



WELL LIVING LAB RESEARCH: STUDY 4

Detection of acute mental stress in the workplace

If you are a working adult, you likely are part of a staggering statistic: 65% of employees in the U.S. report that their job is a primary source of stress in their lives. It's easy to see why stress is so prevalent, considering today's heavy workloads and long work hours, high-pressure demands and rapidly changing circumstances, deadlines and quotas, job insecurity and layoffs. Stress also is a common reaction when people encounter hostile interactions and pressures or demands that exceed their skills or capacity. Research suggests that the physical environment can also contribute to your workplace stress, especially sound, but also temperature and lighting. It's also easy to see how stress correlates to financial ramifications for employers – research indicates it costs American companies \$300 billion annually from lost productivity, higher absenteeism and medical and insurance expenses for stress-related illnesses.

How is the Well Living Lab attempting to measure stress without subjecting people to intrusive tests?

What's not so easy is to make employees aware of their stress levels, the type of stress they are experiencing and for them to recognize what is causing their stress. What's also not so easy is to find a way to accurately assess stress levels that does not require people to undergo intrusive tests such as saliva tests for cortisol levels, in addition to answering questionnaires. These questions are important to be able to help employees reduce their stress levels. To investigate the feasibility of using a combination of wearable data streams to recognize stress events, the lab recruited 18 volunteers to experience a situation known to elicit acute stress and to compare results from the gold-standard cortisol testing methods with a noninvasive wearable wrist monitor.

TYPES OF STRESS

Eustress

Positive stress that is not overwhelming. It provides a sense of motivation and results in a sense of fulfillment.

Distress

Negative stress that impacts a person's health and well-being, classified at three levels:

- **Acute:** Short term, usually occurring occasionally during everyday life and does not cause long-term harm.
- **Episodic:** Acute stress that occurs more frequently, which can have harmful effects on physical and mental health.
- **Chronic:** Ongoing stress that can negatively affect health such as increasing the risk of heart disease, high blood pressure, depression, weight gain and inability to sleep.

HOW STRESS MANIFESTS

A person's stress response is a dynamic, complex process. When you perceive a threat, your body responds by activating the sympathetic branch of the autonomic nervous system, which prepares the body for action by innervating organs that trigger an arousal. The main effector of this response are the adrenal glands located on the top of the kidneys, which secrete hormones such as adrenaline and cortisol that trigger a series of

physiological changes including an increase in heart rate, respiration rate, perspiration and blood flow through major body organs. Cortisol levels have been used in clinical research to assess the activation of a person's stress response. However, these measurements are intrusive and time consuming. They involve needle-stick blood samples or mouth scraping saliva swabs using clinical lab procedures for testing and analysis.

THE STUDY

For this pilot study, we followed the Trier Social Stress Test (TSST), psychological stress protocol used to reliably induce stress. The Well Living Lab was converted into a reception area and a conference room. Lab personnel explained to the volunteers they would go into the conference room for a simulated job interview. In the room, the interviewees were first asked to spend five minutes preparing their talking points. Then they were asked to stand in front of a microphone for five minutes, speaking continuously and explaining why they should be offered the job. A video camera was aimed at them and two interviewers listened and gave no verbal or facial encouragement to the interviewee. Next, they were asked to count backwards from 1,022 in increments of 13. If they made a mistake, one of the interviewers would tell them to start over. The math test lasted five minutes. Afterwards, each interviewee walked back to the reception area and was told to rest and relax. Each remained in this area for 60 minutes to recuperate and debrief.

RESULTS

The lab used traditional saliva tests (gold standard), self-assessments and a wearable biometric device to assess stress. The saliva tests showed highest levels of cortisol occurred after the job interview, during the first resting period, which is consistent with previous findings in research literature. That's because there is a short lag time between a stress event and actual changes in cortisol levels. The stress self-assessment showed the highest stress levels both during and immediately after the job interview. The skin conductance data collected using a wearable device showed results similar to the salivary cortisol and self-ratings of stress. These results indicate that wearable data streams such as electrodermal activity could be used for detecting the presence of acute stress events. However, more research needs to be done to achieve a more precise characterization of biometric outputs that reflect autonomic nervous system activity.

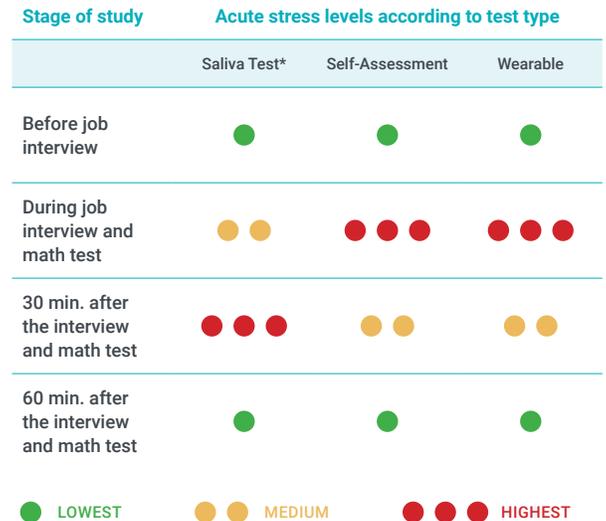
SUMMARY

This is a first step toward investigating the feasibility of using wearable data streams such as electrodermal activity and heart rate to identify different levels of mental stress non-invasively at the Well Living Lab. Future studies will explore the discrimination potential of combining heart rate, heart rate variability and electrodermal activity features from wearables and other physiological sensors under conditions of work stress to determine stress levels sustained by office workers.

Saliva Test: Measures cortisol levels

Self-Assessment: Measures perceptions of stress levels

Wearable wrist monitor: Measures skin conductivity and heart rate changes in response to acute stress



**Note: Cortisol peaks 15 minutes after a stress event, thus the saliva test shows higher results.*



ABOUT THE WELL LIVING LAB

The Well Living Lab, a collaboration of Delos™ and Mayo Clinic, is dedicated to identifying how indoor environments impact human health and well-being. It conducts scientific research with human subjects in a simulated real-world environment and shares practical findings that can be applied to improving indoor spaces where most people spent approximately 90 percent of their time. The lab has 5,500 square-feet of sensor rich, reconfigurable space in downtown Rochester, Minnesota.

Learn more at WellLivingLab.com