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A Pilot Study in Healthcare: Salivary Cortisol Levels and Burnout

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KEYWORDS

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ABSTRACT

This pilot study investigated levels of burnout in non-clinical workers in a healthcare setting and compared them to salivary cortisol concentrations. Mashlach's Burnout Inventory-Human Service Survey for Medical Personnel (MBI-HSS(MP)) was used to evaluate self-perceived levels of burnout. Saliva samples were collected to measure cortisol concentrations at four times during participants' shift. The study included subjects exposed to multiple high-stress factors such as working in a healthcare setting in post-COVID-19 conditions at a major medical center in Southwest Montana. The results revealed a significant correlation ($P\text{-value} < 0.05$) between morning salivary cortisol secretion concentrations and mean survey scores. Significant differences were also found between the three dimensions measured by the MBI-HSS(MP): burnout, depersonalization, and personal achievement, $p\text{-value} < 0.05$. The pilot study has several limitations that should be considered when interpreting results. Findings do suggest that future investigation among this group is warranted. Results may help guide interventions that support the mental health and wellbeing of medical support personnel, reduce stress, and avoid burnout.

1. INTRODUCTION

Stress and burnout are rampant in healthcare. The pandemic created the perfect storm that exacerbated levels of stress among all types of healthcare workers (Shanafelt et al., 2022; Westcar-Gray et al., 2023). Research has revealed that burnout levels in healthcare workers are some of the highest compared to other high-stress industries as a result of the pandemic. In a study comparing the incidents of burnout in physicians and a control population, burnout was present in 37.9% of physicians compared to 27.8% of the control population (Shanafelt et al., 2012). In 2020, the Medscape National Physician Burnout and Suicide Report determined a burnout rate of 43% among physicians (Kane, 2020). Another study, completed by the National Environmental Health Association (2020) investigated stress levels among public health workers and found 74% reported feeling emotionally exhausted and 54% felt burnout. A more recent study in Montana found that 84% of MT environmental health professionals/sanitarians reported feeling moderately or severely stressed

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(Westcar-Gray et al., 2023). In a national study that included 104 organizations and received a robust 20,947 responses that indicated 38% had anxiety or depression, 43% experienced work overload, and 49% reported feeling burnout (Prasad, 2021). Internationally, researchers investigated 1,091 adults in 41 countries using the Perceived Stress Level (PSS-10). The researchers found 76% reported increased worry due to the pandemic (Limcaoco et al., 2020). Investigators reported stress levels at 19.1 on the scale of 0 – 40 indicating moderate stress due to perceived susceptibility to COVID-19. They also found women had higher levels of stress compared to men at 18.3 and 15.6 respectively and the highest levels were among the younger age group less than 30 years and students at 20.4 and 20.7 respectively (Limcaoco et al., 2020).

There is no single-use definition of burnout, but rather it is defined as a multifactor cause and effect (Maslach and Jackson, 1981). Christina Maslach, Ph.D., psychologist, and Susan E. Jackson were the creators of Maslach's burnout inventory, a commonly used psychological assessment tool for occupational burnout in healthcare (Maslach and Jackson, 1981). The survey classifies burnout in three dimensions of mental health: burnout, depersonalization, and level of personal accomplishment (Maslach and Jackson, 1981). Healthcare employees have the potential to experience one or more symptoms due to burnout including exhaustion, emotional distress, feeling negatively toward the job, depression, reduced job performance, medical error, and other severe ailments (Brennan et al., 2019). The symptoms can be triggered by one or more factors including, but not limited to, unmanageable workloads, overloaded schedules, long hours, lack of support from management, high-stress environments, intense psychological demands, negative nurse-physician relationship, and inadequate staffing (Dall'Ora, Ball, Reinius and Griffiths, 2020).

2. BACKGROUND

2.1 Function of Cortisol in the Body and its Role in Stress Research

Cortisol is a biomarker in stress research because it is associated with the release of glucose for the sympathetic nervous system's fight or flight response (Mayo Clinic, 2023). Cortisol is a hormone that is naturally secreted by the hypothalamus pituitary axis (HPA-axis) in the body. The hormone functions as a messenger to the rest of the body to facilitate the fight or flight responses (see Figure 1).

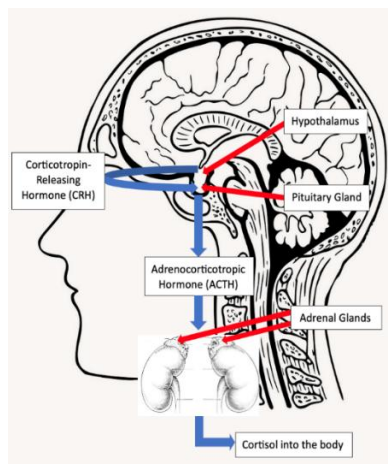


Figure 1. Cortisol Production in the Body

The hypothalamus secretes corticotropin-releasing hormone (CRH), which is sent back to the pituitary gland. Then, the pituitary gland secretes adrenocorticotrophic hormone (ACTH) to the adrenal glands, which signals cortisol to disperse to many organs in the body (Thau et al., 2022). Some organ systems that have respond to cortisol secretion include the nervous, immune, cardiovascular, respiratory, reproductive, musculoskeletal, and integumentary systems (Thau et al., 2022).

The hormone, cortisol, is associated with several human functions and responses and is most commonly referred to as the psychological stress hormone (Cleveland Clinic, 2021). Cortisol is the most abundant endogenous glucocorticoid; these are essential immune responses, but an excess or shortage of secretion can be problematic (McEwen, 2019). Additionally, health impacts can arise even with normal levels of secretion of glucocorticoid, receptors may respond inadequately to the glucocorticoid signals. An impaired glucocorticoid receptor can be a consequence of reduced binding affinity, nuclear translocation, or other dysfunctional transcription interactions (Silverman and Sternberg, 2012).

