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An exploratory study of clinical and physiological correlates of problematic social media use in adolescents

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ABSTRACT

Prior validation studies of the Bergen Social Media Addiction Scale (BSMAS) demonstrate its utility for identifying problematic social media use in adolescents. There are knowledge gaps regarding the potential clinical and physiological underpinnings of problematic social media use in adolescents. This cross-sectional, single-visit study examined a sample of depressed (n = 30) and healthy (n = 30) adolescents who underwent clinical assessments of depressive symptom severity, bullying, cyberbullying, self-esteem, salivary measures of stress (cortisol and α-amylase) to identify correlates with adolescent and parental reports of the BSMAS. LASSO-penalized multiple linear regression models were implemented. With respect to the adolescent BSMAS scores in all subjects, the risk of problematic social media increased as depressive symptom severity increased. Depressed female adolescents appeared to have a greater risk. Based on parental BSMAS scores, depression status, depressive symptom severity, cyberbullying score, and salivary cortisol significantly predicted problematic social media use. For the depressed sample, the risk of problematic social media use increased as salivary cortisol increased. No significant predictors of problematic social media usage emerged in the healthy control sample. These preliminary results provide novel insights into clinical and physiological characteristics of problematic social media use in adolescents.

1. Introduction

There are ongoing concerns regarding problematic, addictive, and compulsive social media use in adolescents (Andreassen et al., 2012; Shafi et al., 2018; Chen et al., 2020). Although social media addiction has not yet been acknowledged in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), (American Psychiatric Association 2013) burgeoning evidence suggests that it is a discrete psychiatric disorder or a group of incompletely understood endophenotypes in mood and anxiety disorders (Banyai et al., 2017; Nesi et al., 2019; Shafi et al., 2020). Experts have suggested that problematic social media use resembles an addiction with related compulsvie behaviors, tolerance, withdrawal, motivational salience, and functional impairment. It has been estimated that at least 12% of all individuals who use social networking sites have an addiction to this from of interaction. (Marion et al. 2018). Emerging studies suggest that problematic social media use is an international public health concern (Banyai et al., 2017; Vannucci et al., 2017; Booker et al., 2018). For example, some studies suggest that the majority of young people check their smart phones every 12 minutes and that the proportion of young people with near continuous internet use continues to increase (Turkle 2015; Reid Chassiakos et al. 2016; Raudsepp and Kais 2019). Research on social media addiction is a relatively new area with considerable challenges as social media platforms evolve rapidly (Dalope and Woods 2018; Burke et al., 2020).

Abbreviations: BSMAS, Bergen Social Media Addiction Scale; MDD, major depressive disorder; MINI-KID, Mini-International Neuropsychiatric Interview for Children and Adolescents; QIDS-A17-C, Quick Inventory of Depressive Symptoms−adolescent (17-item)−clinician-rated; QIDS-A17-SR, Quick Inventory of Depressive Symptoms−adolescent (17 item)−self-report; RESES, Rosenberg Self-Esteem Scale; SMU, Social Media Use.

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Addictions are typically characterized by fixation, aberrant salience, and persistent changes in brain function (American Psychiatric Association 2013; Chen et al., 2020). Clinical signs relevant to social media include an excessive focus on social media use, an overwhelming drive to check or log on to social media, spending disproportionate amounts of time using social media, and irritability or anxiety on limitation of access to social media (Chen et al., 2020; Pettorruso et al., 2020). There are ongoing efforts to develop psychometrically-valid scales to measure problematic social media use and addictions in adolescents (Andreassen et al., 2012; van den Eijnden, Lemmens, and Valkenburg 2016).

The Bergen Social Media Addiction Scale (BSMAS) is a scale for assessing problematic or addictive social media use. However, the BSMAS was previously validated in student rather than clinical samples (Andreassen et al., 2012). This scale measures six key symptoms that match addiction diagnostic criteria with respect to social media use over the past year, which include duration of time thinking or planning to use social media, urges to use more social media, use of social media to forget about stressors, failed attempts to curtail use of social media use, distress associated with restricted use to social media, and the negative academic or occupational impact of social media use. The BSMAS has been translated into multiple languages, and consistently demonstrates good psychometric properties (Andreassen et al., 2012; Banyai et al., 2017; Chen et al., 2020).

