

The Pathological Freshman Year: Assessing Correlations Between Cortisol and Symptoms of Depression in Idaho Resident Freshmen

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Abstract: *College freshmen experience unique stressors when transitioning from high school to college. In Idaho, the freshman attrition rate is higher than the national average, which may be partially explained by the higher prevalence of depression in this region. The current study investigated the potential of cortisol, a stress hormone, to be a biomarker for depression to help identify those freshmen with depression that may be at a higher risk of dropping out. In a group of 45 college freshmen, no correlations were observed between serum cortisol and depression severity as measured by the Patient Health Questionnaire 9 (PHQ-9). However, those with a self-reported history of depression scored significantly higher on the PHQ-9, confirming the reliability and validity of the PHQ-9 in a college student population.*

Key Words: PHQ-9, cortisol, freshman, Idaho, depression

INTRODUCTION

Higher education in Idaho is struggling. Idaho ranks last in the nation in the proportion of high schoolers that go on immediately to college after graduating from high school (National Center for Higher Education Management Systems, 2015). In addition, only 70.4% of Idaho college freshmen return for their sophomore year, which corresponds to a rank of 43rd in the nation. (Idaho State Board of Education, 2018).

Some of the risk factors for increased freshman attrition are being an ethnic minority, low socioeconomic status, disability, and mental illness (O'Keefe, 2013). Due to the higher incidence of high depression and suicide rates in the Mountain West region, the relationship between mental health in college freshmen and how it affects attrition rates is a relationship worth further exploration (Watson, 2019, University of Washington, 2019).

Improving mental health services on college campuses is a natural next step in reducing attrition rates among college students, but students requiring mental health services must first be identified. Currently, there is no biomarker that has been identified for depression. Research has been done on the potential for cortisol to be a biomarker for depression. Cortisol is a stress hormone that is released in response to psychological distress (Burtis and Bruns, 2015).

Research question: Is cortisol concentration an effective biomarker for depression that could be utilized as a screening tool to identify college freshmen in Idaho that are suffering from depression?

METHODOLOGY

PARTICIPANTS

Fifty Idaho State University (ISU) freshmen were recruited for the study prior to the beginning of the fall semester. In order to qualify for participation in the study, the student was required to fulfill all of the following criteria:

- Age of 18 or older
- Full-time student status (course load of at least 12 credits) during the semester of the study
- Freshman status (maximum of 25 total credits earned)
- Idaho resident

STUDY APPROVAL

All procedures were approved by the Idaho State University Institutional Review Board. Informed consent was obtained prior to participation.

PATIENT HEALTH QUESTIONNAIRE 9 (PHQ-9)

The PHQ-9 is a 9-item screening questionnaire based on the criteria set forth in the *Diagnostic and Statistical Manual of Mental Disorders*, 4th edition. The PHQ-9 screening for depression and has excellent reliability and validity (Kroenke, Spitzer, and Williams, 2001). Its validity has also been confirmed in university students in the United States (Keum, Miller, and Inkelas, 2018).

CORTISOL ANALYSIS

Blood was collected via venipuncture in serum separator tubes and centrifuged for 10 minutes at 5000 RPM within 2 hours of collection. Samples were stored refrigerated until analysis, which occurred no longer than 2 days after sample collection. Total serum cortisol was measured using competitive binding immunoenzymatic assay in ISU's certified clinical laboratory.

PROCEDURE

Participants were assessed at the beginning and end of the 2019 Fall semester at ISU. Session one took place during the first 3 weeks of the fall semester. To account for the diurnal variation of cortisol, each student was scheduled for both a morning and evening appointment. The morning appointment was scheduled between 6 am and 9 am, and the evening session took place between 5 pm and 8 pm. During the morning appointment, the student completed the PHQ-9 screen, and a short questionnaire for demographic information and history of depression and stress. Then blood was obtained from the student through venipuncture in serum separator tubes for cortisol analysis. During the evening appointment, only blood was collected for cortisol analysis. Session 2 took place during the 2 weeks prior to finals week. The methods session two were identical to session 1.

STATISTICAL ANALYSIS

Spearman’s rho was used to evaluate intercorrelations between nonparametric measures within each session. The Mann-Whitney U-test was used to evaluate the correlation between depression history, PHQ-9 scores, and cortisol concentrations within each session. The Wilcoxon rank sum test was used to evaluate changes from Session 1 to Session 2. These tests did not assume that the data are normally distributed.