The disfunction of HPA-axis responsiveness has been linked to many inflammatory responses and illnesses such as Crohn's disease, irritable bowel syndrome, chronic fatigue syndrome, rheumatoid arthritis, colitis, and other auto-immune disorders (Silverman and Sternberg, 2012). Excess cortisol production is seen in Cushing's syndrome, which causes adverse responses such as high blood pressure, weight gain, redness in the face, excess hair growth, and other negative effects (Mayo Clinic, 2023). Regular levels of secretion allow the body to regulate circadian rhythm, the body's use of macronutrients, blood pressure, blood sugar, and energy levels (Johnson et al., 2022). Levels can become irregular or fluctuate greatly in response to several endogenous and exogenous factors including sleep, exercise, stress, medications, and others (Cleveland Clinic, 2021). Cortisol secretion has high temporal variability; levels are typically high in the morning and low in the evening (Thau et al., 2022).

Hypercortisolism is a result of excessive tissue exposure to cortisol, which leading to Cushing's syndrome if it is sustained (Mayo Clinic, 2023). Hypocortisolism is the opposite effect; it is a deficiency in either the secretion from the HPA-axis or binding at the receptor (Kakiashvili, Leszek and Rutkowski, 2013). The hyper state occurs approximately 6.21/100,000 (Hakami, Ahmed and Karavitaki, 2021). Whereas Addison's disease is more frequent with a rate of 22.1/1000 (Olafsson and Sigurjonsdottir, 2016). A study published in the Medical Perspective on Burnout showed that acute stress causes high cortisol levels- hypercortisolism- in the blood but decline during chronic stress- hypocortisolism (Kakiashvili, Leszek and Rutkowski, 2013). Another study published by The Physiological Society of Japan and Springer yielded results displaying temporal changes in salivary cortisol levels can indicate work-related stress and recovery, even when diurnal variation and gender differences were accounted for (Nakajima et al., 2012). This study, among others, validate the use of cortisol as a biomarker for stress, as well as acute and chronic stress exposure's respective effects on high cortisol levels.

There are multiple factors affecting HPA-axis dysfunction and a difference in irregularity with secretion vs. the glucocorticoid receptors. Despite these factors, the literature reveals a strong link between psychological stress and its respective negative physiological responses in the body (Maslach and Jackson, 1981). Burnout is not the same as just feeling stressed in the moment, but due to the characteristic presence of chronic stress. This research aims to investigate the relationship of psychological distress and burnout to cortisol levels. The presence of high levels of burnout creates a priority need for further research for assessment, management, and mitigation.

2.2 Maslach's Burnout Inventory – Human Service Survey for Medical Personnel

Maslach's Burnout Inventory – Human Service Survey for Medical Personnel (MBI-HSS(MP)) is a 22-question survey designed to evaluate levels of burnout, specifically for individuals working in healthcare. The questions seek to identify and classify a worker's level of burnout through analysis of three dimensions: emotional exhaustion, depersonalization, and personal accomplishment. There are seven response options: 1) never, 2) a few times a year or less, 3) once a month or less, 4) a few times a month, 5) once a week, 6) a few times a week, 7) every day (Maslach and Jackson, 1981).

The survey was designed by Christina Maslach and Susan E. Jackson in 1981 and has been considered a well-researched assessment since its creation (Maslach and Jackson, 1981). In a study completed and published by Cell Press, MBI-HSS(MP) with 282 participants in healthcare during their shift (Pereira et al., 2021). The results were associated with factors commonly recognized for effecting stress levels, such as marital status, weekly workload, sleep duration, drug usage, alcohol consumption, and several others. The comparison between MBI-HSS(MP) and the sociodemographic factors yielded results that confirmed the theoretical model of three dimensions of burnout that make up the structure of MBI-HSS(MP). The study displayed adequate internal consistency for health professionals and similar studies in other countries indicate the same, meaning it maintains validity across cultures (Pereira et al., 2021).

2.3 Study Location and Sample Population

This pilot study was performed at a healthcare facility in Southwest MT. The need to study burnout in Montana is paramount because of the incidence of a more distressed population. In America's Health Rankings from the United Health Foundation, 22.8% of MT adults have reported a diagnosis of depression. This rate is just under 5% less than the state with the highest rates and only sixteen states have higher reported rates (America's Health Rankings, 2023). In the National Vital Statistics Report for 2020, Montana was reported as having the third-highest suicide rate in the United States (Aria et al., 2022). Additionally, it has been ranked in the top five for the last thirty years for suicide rates. Montana has been identified as being at risk for suicide because of multifactor depressive effects. Some factors that may be affecting the rates are vitamin D deficiencies, alcohol consumption as a coping strategy, high altitudes, social isolation, lack of behavioral health services, and several others (Montana Health Alert Network, 2023).

This pilot study was unique due to its location and the healthcare population sampled. Participants did not include physicians or nurses, but support personnel working in the healthcare facility such as administrative workers, construction workers, managers, directors, and supervisors.

3. OBJECTIVES

The main objective of the study was to investigate the relationship between the MBI-HSS(MP) findings and measured cortisol levels.

The specific aims were:

- to assess burnout using the MBI-HSS(MP) survey among this healthcare population.
- to assess cortisol levels using four salivary samples obtained in one day among the same population, and

- to evaluate the relationship between salivary cortisol concentrations and perceived burnout in a healthcare setting.

