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Title: Examining the relationship between physiological measurements and self-reports of stress and well-being in middle school teachers over one school year

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Title: Examining the relationship between physiological measurements and self-reports of stress and well-being in middle school teachers over one school year

Background / Context:

Teachers report some of the highest level of occupational stress (Johnson, et al., 2005). Educators are exposed to a variety of stressors, which can lead to poorer teaching performance, burnout, and increased student misbehavior (Jennings & Greenberg, 2009). Although self-report measures of stress are most commonly used in education research, physiological measures of stress may also contribute to our understanding of educators' stress, as well as their responsiveness to interventions designed to reduce stress and promote well-being.

Physiological measures of stress are gaining popularity in psychosocial research because of their assumed objectivity (Granger, 2007). However, self-report and physiological measures of health and stress are not always consistent with one another. This inconsistency is noteworthy, given that the field of education currently relies primarily on self-report. Understanding where these measures diverge or overlap could help education researchers determine whether physiological measures that are costly, are worthwhile to incorporate into studies related to well-being. There is a need for research directed towards understanding the physical and psychological effects of teaching and how to facilitate optimal functioning.

Some studies show a relationship between self-reported burnout and cortisol levels. For example, the cortisol awakening response is positively associated with job stress and negatively associated with burnout (Chida & Steptoe, 2009). Grossi et al., (2005) found that in their sample of 154 workers, those in the high burnout group had higher cortisol concentrations at waking and 30 minutes later as well as greater area under the curve for salivary cortisol.

Salivary alpha amylase (sAA) research indicates that it is a highly sensitive indicator of changes caused by psychological stressors (Granger, Kivlighan, El-Sheikh, Gordis & Stroud, 2007). Many studies have measured change in sAA in response to acute stress stimuli (Nater & Rohleder, 2009), but few have reported associations with stress and diurnal patterns of sAA. Also not all studies reporting on sAA patterns are consistent since it is a relatively new biomarker in psychological research. A study of nurses found no association between sAA with work stress or burnout (Wingenfeld, Schulz, Damkroeger, Philippsen, Rose& Driessen, 2010). However, other studies have shown that the daily secretion pattern of sAA is altered in individuals reporting chronic stress (Nater et al., 2007), in young women experiencing chronic shame (Rohleder, Chen, Wolf & Miller, 2008) and in caregivers for cancer patients (Rohleder , Marin, Ma & Miller, 2009).

Studies incorporating salivary measures and self-reports of stress and burnout in teachers are rare and findings are inconsistent. One study showed that teachers with high levels of burnout showed blunted cortisol levels after waking (Pruessner, Hellhammer & Kirschbaum, 1999). In two other studies, neither Bellingrath, Weigl and Kudielka (2008) nor Moya-Albiol, Serrano and Salvador (2010) found associations between cortisol and burnout. No studies are available that investigate salivary alpha amylase's association with burnout in teachers.

Purpose / Objective / Research Question / Focus of Study:

This study employs an innovative measurement design to facilitate the examination of associations between physiological indicators and self-reported measures related to stress and health. We examine associations between salivary biomarkers of teachers at the beginning of the school year and their self-reported levels of stress and burnout both concurrently and in the spring of that school year. We hypothesize that self-reports of burnout will be negatively and significantly associated with salivary measures the cortisol awakening response similar to the

Pruessner et al. (1999) finding. We also hypothesize that blunted cortisol awakening responses in the fall will be predictive of higher rates of burnout and perceived stress in the spring.

Setting:

This study was conducted in two middle schools in Central Pennsylvania over the course of one school year.

Population / Participants / Subjects:

This study included educators from one public middle school in central Pennsylvania (N=30; see Table 1). Study volunteers participated in an evaluation of an intervention to promote teacher wellbeing. This poster will focus on teachers in the control school in the Fall and Spring of one school year. All procedures for data collection were approved by the Penn State Institutional Review Board and teachers actively consented for participation.

Intervention / Program / Practice: Not applicable

Research Design:

This is a short-term longitudinal study. Self-report and physiological data were collected at two time points: fall 2012 and spring 2013.