RESULTS

Five students did not complete the study, resulting in a 90% (n=45) participation retention. Of the participants that participated in both session 1 and session 2, 32 (71%) were female, and 13 (29%) were male. The participants ranged in age from 18 to 72 years with the average age being 20.1 years. The majority of participants (n=31, 68%) identified as white. The second most common ethnicity that was reported was “Hispanic or latino/a,” and 6 participants (13%) identified as this.

Out of the 45 participants completing the study, approximately half scored in the PHQ-9 depression category of “no depression/minimal” in sessions 1 and 2 (Figure 1). The number of participants scoring in each depression category is displayed in Table 1.

Figure1

Number of participants scoring in each depression category of the PHQ-9 by session.

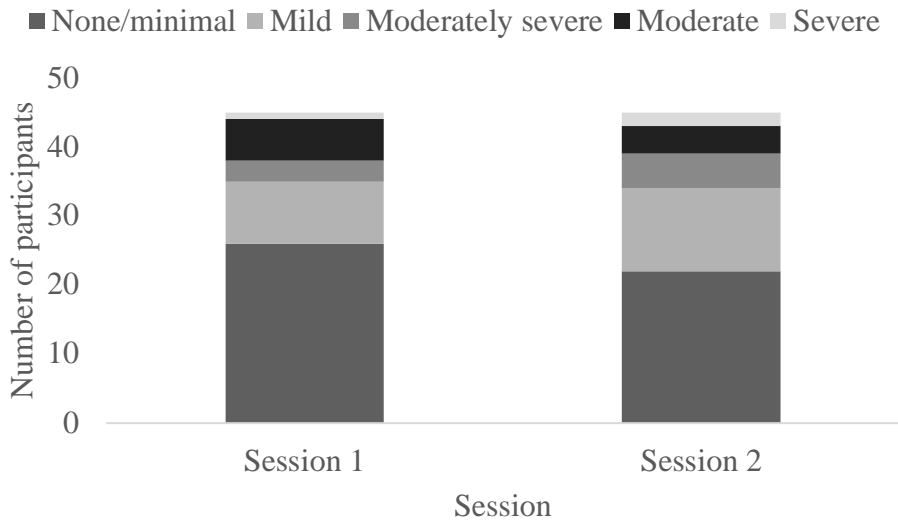


Figure 2

*Session 1 serum cortisol concentration by history of depression diagnosis. Horizontal lines within the boxes represent the medians. Upper and lower boundaries of the boxes represent the interquartile range (75th and 25th percentiles, respectively). Whiskers represent “minimum” (1.5*interquartile range below the 25th percentile) and “maximum” (1.5*interquartile range above the 75th percentile). Dots represent individual data points.*

Table 1

Number of participants scoring in each depression category of the PHQ-9 by session

	PHQ-9 Depression Category				
	None/minimal	Mild	Moderate	Moderately severe	Severe
Session 1	26 (57%)	9 (20%)	3 (6.7%)	6 (13%)	1 (2.2%)
Session 2	22 (49%)	12 (27%)	5 (11%)	4 (8.9%)	2 (4.4%)

There were no significant differences in morning or evening cortisol concentration from session 1 to session 2. Furthermore, there were no significant correlations between PHQ-9 scores and morning or evening serum cortisol concentrations during either session 1 or session 2. Similarly, there was no significant correlation between PHQ-9 scores and evening/morning cortisol ratio during either session 1 or session 2.

As shown in Figures 2 and 3, there were no significant differences in morning or evening serum cortisol concentration between those with no history of depression and those with a current or past depression diagnosis. This was true for both session 1 (Figure 2) and session 2 (Figure 3).

The mean PHQ-9 score did not change significantly from session 1 to session 2 (Figure 4). In session 2, those participants with either a history of or a current diagnosis of depression had

significantly higher ($\alpha=0.05$) sum of ranks of PHQ9 scores than those of the participants with no history of depression (Figure 5). This significant difference was not observed during session 1.