4. METHODS

4.1 Human Research Approval, Informed Consent, and Privacy

The study protocol was approved by the University Institutional Review Board (IRB). The study population was a group of healthcare workers from a variety of specific jobs at a local healthcare facility. All study subjects were adults employed by the center. Participation was voluntary. Subjects were recruited through a facility manager who emailed an invitation to workers. An informed consent was distributed to all study participants. This included a description of the study expectations, risks of discomfort, benefits to the participants, measures for confidentiality, and participant rights. All participants were required to sign the informed consent form before they could participate in any part of the study. Names were used to match the survey results to the salivary cortisol samples. All personal identifying information was protected and remained within the research team. All information was stored on a password-protected computer in a locked office.

4.2 Verisana Salivary Cortisol Sampling Kits

The team collected salivary cortisol sampling using the Verisana Salivary Cortisol Sampling Kits throughout the workday on four occasions (see Figure 2). The four salivary samples were representative of real-time fluctuations in the HPA-Axis activity (see Figure 3). The salivary samples were obtained at the start of the work shift, two hours, four hours, and eight hours. Each kit contained four vials to collect the saliva at the designated times. Eighteen subjects were asked to spit into the plastic vials, seal them, and return them to the site coordinator who then returned them to the researchers at the university. Samples from all twenty participants were sent to a CLIA-certified lab for analysis. The lab used reverse-transcription polymerase chain reaction (RT-PCR) assay to detect cortisol concentrations (Ayumetrix, 2023).



Figure 2: Salivary Cortisol Sampling Test Kits



Figure 3. Test tubes for saliva from Salivary Cortisol Sampling Test Kits

4.3 Survey Completion

The MBI-HSS(MP) is a 22-question survey with an anticipated completion time of about 20 minutes. All twenty participants completed the survey at the start of the shift at the same time their first cortisol sample was obtained. The completed survey was returned to the site coordinator and returned to the university. The survey was matched to the cortisol kit and all personal identifiers were removed.

Because the participants were support personnel working in non-clinical settings, seven of the 22 questions specific to clinical setting employees were removed. Additionally, to analyze data, the answers were tied to a score 1-7 where 1=positive outcome and 7=negative outcome. Because of the wording of the questions, some positive outcomes would be associated with the “never” response and others would be negatively associated with the “never” response. Essentially, the range for responses was consistently seven possibilities but flipped for certain questions so the higher score was always related to the negative outcome and the lower scores to the positive outcome.

4.4 Data Analysis

Both the MBI-HSS(MP) scores and cortisol concentrations were entered into excel and sorted for analysis. Then, the research team used Spearman’s Correlation on Minitab to conclude if the correlation between mean survey scores and cortisol concentrations were statistically significance ($p \leq 0.05$). A Games Howell one-way analysis of variance (ANOVA) was conducted for the difference of mean survey scores for each of the three survey dimensions. Finally, linear regression models were created for the association between cortisol concentration at each of the four times and mean survey scores. Each graph displays an equation for the linear regression and an R^2 value, which helped the research team understand the percent variation of mean survey score that is explained by the variation of cortisol concentrations.

5. RESULTS

A total of eighteen salivary cortisol kits were received by the research team and sent to the lab for analysis. Of those eighteen, only eight of them were completed correctly and able to be analyzed. The survey was filled out by seventeen participants, eight of which also had salivary cortisol data. Of those that filled out the survey, 47.1% were men and 52.9% were women. Of the salivary samples that were able to be analyzed by the lab, one participant was male and the rest were female.

Figure 4 displays the difference in mean survey scores for each survey dimension (burnout, depersonalization, and personal achievement). The depersonalization dimension yielded the highest mean score [3.838(3.327, 4.350) and $\sigma=2.113$]. The burnout dimension had the second-highest mean score [3.496(3.151, 3.841) and $\sigma=1.899$]. The personal achievement dimension yielded the lowest mean score [2.706(2.309, 3.103) and $\sigma=1.640$]. The ANOVA used Welch's test first, with null hypothesis (H_0): All group means are equal and alternative hypothesis (H_A): At least one group mean is different from the rest. The Welch's Test revealed $p=0.001$, therefore, the research team was able to reject the null hypothesis for mean survey scores of each dimension. Finally, the ANOVA displayed a statistically significant difference between personal achievement and burnout, as well as personal achievement and depersonalization with values $p=0.009$ and $p=0.002$ respectively.