Data Collection and Analysis:

Biomarkers. Participants provided saliva samples at four time points (waking, 30 mins later, lunchtime, bedtime) during a typical work day. Saliva samples were collected using cotton salivettes (Sarstedt, Nümbrecht, Germany) and is a non-invasive technique associated with good compliance (Hellhammer, Wüst & Kudielka 2009). Four saliva samples were taken over the course of one normal teaching day to capture the diurnal patterns of cortisol and sAA over the course of one work day. Research assistants described the procedure to the participants and included specific written directions in the kits. They were instructed to not eat, drink, smoke or brush their teeth 30 minutes prior to taking their saliva, nor touch the salivette with their hands. Participants' reported their sampling times in addition to medication use. Participants stored their samples in their refrigerator after collection and returned them to the research assistants the following day. Upon arrival at the lab saliva samples were stored at -80˚ Celsius. Saliva samples were assayed for a variety of biomarkers related to stress and health. This study will utilize cortisol and salivary alpha amylase for analyses.

Burnout. Burnout was measured using the Maslach Burnout Inventory (MBI) (Maslach and Jackson, 1986). The MBI is composed 22 statements about job-related feelings. There are 3 subscales: MBI-EE: emotional exhaustion; MBI-DP: depersonalization; and MBI-PA: personal accomplishment. The MBI-EE scale consists of nine items (e.g. "I feel burned out from my work"). The MBI-DP scale contains five items (e.g. " I do not really care what happens to my students") and the MBI-PA has 8 items (e.g. "I can easily create a relaxed atmosphere with my students"). In this study the alpha Cronbach alpha scores were 0.91 (MBI-EE), .82 (MBI-PA) and .73 (MBI-DP).

Perceived Stress. The Perceived Stress Scale (Cohen, Kamarck & Mermlstein, 1983) included likert ratings for four items on perceived stress during the last month (e.g. "in the last month, how often have you felt you were unable to control the important things in your life?"). Scores were totaled and Cronbach's alpha in this study was .88.

Emotional Regulation. The emotional regulation questionnaire (ERQ) asks participants about their emotional life and how they control and regulate their emotions with questions that ask about their emotional experience as well as expression. The ERQ assesses the regulation of emotion expression by 2 subscales; suppression and cognitive reappraisal. The scale reflected high internal consistency in this study with a Cronbach's alpha of .93.

Time Urgency. This consisted of 33 statements that describe a person's behavior with respect to usage of time. Five response options ranged from Strongly disagree (1) to Strongly agree (5). Cronbach's alpha for this scale was 0.76.

Symptoms of Anxiety. Symptoms of generalized anxiety disorder were assessed using the Generalized Anxiety Disorder 7 (GAD-7) questionnaire (Spitzer ,Williams & Löwe ,2006). GAD-7 has seven items (e.g., "not being able to stop or control worrying"), which measure the severity of signs of GAD with response categories ranging from "not at all" to "nearly everyday". Assessment is indicated by total score. The scale has high internal consistency with Cronbach's alpha of 0.91.

Depressive Symptoms. The eight item Patient Health Questionnaire depression scale(PHQ) is a valid diagnostic and severity measures for depressive disorders that asks if in the last two weeks participants have been bothered by a range of problems (e.g., 'Little interest or pleasure in doing things") with 5 response options ranging from "not at all" to "nearly everyday". The Cronbach's alpha for this scale was 0.85.

Data Collection and Analysis:

The data on salivary cortisol and sAA were treated in two ways. First, the awakening response (AR) was calculated for each (defined as the difference between waking and 30 minutes later). This is a frequently used measure with cortisol and is considered a reliable measure of HPA activity (Grossi et al., 2005). SAA also shows this response but there is less data on the patterning of this time-related profile (Ghiciuc et al., 2011). Secondly, the area under the curve (AUC) was calculated for each measure. This is determined by biomarker measures on the *y*-axis and the time between measures on the *x*-axis.

SAS 9.3 (SAS, Inc.) and Statistical Package for the Social Sciences (SPSS, Version 21) were used for the statistical analysis, employing Pearson's bivariate correlations, ANOVA with repeated measures and one-way ANOVAs. Correlational analyses were performed on the physiological and psychological data for each time point to identify any associations.