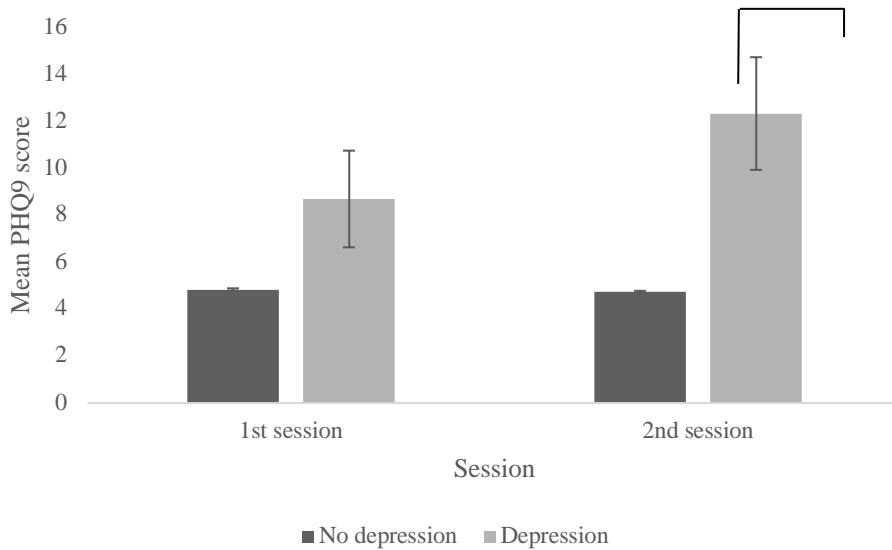
Figure 3

*Session 2 serum cortisol concentration by history of depression diagnosis. Horizontal lines within the boxes represent the medians. Upper and lower boundaries of the boxes represent the interquartile range (75th and 25th percentiles, respectively). Whiskers represent “minimum” (1.5*interquartile range below the 25th percentile) and “maximum” (1.5*interquartile range above the 75th percentile). Dots represent individual data points.*

Figure 4

*PHQ-9 scores by session. Horizontal lines within the boxes represent the medians. Upper and lower boundaries of the boxes represent the interquartile range (75th and 25th percentiles, respectively). Whiskers represent “minimum” (1.5*interquartile range below the 25th percentile) and “maximum” (1.5*interquartile range above the 75th percentile). Dots represent individual data points.*

Figure 5. Mean PHQ-9 scores for each session by history of depression. Bars are +/- standard error of the mean. Asterisk signifies significance at alpha = 0.05.



DISCUSSION

These results show no significant correlation between serum cortisol concentration and depression severity as measured by PHQ-9 in our subject group of freshmen at ISU. There were

no significant correlations between PHQ-9 scores and morning cortisol concentration, evening cortisol concentration, or evening/morning cortisol concentration ratio.

Our finding that cortisol did not correlate with PHQ-9 score agrees with a study by Krogh et al. (2012), which found no increase in salivary cortisol levels in mildly- and moderately-depressed subjects. However, it conflicts with a more recent study by Jia et al. (2019), who found significantly elevated serum cortisol levels in patients with mild, moderate, and severe depression. The discrepant findings may be explained by differences in the two patient populations, time of collection, or longitude of the study. One semester may not be sufficient to track significant changes in cortisol. Additional timepoints may also have been prudent, as symptoms of stress and depression may ebb and flow during the course of the semester.

Approximately half of our participants scored in the “no depression/minimal” category of the PHQ-9 in both sessions. During session 1, only one subject scored in the “severe depression” category, and during session 2, only two subjects scored in the “severe depression” category. Among those scoring positive for depression, most scored in the “mild depression” category. It is possible that serum cortisol concentration is not sensitive enough to detect depression in those with mild or moderate depression.

Twenty-seven percent of our subjects reported that they had been diagnosed with depression. This is slightly higher than the 24.9% reporting a history of depression in a survey of college students by the American College Health Association in 2019. Our finding of a rate of 27% reported history of depression is very similar to that of Lipson, Lattie, and Eisenberg (2019). In their large-scale study of 196 U.S. college campuses, they found a 29.9% prevalence of depression as measured by the PHQ-2, a 2-item version of the PHQ-9.

The PHQ-9 scores of our subjects were also comparable to reported rates of depression among college students in the U.S. A score of greater than 10 has been shown to have a high correlation with the presence of depression, while scores below 10 are rarely observed in those with active, symptomatic depression (Kroenke, Spitzer, and Williams, 2001). The percentage of subjects in the present study scoring above 10 on the PHQ-9 was 22% during the first session and 24% during the second session.

At the second session (near the end of the fall semester), those subjects who reported a history of a depression diagnosis had a significantly higher mean PHQ-9 score than those subjects who reported no history of depression. Those with no history of depression had a mean PHQ-9 score of 4.7, while those with a history of depression had a mean score of 12.3. This supports the reliability and validity of the PHQ-9 in a college student population that has previously been demonstrated by Keum, Miller, and Inkelas (2018).

CONCLUSION

The results of this study do not support serum cortisol testing as a tool to monitor freshman depression. However, we recommend further studies with increased longitude, and assessing additional health markers of stress and depression.

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