3)
   - Fairly Often (4)
   - Very Often (5)

Q3 In the past 3 weeks, how often have you felt nervous and "stressed"?
   - Never (1)
   - Almost Never (2)
   - Sometimes (3)
   - Fairly Often (4)
   - Very Often (5)
Q4 In the past 3 weeks, how often have you dealt successfully with day to day problems and annoyances?

- Never (5)
- Almost Never (4)
- Sometimes (3)
- Fairly Often (2)
- Very Often (1)

Q5 In the past 3 weeks, how often have you felt that you were effectively coping with important changes that were occurring in your life?

- Never (5)
- Almost Never (4)
- Sometimes (3)
- Fairly Often (2)
- Very Often (1)

Q6 In the past 3 weeks, how often have you felt confident about your ability to handle your personal problems?

- Never (5)
- Almost Never (4)
- Sometimes (3)
- Fairly Often (2)
- Very Often (1)
Q7 In the past 3 weeks, how often have you found that you could not cope with all the things that you had to do?
- Never (1)
- Almost Never (2)
- Sometimes (3)
- Fairly Often (4)
- Very Often (5)

Q8 In the past 3 weeks, how often have you been able to control irritations in your life?
- Never (5)
- Almost Never (4)
- Sometimes (3)
- Fairly Often (2)
- Very Often (1)

Q9 In the past 3 weeks, how often have you felt that you were on top of things?
- Never (5)
- Almost Never (4)
- Sometimes (3)
- Fairly Often (2)
- Very Often (1)

Q10 In the past 3 weeks, how often have you been angered because of things that happened that were outside of your control?
- Never (1)
- Almost Never (2)
- Sometimes (3)
- Fairly Often (4)
- Very Often (5)
Q11 In the past 3 weeks, how often have you found yourself thinking about things that you have to accomplish?
- Never (1)
- Almost Never (2)
- Sometimes (3)
- Fairly Often (4)
- Very Often (5)

Q12 In the past 3 weeks, how often have you been able to control the way you spend your time?
- Never (5)
- Almost Never (4)
- Sometimes (3)
- Fairly Often (2)
- Very Often (1)

Q13 In the past 3 weeks, how often have you felt difficulties were piling up so high that you could not overcome them?
- Never (1)
- Almost Never (2)
- Sometimes (3)
- Fairly Often (4)
- Very Often (5)

Q14 In the past 3 weeks, I felt emotionally drained by my studies.
- Strongly disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)
Q15 In the past 3 weeks, I felt used up at the end of a day at university.
- Strongly disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q16 In the past 3 weeks, I felt tired when I get up in the morning, and I have to face another day at the university.
- Strongly disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q17 In the past 3 weeks, I felt studying or attending a class was a strain for me.
- Strongly disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q18 In the past 3 weeks, I felt burned out from my studies.
- Strongly disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)
Q19 In the past 3 weeks, I had become less interested in my studies since my enrollment at the University.
   ☐ Strongly disagree (1)
   ☐ Disagree (2)
   ☐ Neither agree nor disagree (3)
   ☐ Agree (4)
   ☐ Strongly agree (5)

Q20 In the past 3 weeks, I had become less enthusiastic about my studies.
   ☐ Strongly disagree (1)
   ☐ Disagree (2)
   ☐ Neither agree nor disagree (3)
   ☐ Agree (4)
   ☐ Strongly agree (5)

Q21 In the past 3 weeks, I had become more cynical about the potential usefulness of my studies.
   ☐ Strongly disagree (1)
   ☐ Disagree (2)
   ☐ Neither agree nor disagree (3)
   ☐ Agree (4)
   ☐ Strongly agree (5)

Q22 In the past 3 weeks, I doubted the significance of my studies.
   ☐ Strongly disagree (1)
   ☐ Disagree (2)
   ☐ Neither agree nor disagree (3)
   ☐ Agree (4)
   ☐ Strongly agree (5)
Q23 In the past 3 weeks, I could effectively solve the problems that arise in my studies.
- Strongly agree (1)
- Agree (2)
- Neither agree nor disagree (3)
- Disagree (4)
- Strongly disagree (5)

Q24 In the past 3 weeks, I believe that I had made an active contribution to the classes that I attend.
- Strongly agree (1)
- Agree (2)
- Neither agree nor disagree (3)
- Disagree (4)
- Strongly disagree (5)

Q25 In the past 3 weeks, I felt that I am a good student.
- Strongly agree (1)
- Agree (2)
- Neither agree nor disagree (3)
- Disagree (4)
- Strongly disagree (5)

Q26 In the past 3 weeks, I felt stimulated when I achieve my study goals.
- Strongly agree (1)
- Agree (2)
- Neither agree nor disagree (3)
- Disagree (4)
- Strongly disagree (5)
Q27 In the past 3 weeks, I had learned many interesting things during my studies.
- Strongly agree (1)
- Agree (2)
- Neither agree nor disagree (3)
- Disagree (4)
- Strongly disagree (5)