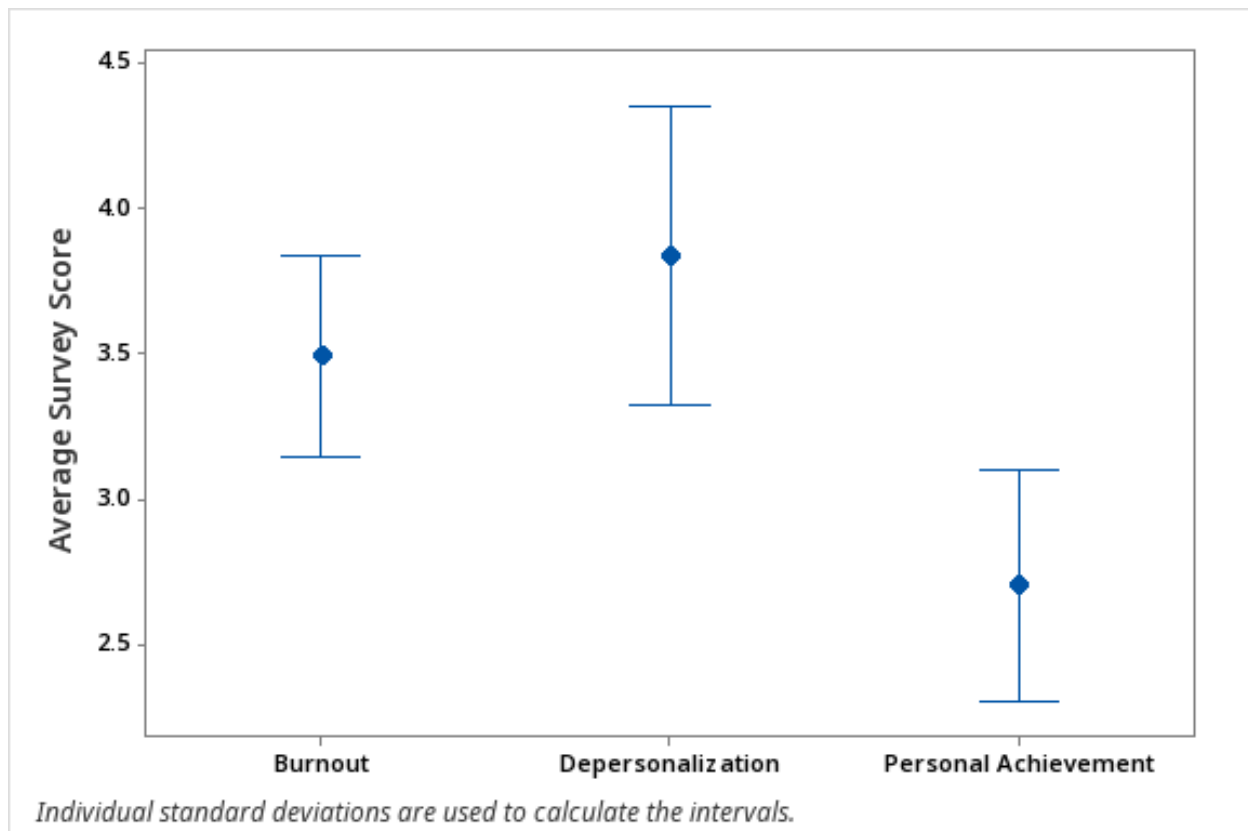


Figure 4. Difference in mean survey scores for each survey dimension from ANOVA

Figure 5 displays the low, medium and high scores of each of the three survey dimensions. The low score category includes responses never and once a year or less, which is associated with numbers one and two. The moderate score category includes responses once a month, a few times per month, and once a week, which is associated with numbers three, four, and five. The high score category included responses a few times a week and every day, which is associated with numbers six and seven. For burnout, scores were 38.7% low, 38.7% moderate, and 22.6% high. For depersonalization, scores were 36.8% low, 32.3% moderate, and 30.9% high. For sense of personal achievement, scores were 55.9% low, 36.8% moderate, and 7.3% high.

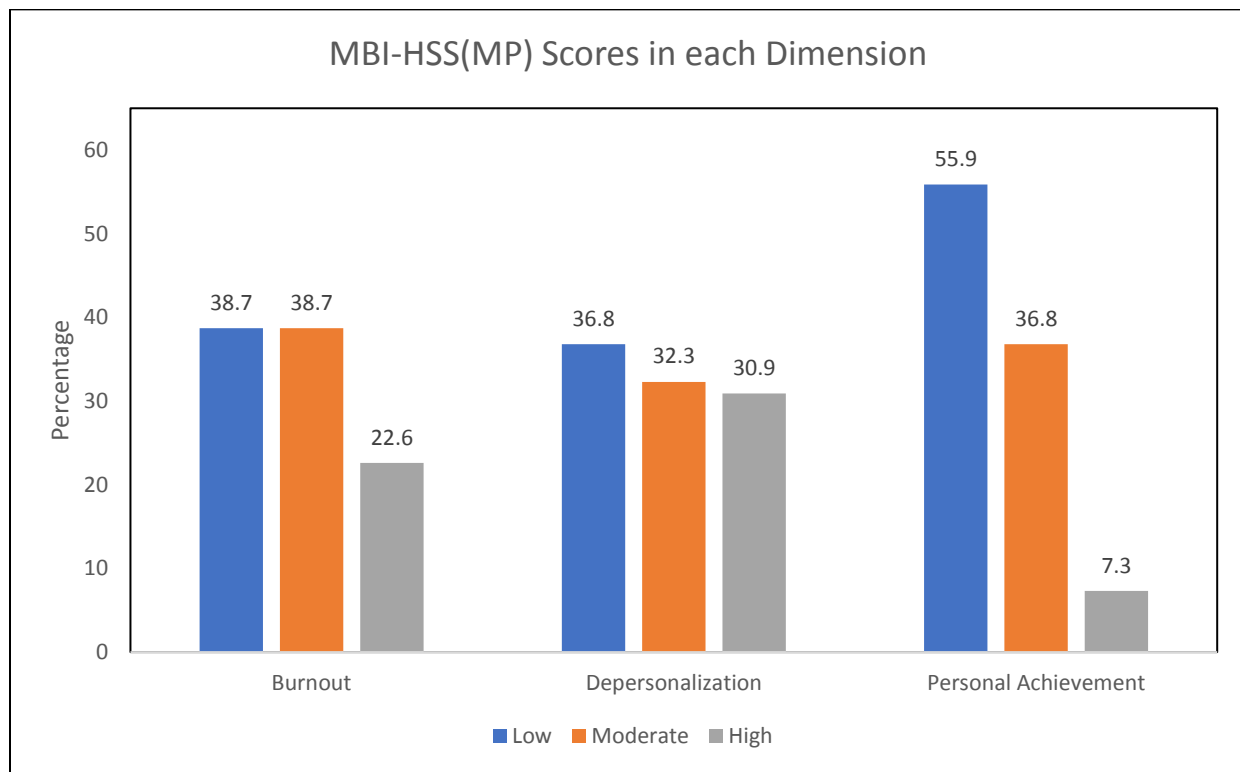


Figure 5. MBI-HSS(MP) low, medium, and high scores for each of the three survey dimensions.

The eight cortisol concentrations that were analyzed for all four times of collection were compared with each respondent's mean survey score. Of that group of eight, three scored in the low range as specified previously (\bar{X} =1.73, 1.8, and 1.93). The other five scored in the moderate range as specified previously (\bar{X} =2.53, 3.87, 4.27, 4.93, and 5.07).