Prior work suggests that low self-esteem, narcissism (measured with objective rating scales), and female sex may correlate with elevations in the BSMAS and pose a putative risk for problematic or addictive use of social media (Andreassen et al., 2017; Banyai et al., 2017). Other research has demonstrated that adolescents with problematic social media have lower global levels of well-being compared to adolescents without problematic social media use (Vanman et al., 2018; Booker et al., 2018). Notwithstanding the importance of this prior work, social media addiction research in adolescents is a nascent area with many unanswered questions regarding a growing public health concern. One dearth in the literature to date is the absence of physiological markers of stress or biomarkers(Odgers 2018; Shafi et al., 2018).

There are many complex, unanswered questions related to problematic social media use for parents, clinicians, researchers, and policy makers. Social media use in the context of adolescent psychiatric disorders and health has not been well characterized. Heterogenous, maladaptive and adaptive behaviors related to social media likely coexist and vary among psychiatric disorders. Further understanding of clinical, physiological, behavioral, and historical characteristics could inform future systematic research, diagnostic criteria for social media addictions and inform intervention development (Burke et al., 2020). The goal of the present study was to advance existing knowledge for hypotheses generation regarding problematic social media use in adolescents with an emphasis on informing early identification and intervention for problematic social media use in adolescents. In particular, we examined potential predictors of problematic social media usage in a sample of adolescent youth. Social media can be broadly defined to include any interactive sites involving the internet. For the purpose of this study, social media was conceptualized as social networking communication platforms such as Instagram, Facebook, and Twitter.

2. Method

2.1. Subjects

This study was conducted in a manner consistent with the Declaration of Helsinki. Institutional review board approval was obtained prior to any subject recruitment or research activity. Two groups of subjects aged 13 to 17 years were recruited for a single-visit study during 2018–2019. A sample of healthy control adolescents were recruited from the community via approved advertising. Participants with major depressive disorder (MDD) were recruited from an adolescent inpatient psychiatry unit. Parents provided informed consent and adolescents provided informed assent.

2.2. Procedures and measures

Subjects underwent a clinical interview and structured diagnostic interview with the Mini-International Neuropsychiatric Interview for Children and Adolescents (MINI-KID) to confirm the presence or absence of MDD and other psychiatric diagnoses (Sheehan et al., 2010). Depressive symptom severity was assessed with the 17-item Clinician Rated Quick Inventory of Depressive symptoms (QIDS-A17-C), which is a validated, clinician-rated scale with a total score ranging from 0 to 27 and higher scores representing greater severity of depressive symptoms (Bernstein et al., 2010). Self-esteem was assessed with the Rosenberg Self-Esteem Scale (RESES), a self-report questionnaire with 10 items and a 4 point Likert scale with scores ranging from 0 to 40 (Gray-Little et al., 1997). The RESES examines the adolescent's global perception of self-worth with higher scores indicating greater self-esteem. Bullying was assessed with the Illinois Bully Scale, which is an 18 point scale with three subscales that assesses both the presence and frequency of victimization (range of 0–16), bullying (range of 0–36), and fighting (range of 0–20) (Hamburger, 2011). Higher scores indicate more frequent occurrences of victimization, bullying, or fighting (Kapoor et al., 2016). A previously validated cyberbullying assessment of victimization (range of 0–56 with higher scores reflecting greater victimization) was also administered (Stewart et al., 2014).