Q28 During classes, in the past 3 weeks, I felt confident that I was effective in getting things done.
- Strongly agree (1)
- Agree (2)
- Neither agree nor disagree (3)
- Disagree (4)
- Strongly disagree (5)

Q29 The wearable device was able to determine stress levels effectively.
- Strongly agree (5)
- Somewhat agree (4)
- Neither agree nor disagree (3)
- Somewhat disagree (2)
- Strongly disagree (1)

Q30 Please share your experience using this device and apps. Also, elaborate why you had chosen the answer to the previous question.
Q31 I took steps to reduce stress whenever I was notified.
- Strongly agree (5)
- Somewhat agree (4)
- Neither agree nor disagree (3)
- Somewhat disagree (2)
- Strongly disagree (1)

Q32 Please elaborate on the answer to the previous question.
# APPENDIX E: PRE QUESTIONNAIRE RESPONSE

| U10 | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | Q11 | Q12 | Q13 | Q14 | Q15 | Q16 | Q17 | Q18 | Q19 | Q20 | Q21 | Q22 | Q23 | Q24 | Q25 | Q26 | Q27 | Q28 | Q29 | Q30 | Q31 | Q32 | Q33 | Q34 | Q35 | Q36 | Q37 | Q38 | Q39 | Q40 | Q41 | Q42 | Q43 | Q44 | Q45 | Q46 | Q47 | Q48 |
|-----|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CWDRB26 | 5 | 2 | 1 | 2 | 4 | 2 | 1 | 2 | 3 | 4 | 5 | 3 | 5 | 2 | 3 | 4 | 5 | 3 | 4 | 5 | 2 | 3 | 4 | 5 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 |
| CWDRB18 | 6 | 2 | 1 | 2 | 4 | 2 | 1 | 2 | 3 | 4 | 5 | 3 | 5 | 2 | 3 | 4 | 5 | 3 | 4 | 5 | 2 | 3 | 4 | 5 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 |
| CWDRB25 | 5 | 2 | 1 | 2 | 4 | 2 | 1 | 2 | 3 | 4 | 5 | 3 | 5 | 2 | 3 | 4 | 5 | 3 | 4 | 5 | 2 | 3 | 4 | 5 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 |
| CWDRB20 | 5 | 2 | 1 | 2 | 4 | 2 | 1 | 2 | 3 | 4 | 5 | 3 | 5 | 2 | 3 | 4 | 5 | 3 | 4 | 5 | 2 | 3 | 4 | 5 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 |
| CWDRB11 | 5 | 2 | 1 | 2 | 4 | 2 | 1 | 2 | 3 | 4 | 5 | 3 | 5 | 2 | 3 | 4 | 5 | 3 | 4 | 5 | 2 | 3 | 4 | 5 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 |
| CWDRB34 | 5 | 2 | 1 | 2 | 4 | 2 | 1 | 2 | 3 | 4 | 5 | 3 | 5 | 2 | 3 | 4 | 5 | 3 | 4 | 5 | 2 | 3 | 4 | 5 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 |
| CWDRB16 | 5 | 2 | 1 | 2 | 4 | 2 | 1 | 2 | 3 | 4 | 5 | 3 | 5 | 2 | 3 | 4 | 5 | 3 | 4 | 5 | 2 | 3 | 4 | 5 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 |
| CWDRB24 | 5 | 2 | 1 | 2 | 4 | 2 | 1 | 2 | 3 | 4 | 5 | 3 | 5 | 2 | 3 | 4 | 5 | 3 | 4 | 5 | 2 | 3 | 4 | 5 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 |
| CWDRB29 | 5 | 2 | 1 | 2 | 4 | 2 | 1 | 2 | 3 | 4 | 5 | 3 | 5 | 2 | 3 | 4 | 5 | 3 | 4 | 5 | 2 | 3 | 4 | 5 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 |
| CWDRB39 | 5 | 2 | 1 | 2 | 4 | 2 | 1 | 2 | 3 | 4 | 5 | 3 | 5 | 2 | 3 | 4 | 5 | 3 | 4 | 5 | 2 | 3 | 4 | 5 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 |
| CWDRB21 | 5 | 2 | 1 | 2 | 4 | 2 | 1 | 2 | 3 | 4 | 5 | 3 | 5 | 2 | 3 | 4 | 5 | 3 | 4 | 5 | 2 | 3 | 4 | 5 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 |
| CWDRB32 | 5 | 2 | 1 | 2 | 4 | 2 | 1 | 2 | 3 | 4 | 5 | 3 | 5 | 2 | 3 | 4 | 5 | 3 | 4 | 5 | 2 | 3 | 4 | 5 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 |
| CWDRB12 | 5 | 2 | 1 | 2 | 4 | 2 | 1 | 2 | 3 | 4 | 5 | 3 | 5 | 2 | 3 | 4 | 5 | 3 | 4 | 5 | 2 | 3 | 4 | 5 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 |
| CWDRB27 | 5 | 2 | 1 | 2 | 4 | 2 | 1 | 2 | 3 | 4 | 5 | 3 | 5 | 2 | 3 | 4 | 5 | 3 | 4 | 5 | 2 | 3 | 4 | 5 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 |
| CWDRB42 | 5 | 2 | 1 | 2 | 4 | 2 | 1 | 2 | 3 | 4 | 5 | 3 | 5 | 2 | 3 | 4 | 5 | 3 | 4 | 5 | 2 | 3 | 4 | 5 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 |
| CWDRB33 | 5 | 2 | 1 | 2 | 4 | 2 | 1 | 2 | 3 | 4 | 5 | 3 | 5 | 2 | 3 | 4 | 5 | 3 | 4 | 5 | 2 | 3 | 4 | 5 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 |
| CWDRB36 | 5 | 2 | 1 | 2 | 4 | 2 | 1 | 2 | 3 | 4 | 5 | 3 | 5 | 2 | 3 | 4 | 5 | 3 | 4 | 5 | 2 | 3 | 4 | 5 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 |
| CWDRB26 | 5 | 2 | 1 | 2 | 4 | 2 | 1 | 2 | 3 | 4 | 5 | 3 | 5 | 2 | 3 | 4 | 5 | 3 | 4 | 5 | 2 | 3 | 4 | 5 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 |
| CWDRB21 | 5 | 2 | 1 | 2 | 4 | 2 | 1 | 2 | 3 | 4 | 5 | 3 | 5 | 2 | 3 | 4 | 5 | 3 | 4 | 5 | 2 | 3 | 4 | 5 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 |
APPENDIX F: POST QUESTIONNAIRE RESPONSE