For each time cortisol concentrations were gathered, there are reference ranges that are considered normal concentration ranges reported by Verisana (see Table 1). Of 32 concentrations (four collection times for eight participants), seven (20.6%) landed outside and above the reported reference ranges. Reference ranges from Verisana are detailed below.

Table 1. Reference ranges of cortisol concentrations for collection times as specified by Verisana

Reference Ranges	Start of Shift	2 hours	4 hours	8 hours
	1.5-9.6 ng/mL	0.6-4.1 ng/mL	0.2-2.3 ng/mL	0.1-1.8 ng/mL

Descriptive statistics were found for each cortisol concentration time: start of shift [3.45 (0, 9) and σ =2.78], two hours [2.15 (0, 4.81) and σ =1.33], four hours [1.39 (0, 3.106) and σ =0.858], and eight hours [1.36 (0, 2.42) and σ =1.06].

Figure 6 shows the mean survey scores compared with each of the four salivary cortisol collection times for eight participants. Each data set is displayed with an equation for its linear regression, as well as an R^2 value to show the variation in cortisol concentrations explained by the variation of mean survey scores. The start of shift concentrations and mean survey scores yielded R^2 =0.7352, which

showed a high strength of association between the two variables. The correlation was further analyzed with a Pairwise Spearman Correlation test on Minitab. This confirmed the strength of association with a $p=0.001$, meaning the correlation was statistically significant between the two variables. The rest of the data was not strongly correlated with $R^2=0.2167$ and $p=0.471$ for two-hour concentrations, $R^2=0.1363$ and $p=0.844$ for four-hour concentrations, and $R^2=0.1268$ and $p=0.649$ for eight-hour concentrations.

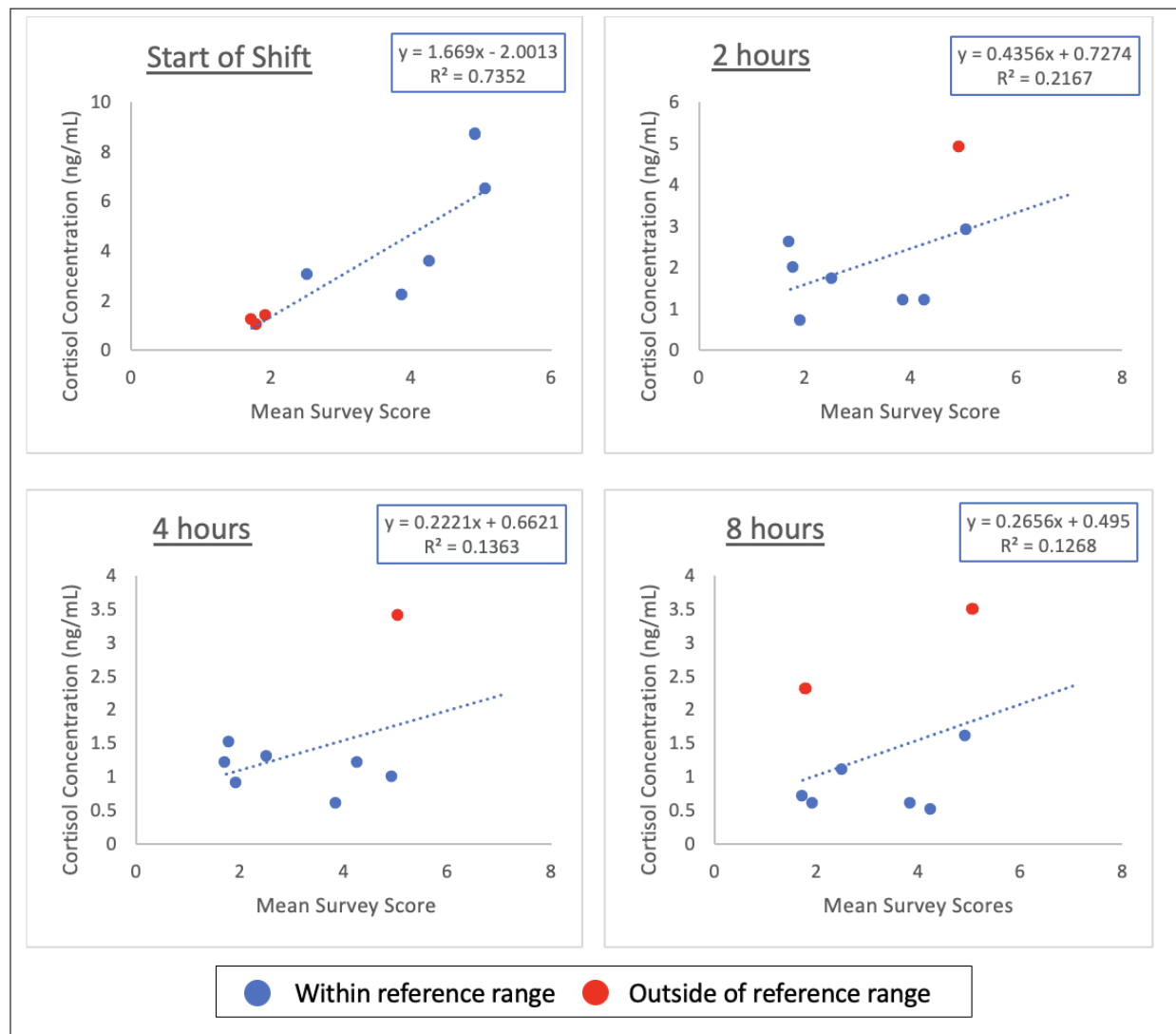


Figure 6. Mean survey scores compared with concentrations at all four times of saliva collection.