Subjects abstained from all social media use, caffeine, and exercise for 24 hours prior to the study. Subjects had nothing to drink or eat for 2 hours prior to the study. Subjects did not use nicotine for 1 hour prior to the study. The study visits were at a consistent time of day (1:00–3:00 PM) to mitigate diurnal variability of cortisol measures. Subjects that used corticosteroid-based medications at the time of the study were not enrolled (Kirschbaum and Hellhammer 1989; Kirschbaum et al., 1993; Kirschbaum and Hellhammer 1994). The salivary samples were collected from the youth participant with SalivaBio passive drool saliva kits (Salimetrics). All salivary samples were centrifuged and stored at −80°C prior to processing with cortisol enzyme-linked immunosorbent assay kits and α-amylase kinetic enzyme kits (Salimetrics) as per manufacturer instructions.

2.3. Outcome variable

The primary outcome variable was problematic social media usage. Social media usage was assessed using the Bergen Social Media Addiction Scale (BSMAS), which is a validated, 6-item scale that measures risk of social media addiction over the past year. Total score on the BSMAS ranges from 6 to 30, with higher scores representing greater risk of social media addiction (Andreassen et al., 2012). The BSMAS was completed by both the adolescent participant and a parent of the youth (to assess the parent's perspective of the adolescent's social media usage).

2.4. Potential predictor variables

An initial pool of 9 characteristic variables was selected for analysis as potential predictors of social media usage (Table 1). These variables were selected based on the results of previously published findings and other factors that have been associated with effect of the social media exposure among adolescent youth (Reid Chassiakos et al. 2016; Banyai et al., 2017; Raudsepp and Kais 2019). The pool of potential predictors, which was selected *a priori*, included: sex, MDD status (MDD vs. normal control), depression severity (as assessed with the QIDS-A17-C), self--reported self-esteem (as assessed by the Rosenberg Self-Esteem Scale), self-reported cyberbullying score (as assessed by the Cyberbullying scale), self-reported bullying perpetrator score (as assessed by the Illinois Bully Scale, bully subscale), self-reported bullying victim score (as assessed by the victim subscale), and measures of stress response using

Table 1
Potential predictors of problematic social media use.

Predictor	Assessment
Bullying (perpetration)	Illinois Bully Scale (Bully Subscale)
Bullying (victimization)	Illinois Bully Scale (Victim Subscale)
Cyberbullying (victimization)	Cyberbullying Scale
Diagnosis of Major Depressive Disorder	Mini-International Neuropsychiatric Interview for Children and Adolescents (MINI-KID)
Depressive Symptom Severity	17-item Clinician Rated Quick Inventory of Depressive Symptomatology (QIDS-A17-C)
Self-Esteem	Rosenberg Self-Esteem Scale (RESES)
Sex	Interview and Medical Record Review
Stress biomarker	Salivary α-amylase
Stress biomarker	Salivary Cortisol

salivary cortisol (μg/dL) and salivary α-amylase (U/mL).

2.5. Statistical analysis

Demographic and clinical characteristics for the sample of 60 adolescents were described using the sample mean and standard deviation for continuous variables and the frequency and percentage for categorical variables. To identify any differences between characteristics of the two groups [MDD ($n = 30$) vs. normal controls ($n = 30$)], the two-independent sample *t*-test with the Satterthwaite method for unequal variances (continuous variables) and Fisher's exact test (categorical variables) were used.

Starting with the initial pool of 9 variables, a filtering process was used to identify a subset of variables that seemed to contain predictive power. The process was implemented using the Lasso-penalized variable selection method, with Akaike's Information criterion, in the context of a multiple linear regression model for the outcome of social media usage (BSMAS) that was based on 10,000 bootstrap samples. The goal of the LASSO-penalized linear regression was to select a parsimonious and well-fitting subset of potential predictors of social media usage by performing simultaneous variable selection and parameter estimation (Tibshirani 1996). This was done by optimizing a penalized least squares criterion that expressed a balance between good fit and parsimony.

Statistical analyses were carried out using SAS software, version 9.4 (SAS Institute, Inc., Cary, NC). The level of significance was set at $\alpha = 0.05$ (two-tailed) and we implemented the False Discovery Rate (FDR) procedure, where applicable, to control false positives over the multiple tests (Benjamini and Hochberg 1995).