Findings / Results:

Diurnal cortisol and sAA

Diurnal cortisol and sAA. 30 participants were asked to collect saliva samples and one did not. Some participants were missing the appropriate data to compute variables and one did not return a saliva sample. Therefore, the sample size for analyses involving salivary biomarkers was 24.

Separate RMANCOVAs for cortisol and sAA, *Time* (waking, 30 minutes later, lunchtime and bedtime) controlling for gender and medication use. There was a significant main effect of sampling time for both biomarkers. Cortisol changed in the expected diurnal pattern with cortisol levels increasing 30 minutes after waking and declining over the remainder of the day [$F(3,174)=202.9$; $p=.000$](see Figure 1); each time point was significantly different from one another (p's<0.05).There was also a significant change in sAA concentration over time [$F(3,168)=32.82$; $p=.000$) (see Figure 2). Consistent with Ghiciuc and colleagues (2011), sAA levels sharply declined 30 minutes after waking indicating an awakening response ($p<0.05$). A pairwise comparison showed that the mean differences at time 4 were not significantly different than time 1, all other time points were significantly different from one another ($p<.0001$). Before lunch and bedtime sAA levels were higher than the 30 min after waking sample of the day, but were similar to the waking sAA level (p's<0.05) (see Figure 2).

Associations between physiological and psychological measures of stressPartial correlations controlling for medication use and gender were calculated for salivary biomarkers

and self-reports of stress and burnout from the fall (Table 2). Fall sAA awakening response showed significant correlations with educators' reports of time urgency (r=-0.51, p=0.008), the suppression subscale of the emotional regulation questionnaire (r =0.435, $p=0.026$), as well as trend level associations with symptoms of anxiety and depression (r =-0.35 , $p=0.08$ and r =-0.3 , $p=0.1$, respectively). Increased reports of emotional suppression was also significantly associated with higher levels of cortisol area under the curve (r =0. 53, $p=0.006$). This may indicate that participants who report suppressing their emotions in the fall are showing physiological signs of increased stress. Lastly, participants with higher reports of time urgency had less steep cortisol awakening response, which can be an indication of chronic stress. Unexpectedly, the fall perceived stress scale scores showed no association with any of the physiological measures. Further analyses examined the predictive value of fall physiological measures on spring psychological measures. These regressions controlled for fall self-reports, medication use and gender. Results indicated that predictive relationships between fall salivary measures and fall self-report measures indicated in the partial correlation analyses did not persist into the Spring.

Conclusions:

Results show that salivary markers of stress show a modest relationship to self-reported measures in this sample but that measures of cortisol and sAA are not predictive of spring self-reported burnout or stress as was hypothesized. The data did not support the hypothesis that self-reported measures of burnout would be associated with physiological measures of stress. However, these unexpected outcomes were consistent with Bellingrath, Weigl and Kudielka (2008) and Moya-Albiol, Serrano and Salavador (2010) who found no associations between cortisol and burnout and a meta-analysis of 31 studies by Danhof-Pont, Van Veen, and Zitman, (2011) that shows no associations between the cortisol awakening response and burnout.

Results did reveal that fall reports of high time urgency were associated with less steep awakening responses in both sAA and cortisol. With cortisol, a blunted awakening response can be associated with chronic stress (Fries, Dettenborn & Krischbaum, 2009). Though there were no associations between the cortisol awakening response and self-reported stress or burnout, this finding could be an early indication of mounting chronic stress. A person's feeling of time urgency is closely related to their feelings of stress in the workplace (Landy, Haleh, Thayer & Colvin, 1991). Professional development coordinators could use this information to design specific interventions around time management in order to decrease stress and prevent burnout.

Overall, this study demonstrated the feasibility of using salivary measures to assess biomarkers of teacher stress in school-based research. In middle school educators assessed on a typical day of work, cortisol and sAA showed their typical awakening responses and diurnal patterns. Results also indicated that neither physiological measures nor self-report measures alone capture the full picture of educators' stress and burnout, as evidenced by measures that were unexpectedly unassociated such as self-reports of perceived stress and physiological measures of stress. Further research incorporating physiological and self-report measures are needed to bring a deeper understanding about the health and well-being of educators.