6. DISCUSSION

Understanding burnout and the effect it has on the workforce psychologically and physiologically is of high and continually increasing importance. This pilot study was designed to investigate non-clinical healthcare workers in particular and found evidence of burnout, mental and emotional stress, and elevated cortisol levels among the population studied. In a study by Ashill and Rod (2011) who examined burnout in 152 non-clinical personnel in a healthcare setting also found significantly higher scores using the MBI-HSS(MP). The investigators concluded that role ambiguity, role conflict, role

overload, and interpersonal conflict explained variance in emotional exhaustion and depersonalization, $R^2 = .42$ and $R^2 = .46$ respectively. Pindar et al. (2012) also found burnout in 117 non-clinical personnel with 36.6% reporting emotional exhaustion and 48.4% reporting personalization. The researchers concluded that there was a 72% greater possibility for non-clinical personnel chance to develop burnout. Okuda and colleagues (2019) studied 188 non-medical personnel and found burnout using the MBI-HSS(MP). The team found elevated scores for emotional exhaustion and depersonalization and higher scores for personal accomplishment. Studying the non-clinical workforce in clinical healthcare settings may generate more helpful information for assessment and treatment solutions. This pilot study was comprised of a small sample and has other limitations, therefore conclusions and inferences must be made cautiously.

This pilot study revealed a statistically significant correlation between participants' morning cortisol secretion and mean MBI-HSS(MP) scores. Based on this significance, morning cortisol concentrations may be the most accurate gauge of physiological stress or burnout. This is most likely due to a lack of acute stimulators a person has consumed at this point of the day. Some acute stimulators that can raise levels throughout the day include nicotine, caffeine, alcohol, and dietary energy supplies or lack of sleep (Kudielka, Hellhammer, and Wust, 2009). The lack of significant correlation between survey scores and cortisol concentrations at other times of the day may be due to the consumption of one or multiple acute stimulators. They also may be correlated because the survey was completed at the same time the first salivary sample was given.

Additionally, statistical significance was demonstrated between the survey dimensions of personal achievement and burnout, as well as personal achievement and depersonalization. Based on the data, sense of accomplishment and enjoyment from working with people was high among the majority of participants. Literature indicates that chronic emotional exhaustion leads to burnout, which can greatly reduce one's feelings of personal accomplishment (Pehlivanoglu and Civelek, 2019). The high levels of feelings of personal accomplishment found in this study may be due to feeling burnt out only in the short term. Okuda et al (2019) found higher scores in personal accomplishment compared to scores for emotional exhaustion. These feelings may also be credited to such a high level of enjoyment from working with people. In all the responses collected, all questions had at least one or more participants experienced it daily except, except for one: high strain from working with people.

The results of this pilot study are consistent with several similar published studies (Okuda, et al., 2019; Oosterholt et al., 2015; Wang 2020). In a study published by BMC Health Services Research, their results weighed similarly among the three survey dimensions, with higher levels of depersonalization and low levels of lacking feelings of personal achievement (Wang, 2020). The study also found that factors such as age, gender, and occupation had statistically significant effect on burnout and depersonalization. It was also found that marital status had a statistically significant effect on personal achievement (Wang, 2020). Due to these confounders, future studies should consider including an additional questionnaire that accounts for these factors.

Another similar study completed in a palliative care facility and published by Cambridge University Press also displayed agreement with the results of this pilot study. There was a significant difference in cortisol secretion between what they determined as burnout and non-burnout groups. They also discovered a high feeling of personal achievement at 69.9% compared to the 55.9% found in this pilot study (Fernández-Sánchez et al., 2018). Oosterholt and colleagues (2015) examined both clinical and non-clinical personnel and found greater burnout among the clinical personnel and less decline in cortisol levels throughout the day among the non-clinical personnel.

7. LIMITATIONS

Cortisol secretion is a multifactor effect in the human body, meaning levels can be highly variable based on many factors, and the MBI-HSS(MP) survey does not address many of these potential variables that can influence cortisol secretion. Adrenal dysfunction can also vary from proximal or distal factors. Some factors that may affect levels are sleep, diet, exercise level, and medications, as well as several others, and future studies should consider the potential effect of these variables. The factors were not evaluated as covariates.

Additionally, participants were not recruited through a randomized process, making it a convenience sample that may not represent the average healthcare worker. The sample size was small and may be insufficient to make inferences associated with the larger population of non-clinical healthcare workers. The lab analysis reported an error of one percent for the cortisol concentrations. The surveys are self-reported and subject to recall and response bias. Additionally, the sample of MT workers may be different from the general population and prevents generalizing.

Potential Treatments for Burnout

In addition to a lack of methods for assessing burnout, effective treatment for burnout is also unresolved. Treatment is highly dependent the individual and on potentially multiple factors, which makes treatment somewhat of a difficult challenge and is generally managed on a case-by-case basis. However, with sufficient evidence about the prevalence and increasing incidence of burnout, there exists a need to identify evidence-based effective treatments and delivery methods.

There is evidence in the literature and in this pilot study that feelings of personal accomplishment remain high (Okuda et al, 2020). Continuing to create work environments with a high sense of purpose and achievement may limit increased feelings of burnout. Practices such as frequent recognition of contributions or rewarding great work may help maintain and even further improve the workforce's sense of personal achievement. For the dimensions with lower levels, of burnout and depersonalization, some guidance for wellbeing may be helpful for improvement. The National Institute for Occupational Safety and Health (NIOSH) has recently created guidance for total worker health (CDC, 2023). TWH extends consideration beyond safety and health to safety, health, and wellbeing. NIOSH displays a hierarchy of controls of effective strategies specifically for improving worker well-being. NIOSH's guidance for TWH also includes a worker-wellbeing questionnaire for assessment, as well as an example of a Healthy Work Design and Well-Being Program (CDC, 2022).