3. Results

3.1. Participant characteristics

Of the 60 youth, 63.33% were females, 80% were White (non-Hispanic), and the mean age was 15.05±1.18 years (age range=13 to 17 years). Mean age at first use of social media was 11.38±1.53 years. Mean social media addiction score and cyberbullying score of all 60 youth were 14.45±5.86 and 5.60±7.10, indicating moderate addiction and minimal cyber victimization, respectively (Andreassen et al., 2012; Andreassen et al., 2017). Demographic and clinical characteristics of the 60 adolescents, overall and by group, are shown in Table 2.

3.2. Predictors of social media usage

We reported the averaged LASSO-penalized parameter estimates and standard deviation that were based on 10,000 bootstrap samples of the multiple linear regression models along with the 95% bootstrap confidence interval. For the 95% CI that did not contain zero, the respective mean parameter estimate was statistically significant at alpha=0.05 (two-tailed).

Table 2
Demographic and clinical characteristics of the overall sample and by group.

Characteristic	Overall Sample ($N = 60$)	MDD ($n = 30$)	Normal Control ($n = 30$)	p-value (FDR)
Patient Demographics				
Age, years, M (SD)	15.05 (1.18)	15.26 (1.22)	14.83 (1.11)	0.15 (0.20)
Grade in School, Median (IQR)	10.00 (02)	10.00 (02)	9.00 (02)	0.14 (0.20)
Female Sex,% (n)	63.33% (38)	63.33% (19)	63.33% (19)	1.00 (1.00)
White, Non-Hispanic,% (n)	80.00% (48)	80.00% (24)	80.00% (24)	1.00 (1.00)
Patient Factors				
Age at First use of Social Media, M (SD)	11.38 (1.53)	11.03 (1.37)	11.73 (1.61)	0.07 (0.12)
Baseline QIDS-C Total, M (SD)	10.08 (7.42)	16.86 (3.79)	3.30 (1.58)	<0.0001 (0.0003)
Baseline Self-Esteem Score, M (SD)	28.21 (7.62)	22.16 (4.84)	34.26 (4.37)	<0.0001 (0.0003)
Baseline Social Media Addiction Score (via youth), M (SD)	14.45 (5.86)	17.56 (5.47)	11.33 (4.46)	<0.0001 (0.0003)
Baseline Social Media Addiction Score (via parent), M (SD)	16.72 (6.28)	20.20 (5.64)	13.23 (4.83)	<0.0001 (0.0003)
Baseline Cyberbullying Score, M (SD)	5.60 (7.10)	8.43 (8.50)	2.76 (3.72)	0.001 (0.002)
Baseline Bullying Perpetrator Score, M (SD)	1.78 (2.40)	2.00 (1.85)	1.56 (2.86)	0.49 (0.61)
Baseline Bullying Victim Score, M (SD)	2.38 (3.63)	3.80 (4.41)	0.96 (1.79)	0.002 (0.004)
Baseline Salivary Cortisol, ug/dL, M (SD)	0.16 (0.09)	0.20 (0.09)	0.13 (0.06)	0.003 (0.005)
Baseline Salivary Amylase, U/mL, M (SD)	194.33 (133.39)	185.91 (147.45)	202.47 (120.23)	0.63 (0.72)
History of Depression,% (n)	45.00% (27)	90.00% (27)	0.00% (00)	<0.0001 (0.0003)

Note. *M*=Sample Mean; SD=Standard Deviation. Two-independent sample *t*-test with the Satterthwaite method for unequal variances (continuous variables), Median one-way ANOVA for median values, and Fisher's exact test (categorical variables) were used to identify any differences between characteristics of the two groups. P-value (two-tailed) associated with the test of group differences (MDD vs. Control) on each characteristic. QIDS-C Total = Quick Inventory or Depressive Symptoms Clinician-Rated. FDR = False Discovery Rate. IQR = Interquartile Range.