(Note: The responses of the open ended question Q30 can be seen in Appendix G and for Q32 can be seen in Appendix H)
APPENDIX G: THEMATIC ANALYSIS (STRESS AWARENESS)

(Note: Content highlighted in GREEN signifies positive response to the device making the subjects aware of stress. Contents in YELLOW shows data that provides additional insights. Contents in RED signifies a negative response to making the subject aware of stress.)

I had set the alert to go off at 85bpm. My average resting heart rate would sit somewhere around 70. There was stressful moments in lab or working on lengthy homework assignments where I would get notified about a higher heart rate. During these times, the stress analyzer app would show a higher stress amount. There was also times just during normal life after vigorous activity that would set off the heart rate alert. The stress analyzer seemed to have a harder time in these moments. Sometimes it would mistake my high heart rate and cooling down period as stress but other times it would be accurate in showing a low stress amount even with a slightly higher heart rate. The majority of the time when the device went off, the stress test showed that I had medium to high levels of stress. However, I had to raise the threshold to 90 bpm otherwise it was going off while my stress levels were reading low. After raising the threshold I was almost always at a high stress level when the device went off: I liked using the device, because it made me more cautious about my stress level in daily life. A lot of times I didn't even recognize that I was very stressed until it vibrated. Also it reminded me of taking breaks during studying, which I liked very much. I don't think it was always very effectively, because it also vibrated when I was asleep, and it woke me up a couple of times. Also when I was on vacation, it would not stopp all day. I thouhgt it was also a little bit annoying, when I was taking exams. During everone of my midterms, it vibrated a couple of times. On the one hand, it was nice, because it reminded me on calming down but it also stressed me even more, because it was an additional factor that stressed me besides the exam itself. A lot of times it vibrated in situations besides studying, like when I went on a trip on october break. It worried me, since the band vibrated many times during the day and the stress app said my stress level was extrem high. But it said that, even when I layed in bed and just chilled or watched a tv show for an hour. So I could not believe it everytime it vibrated and after two weeks I was not as sensitive to it anymore as I was in the first weeks. I started to ignore it and continued doing what I did. So all in all, it helped me to notify me about stress, but it also notified me,
when the circumstances were intense but in my opinion not really highly-stressful to me, which made it stressful in the end.

The only issues that I encountered were that I had to charge it every other day and it took a while to the high heart rate correct. Once I set the high heart rate to the correct one then I got the notifications when I was actually doing something physical.

I felt that this may benefit from a potentially more accurate reading. If I set the threshold too low it was alerting me all the time, but setting it too high only alerted me when I was somewhat active. The average obviously helped, but still had some other issues.

Only a few times was I sitting still and I realized I was too stressed.

I found that often times I was working out, walking to class, eating, or doing an activity that would naturally raise my heart rate. It took a while for me to adjust the notification level to effectively notify me when I was stressed and not in an active state.