In terms of medical treatment, some clinicians have treated patients experiencing hypocortisolism with low doses of cortisol. Trials of different drugs, as well as marijuana for medicinal use, have also displayed positive effects on regulating the HPA-Axis (Kakiashvili, Leszek and Rutkowski, 2013). It has also been suggested that certain dietary supplementation would be helpful in cases where HPA-Axis dysfunction is the result of an insufficiency (Kakiashvili, Leszek and Rutkowski, 2013).

8. CONCLUSIONS

Although there is no doubt that burnout frequently affects workers in healthcare settings, both clinical and non-clinical personnel, addressing the issue remains challenging. The multivariable effects of cortisol secretion and its high temporal variability make cortisol secretion measurements limited but useful for assessing burnout when paired with inventory tools such as MBI-HSS(MP). The literature

has indicated that chronic and acute stress may have opposite effects from each other on cortisol secretion (Kakiashvili, Leszek and Rutkowski, 2013). However, cortisol or other biomarkers should continue to be studied, as it still appears there is a correlation between cortisol concentration and perceived stress or burnout.

Finally, further research should be conducted on other assessment methods, as well as existing and proposed treatment methods. One method or a combination of several may be effective for assessing and/or treating burnout.

DECLARATIONS

Conflicts of Interest

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

Author's Contributions

Hannah Oggerino was the graduate student who conceived the project and worked in all phases of the study and manuscript preparation. Ms. Oggerino defended her work and graduated and now is recognized as a Graduate Safety Professional (GSP) and practicing Industrial Hygienist. Hannah earned her bachelor's degree in Occupational Safety and Health and her master's in IH, both at Montana Tech University. Dr. Autenrieth is an Associate professor and Co-Major Advisor who provided statistical guidance and review for this manuscript. Dr. Autenrieth was involved in all phases of the study. Dr. Berrington is an Assistant Professor in the Chemistry Department who inspired Hannah to select the topic and provided a review for the manuscript. Dr. Gilkey was the Co-Major Advisor who worked with Hannah through all phases of the project.

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REFERENCES

- America's Health Rankings. Depression in the United States. Retrieved on 12/5/2023. https://www.americashealthrankings.org/explore/measures/Depression_a
- Arias, E., Xu, J., Tejada-Vera, B., Murphy, S. and Bastin, B. (2022). U.S. State Life Table 2020. National Vital Statistics Report, Vol 71, No 2, p 1-18.
- Ashill, N. J., & Rod, M. (2011). Burnout processes in non-clinical health service encounters. *Journal of Business Research*, 64(10), 1116-1127.
- Ayumetrix.Com. (2023). Frequently asked questions, Saliva. Accessed 30 Nov. 2023. ayumetrix.com/faq/?_gl=1%2A1ngcl4r%2A_ga%2AMTcwMjkzMTUzNy4xNzAxMzgxNTAz%2A_ga_GMJSHHJH2Y%2AMTcwMTM4MTUwMy4xLjEuMTcwMTM4MTU4My4wLjAuMA..&_ga=2.146287412.1086325852.1701381503-1702931537.1701381503.
- Brennan, J., McGrady, A., Tripi, J., Sahai, A., Frame, M., Stolting, A., & Riese, A. (2019). Effects of a resiliency program on burnout and resiliency in family medicine residents. *The International Journal of Psychiatry in Medicine*, 54(4-5), 327-335.