3.3. Adolescent perspective

As shown in Table 3, for the overall mixed sample, the LASSO-penalized least squares multiple linear regression revealed that depression severity (as measured by the QIDS-A17-C) significantly predicted social media usage (adjusted $R^2 = 0.277$). The risk of social media addiction increased as depressive symptom severity increased (unstandardized beta = 0.326, 95% CI: 0.154 to 0.483). For the MDD subsample, the LASSO-penalized least squares multiple linear regression revealed that sex significantly predicted social media usage (adjusted $R^2 = 0.217$). The risk of social media addiction was on average 3.893 (95% CI: 1.573 to 7.033) scale units greater for females than males. No significant predictors of social media usage emerged in the healthy control sample.

3.4. Parent perspective

As shown in Table 4, for the overall mixed sample, the LASSO-penalized least squares multiple linear regression revealed that MDD status (MDD vs. normal control), depression severity (as measured by the QIDS-A17-C), cyberbullying score, and salivary cortisol significantly

Table 3
Multiple linear regression for predictors of social media usage from the adolescent perspective using LASSO-penalized variable selection.

Model Outcome and Predictor Variables*	Mean Estimate	SD	Bootstrapped LASSO Parameter Estimates 95% CI	Standardized Estimate	Adjusted R^2
Social Media Usage (overall sample)					0.277
Intercept	10.789	1.094	8.720 to 12.879	0	
QIDS-C Total	0.326	0.088	0.154 to 0.483	0.368	
Social Media Usage (MDD sample)					0.217
Intercept	8.202	4.909	0.583 to 22.681	0	
Sex (female vs. male)	3.893	1.449	1.573 to 7.033	0.372	
Social Media Usage (Healthy Control Sample)					-
Intercept	11.155	0.728	9.750 to 12.633	0	

Note. The LASSO estimates were based on 10,000 bootstrap samples of the model; Mean Estimate = bootstrap parameter estimate (regression coefficient); SD = standard deviation of the mean parameter estimate; 95% CI for the mean parameter estimate; For the 95% CI that does not contain zero (0), the respective mean parameter estimate is statistically significant at alpha = 0.05 (two-tailed); Standardized Estimate = bootstrap standardized regression coefficient; Adjusted R-squared is the model R-squared based on the LASSO-penalized variable selection; Observed sample: $N = 60$ for the overall sample, $n = 30$ for the MDD subgroup and $n = 30$ for the normal control subgroup.
Social media usage was assessed using the Bergen Social Media Addiction Scale (BSMAS), which is 6-item scale that measures risk of social media addiction over the past year. Total score on the BSMAS ranges from 6 to 30, with higher scores representing greater risk of social media addiction.
No significant predictors emerged in the normal control sample.
* Predictor variables were selected from a pool of 9 potential predictor variables via the LASSO-penalized variable selection method (which performs simultaneous variable selection and parameter estimation) in the context of a multiple linear regression model that was based on 10,000 bootstrap samples.

predicted social media usage (adjusted $R^2 = 0.302$). The risk of social media addiction increased as depression severity (unstandardized beta = 0.176, 95% CI: 0.021 to 0.391), cyberbullying (unstandardized beta = 0.144, 95% CI: 0.041 to 0.321), and salivary cortisol (unstandardized beta = 10.221, 95% CI: 2.868 to 22.711) increased as well as for those with MDD vs. normal controls (2.551 mean scale units greater for MDD patients). Of the selected predictor variables for the overall mixed sample (Table 4), the standardized parameter estimates revealed that MDD status (MDD vs. normal control) can be interpreted as having a greater magnitude of relative importance in the expected relationship with risk of social media addiction (standardized beta = 0.223). For the MDD sub-sample, the LASSO-penalized least squares multiple linear regression revealed that salivary cortisol significantly predicted social media usage (adjusted $R^2 = 0.134$). The risk of social media addiction increased as salivary cortisol increased (unstandardized beta = 18.166, 95% CI: 7.501 to 34.961). No significant predictors of social media usage emerged in the healthy control sample.