These results add to a small but growing literature on teachers' stress and burnout, which will be important in informing future professional development efforts aimed at supporting teacher efficacy and wellbeing. Limitations of this study include a small sample size leading to decreased generalizability and power for statistical analyses. Despite such limitations, this study shows the usefulness and feasibility of incorporating salivary biomarkers into studies of educator health and well-being.

Appendices

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Appendix A. References

References are to be in APA version 6 format.

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Appendix B. Tables and Figures

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Table 1: Sample Description

	N=30	
	Mean	SD
Years Teaching	14.24	9.09
Age	44.7	12.5
Gender	M=5, F=25	

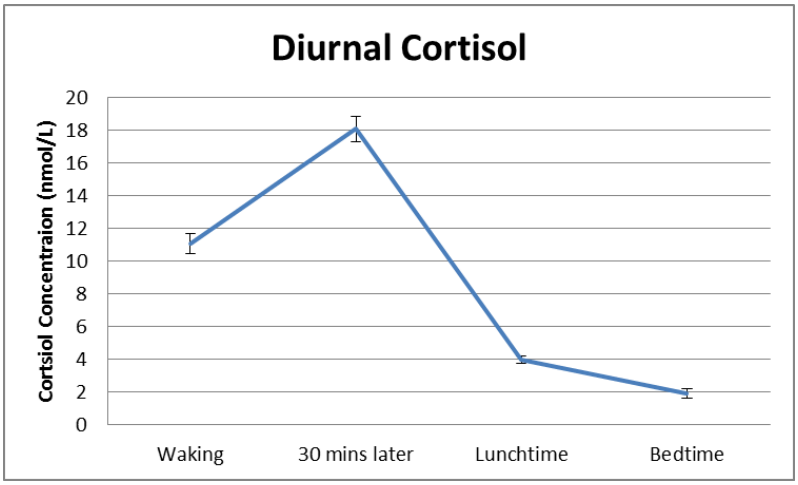

Figure 1: Salivary cortisol (nmol/L) rhythm across the day in middle school educators (N=63) (means ± standard error of the mean).

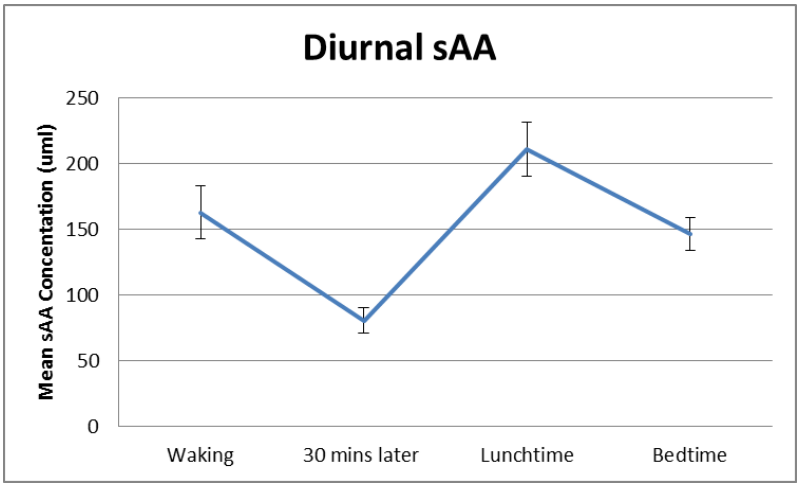

Figure 2: Salivary alpha amylase (U/mL) rhythm across the day in middle school educators (N=63) (means ± standard error of the mean) using untransformed data).

Table 2: Partial correlations of fall salivary biomarkers of stress and self.

	sAA AR	sAA AUC	Cort AUC	Cort AR
Anxiety	**-.348***	-.085	.081	-.276
Depressive Symptoms	**-.322***	-.015	.080	-.139
Time Urgency	**-.508****	-.125	-.084	**-.393****
Reappraisal	.261	.042	-.321	.040
Suppression	**.435****	.077	**.525****	.295
Emotional Exhaustion	-.308	-.044	.227	-.223
Personal Accomplishment	.075	-.153	-.179	.089
Depersonalization	-.232	.151	.187	-.138
Perceived Stress	-.199	-.080	.094	-.069

Notes: Controls: medication use and gender. sAA= salivary alpha amylase; AUC= Area under the Curve; AR= awakening response; . **=p<0.05, *p<0.1