- CDC/NIOSH. (2022) Health work design and well-being program. Retrieved on 12/5/2023. <https://www.cdc.gov/niosh/programs/hwd/default.html>
- CDC/NIOSH. (2023). NIOSH total worker health program. Retrieved on 12/5/2023. <https://www.cdc.gov/niosh/twh/default.html>
- Dall'Ora, C., Ball, J., Reinius, M., & Griffiths, P. (2020). Burnout in nursing: a theoretical review. *Human resources for health*, 18, 1-17.
- Kudielka, B. M., Hellhammer, D. H., & Wüst, S. (2009). Why do we respond so differently? Reviewing determinants of human salivary cortisol responses to challenge. *Psychoneuroendocrinology*, 34(1), 2-18.
- Chaudhry HS, Singh G. Cushing Syndrome. [Updated 2023 Jun 26]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK470218/>
- Cleveland Clinic Medical. (2023). "Cortisol: What It Is, Function, Symptoms & Levels." Cleveland Clinic, my.clevelandclinic.org/health/articles/22187-cortisol. Accessed 5 Nov. 2023.
- Fernández-Sánchez, J., Pérez-Mármol, J., Blásquez, A., Santos-Ruiz, A., & Peralta-Ramírez, M. (2018). Association between burnout and cortisol secretion, perceived stress, and psychopathology in palliative care unit health professionals. *Palliative & Supportive Care*, 16(3), 286-297. doi:10.1017/S1478951517000244
- Hakami, O. A., Ahmed, S., & Karavitaki, N. (2021). Epidemiology and mortality of Cushing's syndrome. *Best Practice & Research Clinical Endocrinology & Metabolism*, 35(1), 101521.
- Johnson, V. R., Washington, T. B., Chhabria, S., Wang, E. H. C., Czepliel, K., Reyes, K. J. C., & Stanford, F. C. (2022). Food as medicine for obesity treatment and management. *Clinical Therapeutics*, 44(5), 671-681.
- Kakiashvili, T., Leszek, J. & Rutkowski, K. (2013). The medical perspective on burnout. *IJOMEH* 26, 401-412. <https://doi.org/10.2478/s13382-013-0093-3>
- Kane, L. Medscape national physician burnout and suicide report 2020: the generational divide. Medscape. January 15, 2020.
- Limcaoco, R. S. G., Mateos, E. M., Fernández, J. M., & Roncero, C. (2020). Anxiety, worry and perceived stress in the world due to the COVID-19 pandemic, March 2020. Preliminary results. *MedRxiv*. <https://www.medrxiv.org/content/10.1101/2020.04.03.20043992v1>
- McEwen, B. S. (2019). What is the confusion with cortisol?. *Chronic Stress*, 3, 2470547019833647.
- Maslach, C., & Jackson, S. E. (1981). The measurement of experienced burnout. *Journal of organizational behavior*, 2(2), 99-113.
- Mayo Clinic. (2023). Chronic stress puts your health at risk. Retrieved 12/5/2023. <https://www.mayoclinic.org/healthy-lifestyle/stress-management/in-depth/stress/art-20046037>
- Montana Health Alert Network. (2023). Mental health status and chronic conditions among Montana adults, 2018. Retrieved on 12/5/2023. <https://www.google.com/url?client=internal-element-cse&cx=013380590290877010950:cml775tndfu&q=https://dphhs.mt.gov/assets/publichealth/BRFSS/Factors/BrfssMhChronic2018.pdf&sa=U&ved=2ahUKEwj8qPzmnPmCAxU-MEQIHbISdcEQFnoECACQAQ&usg=AOvVaw2jb2TQurX6tUTeu6QEHG2R>
- Nakajima Y, Takahashi T, Shetty V, Yamaguchi M. Patterns of salivary cortisol levels can manifest work stress in emergency care providers. *J Physiol Sci*. 2012 May;62(3):191-7. doi: 10.1007/s12576-012-0197-8. Epub 2012 Feb 19. PMID: 22350686; PMCID: PMC5111549.
- National Environmental Health Association (NEHA). (2020, October). COVID 19 environmental health workforce needs assessment II report. https://www.neha.org/sites/default/files/flipping_book/neha-covid-19-eh-workforce-needs-assessment-ii-report/
- Okuda, Y., Iwasaki, S., Deguchi, Y., Nitta, T., Mitake, T., Sakaguchi, A., ... & Inoue, K. (2020). Burnout and occupational stressors among non-medical occupational health staff. *Occupational Medicine*, 70(1), 45-51.
- Olafsson, A. S., & Sigurjonsdottir, H. A. (2016). Increasing prevalence of Addison disease: results from a nationwide study. *Endocrine Practice*, 22(1), 30-35.
- Oosterholt, B. G., Maes, J. H., Van der Linden, D., Verbraak, M. J., & Kompier, M. A. (2015). Burnout and cortisol: evidence for a lower cortisol awakening response in both clinical and non-clinical burnout. *Journal of psychosomatic research*, 78(5), 445-451.
- Pehlivanoglu, M. Ç., & Civelek, M. E. (2019). The effects of emotional exhaustion and depersonalization on personal accomplishment in pharmaceutical industry. *OPUS International Journal of Society Researches*, 11(18), 2071-2086.

- Pereira, S. D. S., Fornés-Vives, J., Preto, V. A., Pereira Junior, G. A. P., Juruena, M. F., & Cardoso, L. (2021). Intervening variables of burnout in health professionals of emergency services. *Texto & Contexto-Enfermagem*, 30.
- Physiology, Cortisol - Statpearls - NCBI Bookshelf, www.ncbi.nlm.nih.gov/books/NBK538239/. Accessed 6 Nov. 2023.
- Pindar, S. K., Coker, A. O., Wakil, M. A., Morakinyo, O., & Coker, A. O. (2012). Comparison of burnout syndrome among clinical and non-clinical staff of two tertiary health institutions in Maiduguri, Nigeria. *Transnatl J Sci Technol*, 2(11), 58-73.
- Prasad, K., McLoughlin, C., Stillman, M., Poplau, S., Goelz, E., Taylor, S., ... & Sinsky, C. A. (2021). Prevalence and correlates of stress and burnout among US healthcare workers during the COVID-19 pandemic: A national cross-sectional survey study. *EClinicalMedicine*, 35, 100879.
- Shanafelt, T. D., Boone, S., Tan, L., Dyrbye, L. N., Sotile, W., Satele, D., ... & Oreskovich, M. R. (2012). Burnout and satisfaction with work-life balance among US physicians relative to the general US population. *Archives of internal medicine*, 172(18), 1377-1385.
- Shanafelt, T. D., West, C. P., Sinsky, C., Trockel, M., Tutty, M., Wang, H., ... & Dyrbye, L. N. (2022, March). Changes in burnout and satisfaction with work-life integration in physicians and the general US working population between 2011 and 2020. In *Mayo Clinic Proceedings* (Vol. 97, No. 3, pp. 491-506). Elsevier.
- Sharma ST, Nieman LK, Feelders RA. Cushing's syndrome: epidemiology and developments in disease management. (2015, April 17.). *Clin Epidemiol*, 17;7:281-93. doi: 10.2147/CLEP.S44336. PMID: 25945066; PMCID: PMC4407747.
- Silverman, M. N., & Sternberg, E. M. (2012). Glucocorticoid regulation of inflammation and its functional correlates: from HPA axis to glucocorticoid receptor dysfunction. *Annals of the new York Academy of Sciences*, 1261(1), 55-63.
- Thau L, Gandhi J, Sharma S. (2023, Updated Aug 28). Physiology, Cortisol. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK538239/>
- Wang, J., Wang, W., Laureys, S., & Di, H. (2020). Burnout syndrome in healthcare professionals who care for patients with prolonged disorders of consciousness: a cross-sectional survey. *BMC health services research*, 20, 1-10.
- Westcarr-Gray, S., Taggart, I., Weiler, E., Havens, Oliver, P. and Gilkey, D.. (2023, September). Montana Sanitarian Needs Assessment: A Post COVID-19 Perspective. *Journal of Environmental Health*, 86, 2, 12 – 21.

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