4. Discussion

This exploratory study sought to identify clinical and physiological characteristics associated with problematic social media use in healthy and depressed adolescents. With respect to the adolescent self-assessments of problematic social media use in the overall sample, greater severity of depressive symptoms was associated with an elevation in problematic social media use. In the subsample with MDD, female sex was associated with greater BSMAS elevations than male sex. There were no predictors in the healthy control adolescent subsample. In the overall sample examining the parental assessment of the adolescent on the BSMAS, MDD status, depressive symptoms severity, cyberbullying score, and salivary cortisol all significantly predicted problematic social media use with MDD status having the greatest magnitude. In the subsample of subjects with MDD, salivary cortisol significantly predicted problematic social media use. There were no significant predictors of problematic social media use in the healthy control adolescent subsample.

4.1. Parental measures

It is noteworthy that the mean parental BSMAS scores was numerically greater than the adolescent mean BSMAS scores in the combined sample, the subsample of adolescents with MDD, and the subsample of healthy control adolescents. This discrepancy suggests that adolescents may underreport problematic patterns of social media use while parents note more concerning behaviors. This may parallel research findings related to parent and child agreement with respect to depressive symptoms (Baumgartner et al., 2020). As social media addiction research progresses this area warrants further study, particularly in the context of scale development (Burke et al., 2020). Given the findings related to parental BSMAS reports in the present study, future work should consider the relationship between social media addiction and attachment style (Monacis et al., 2017). Previous work also suggests that attachment style is a factor in determining the manifestation of hypothalamic-pituitary-adrenal axis dysregulation (Kidd et al., 2011).

4.2. Sex differences

The present findings suggest that depressed adolescent females may be a high risk group for social media addiction. Prior related work also supports this concern. For example, adolescent females are more likely to engage social media than males and appear to be more prone to virtual self-comparisons compared to than their male counterparts (Booker et al., 2018). Depressive symptoms are also generally more common in female adolescents and this may confer vulnerabilities to adverse effects of social media between the ages of 13–15 years. Other research demonstrated that greater baseline depressive symptom severity predicted a steeper increase in problematic social medial use over time in adolescent females (Gomez-Baya et al., 2017; Raudsepp and Kais 2019). Unfortunately, our study did not explicitly examine body image dissatisfaction and this is an important future consideration as body image dissatisfaction may mediate problematic social media use in female adolescents (Emirtekin et al., 2019). Gender differences in social media use and the ensuing inimitable gender specific vulnerabilities is a critical area of focus for future research.

4.3. Stress biomarkers

The association of elevated salivary cortisol with problematic social media use based on parental BSMAS assessments of their offspring is interesting. While this finding does not demonstrate causality, salivary

Table 4
Multiple linear regression for predictors of social media usage from the parent perspective using LASSO-penalized variable selection.

Model Outcome and Predictor Variables*	Mean Estimate	SD	Bootstrapped LASSO Parameter Estimates 95% CI	Standardized Estimate	Adjusted R^2
Social Media Usage (overall sample)					0.302
Intercept	11.103	1.226	8.715 to 13.266	0	
QIDS-C Total	0.176	0.101	0.021 to 0.391	0.169	
Cyberbullying Score	0.144	0.081	0.041 to 0.321	0.126	
Group (MDD vs. normal controls)	2.551	1.474	0.332 to 5.956	0.223	
Salivary Cortisol	10.221	5.175	2.868 to 22.711	0.096	
Social Media Usage (MDD sample)					0.134
Intercept	16.294	1.839	12.220 to 19.338	0	
Salivary Cortisol	18.166	7.381	7.501 to 34.961	0.266	
Social Media Usage (Healthy Control Sample)					-
Intercept	12.921	0.822	11.333 to 14.633	0	