I think heart rate is a great mood indicator

The stress notification keep popping up when I'm walking quite often, hope there's a feature to let user disable the notification when device detected user are moving.

So the device helped me realize when I was straining my body more. I completely agree with that.

However since I was depriving myself of sleep due to try and keep an ok sleep schedule, my hear rate was higher but I wasn't necessarily more stressed. It did help me realize my patterns much more. And it has helped me identify that I need a change in lifestyle a little bit to place less strain on my body.

Although when I was stressed it seemed like it matched up fairly well with about how stressed I felt.

It was very helpful to see my heart rate rising even when I was not thinking about it. Unless I saved an assignment for the last minute, I would take a break every time I noticed it going off a lot. I chose somewhat agree as opposed to strongly just because I had to test my stress level every time it went off, and at a point this got irritating. However, it was still positive because it definitely showed me I was stressed a lot more than I thought I was.

I only somewhat agree with the statement that the device was able to notify me of high-stress effectively. I say this because during any form of physical activity the device would constantly vibrate. This was extremely frustrating to me and would actually stress me out a little more than if I was not wearing the device. But when I was doing schoolwork or going through a normal day and it would notify me, I was able to take steps to reduce my stress.
I really enjoyed using this device. I have significantly changed the way I managed my stress. This device has actually helped me to calm down.

I think the biggest realization is that I need to work more on my cardio fitness. I've yet to find that the phone thinks that I am more than a little stressed. However, this isn't a stressful semester at all in comparison to what I'm used to.
APPENDIX H: THEMATIC ANALYSIS (STEPS TAKEN TO REDUCE STRESS)

(Note: Content highlighted in GREEN signifies positive steps taken by subjects to reduce stress. Contents in YELLOW shows data that provides additional insights. Contents in RED shows sign that the subject didn’t put in the efforts to reduce stress.)

There were moments where I knew why the heart rate alert was going off. Such as exercise, a fast paced walk, or running up the stairs for example. These moments, I usually wouldn’t do anything to reduce my stress as I felt I was notified because of reasons other than stress.

When I got notified during times I didn’t expect to that’s when I would use the stress analyzer app and if it showed as higher stress level I would control my breathing for a little bit to bring my heart rate back down.

When the device went off and I took the stress test and noticed I was at a high stress level, I tried to take a few deep breaths to relax myself and get my heart rate back down and to lower my stress level. If the device went off again in a short amount of time, I took a break from whatever I was working on that was stressing me out. That worked the majority of the time so that the device wouldn’t go off again.

In the first two weeks I tried to take breaks, and to slow down. It helped and I also felt better. When it started to notify me, even though I already laid in bed or woke me up at night, I didn’t take any steps to reduce stress, since it actually made me feel stressed in the first place. I also recognized that sometimes there are just days my heart rate is very high, and everything seems to stress me, especially when I went drinking the night before. After it vibrated several times, I started to ignore it and just accepted the day to not be a good day.

I don’t feel that my heart rate went up due to stress but do to physical exertion and that frequently happened at work.

If I did happen to be sitting still while the stress meter would go off, I would think about what was going on and try to pinpoint if something was stressing me. So it did at least make me stop to think about it from that aspect.

I however never got a stress rating above 20% on the stress check app. So even when it said my heart rate was high never did I have anytime tell me that I was stressed.

When I was notified about stress and I felt there was a cause for me to get stressed I stepped back a little and took a few breaths. There were some times due to a time constraint which I did not step back for a few.
I could have done more to get my heart rate under control. It is high. I am fairly out of shape. I am actually fairly stressed out a lot of the time.

The notification are no always accurate, most time it buzz simply because i'm walking or doing other activity. The band actually works when I'm under a lot of street like during a presentation but it wouldn't notify me when I'm in modest street level like catching a deadline or doing my homework, so it seems the notification didn’t work well to predict my stress level.

I can only reduce my stress by completing the objective I was stressing about. This was not always possible for me to do immediately. I say this because I had to think a couple days ahead and think of how my pattern for activity would be. So I had to plan for the whole week and not just that day in particular.

I tried to reduce stress whenever it went off. However, if it was out of control or having to meet a deadline, I battled through the stress to get what I needed to done.

When I was notified and I was not doing physical activity I took steps to attempt to reduce stress. This was different than in the past because I would normally just de-stress at the end of the day and not throughout it. By reducing stress in small increments I was able to be more effective with the challenges I faced throughout the day.

Knowing what my heart rate is at, has truly helped me to lessen my stress while in school. The device acts a reminder to remain calm and to get up to debrief every once in awhile. Overall, I am very pleased with the device.

Mostly, I just try to control my breathing and clear my mind. I have done a little bit of mindfulness training, so I think I am doing it right. The biggest benefit of the wearable and stress check is that it is a reminder to practice mindfulness.
REFERENCES