Note. The LASSO estimates were based on 10,000 bootstrap samples of the model; Mean Estimate = bootstrap parameter estimate (regression coefficient); SD = standard deviation of the mean parameter estimate; 95% CI for the mean parameter estimate; For the 95% CI that does not contain zero (0), the respective mean parameter estimate is statistically significant at alpha = 0.05 (two-tailed); Standardized Estimate = bootstrap standardized regression coefficient; Adjusted R-squared is the model R-squared based on the LASSO-penalized variable selection; Observed sample: $N = 60$ for the overall sample, $n = 30$ for the MDD subgroup and $n = 30$ for the normal control subgroup.
Social media usage was assessed using the Bergen Social Media Addiction Scale (BSMAS), which is 6-item scale that measures risk of social media addiction over the past year. Total score on the BSMAS ranges from 6 to 30, with higher scores representing greater risk of social media addiction.
No significant predictors emerged in the normal control sample.
* Predictor variables were selected from a pool of 9 potential predictor variables via the LASSO-penalized variable selection method (which performs simultaneous variable selection and parameter estimation) in the context of a multiple linear regression model that was based on 10,000 bootstrap samples.

measures and neurophysiological measures of stress will be important tools for explicating biological liabilities, risks, adverse effects, clinical constructs, and potential endophenotypes of depression and anxiety associated with problematic social media use in adolescents. Prior work by Johnshoy and colleagues suggested that social media use after an acute stressor may modulate neuroendocrine and sympathetic nervous system responses (Johnshoy et al., 2020). Other preliminary work provides conflicting results as it appears that social media use may either dampen or intensify neuroendocrine and system response to acute stressors (Rus and Tiemensma 2017, 2018). Further, focus on biomarkers of stress with respect to problematic social media use is essential to better understand the complexities of inter-individual differences, related psychological constructs, and underlying neurophysiological mechanisms. Longitudinal studies of adolescents have demonstrated associations with elevated cortisol and the onset of addictions. Stressful life experiences catalyze the development of addiction in vulnerable youth with elevated neuroendocrine stress responses (Rao et al., 2009). These findings can inform future work focused on adolescent social media addiction. Adolescents with objective evidence of elevated physiological stress are likely a vulnerable population with respect to developing problematic social media use. Cyberbullying, cyber self-comparison, and a multitude of other poorly understood stressful interactions on social media may paradoxically drive social media addictions in at risk adolescents (Gansner et al., 2019).

4.4. Depressive symptoms

Our findings that depressive symptom severity predicted problematic social media use in all subjects assessed from either an adolescent or parental perspective contributes to coalescing research findings that psychological suffering either is a consequence or a driver of problematic social media use. Recent work with a large sample of university students demonstrated that elevated BSMAS scores were associated with measure of psychological distress assessed with the Hospital Anxiety and Depression Scale (Chan et al., 2010; Chen et al., 2020). Other work focused more broadly on problematic internet use demonstrated that youth with high risk and problematic use had elevated symptoms of depression and anxiety as compared to lower risk groups (Pettorruso et al., 2020). Although, Pettorruso and colleagues postulated that problematic internet use represents a compensatory means of avoiding negative emotional states, (Pettorruso et al., 2020) we propose that the relationship between depressive symptoms and problematic social media use could be bidirectional and more complex.

4.5. Strengths and limitations

The strengths and limitations of our study must be considered in the context of interpreting the findings, future hypotheses generation, and ongoing research study design. We studied a well-characterized sample of depressed and healthy adolescents with clinical, parental, and self-report clinical assessments. The study protocol accounted for potential confounds with respect to collection of salivary biomarkers of stress. The limitations include a small sample size and single study visit study design. The parent report version of the BSMAS has not been adequately validated previously. Future work should replicate the present findings and validate the use of the parental version of the BSMAS. While social media use was restricted during the hospitalization of depressed subjects, healthy control participant social media abstinence relied on the self-report of parents and the adolescent. The present sample included predominantly non-Hispanic, white, females. As a result, the generalizability of the findings is limited. The present findings also do not provide direct evidence of causality.

4.6. Conclusion

In conclusion, this study suggests that problematic social media use in adolescents is associated with depressive symptom severity, cyberbullying, and elevated salivary cortisol measures. These findings provide an important foundation for future longitudinal work focused on understanding the specific vulnerabilities that increase risk for problematic social media use in adolescents. Future work should also focus on prevention and intervention development for problematic social media use early in life.

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