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Emotional Vulnerability in Adolescents (EVA) Study: Identifying Potential Biopsychosocial Markers for Adolescent Depressive Symptoms and Well-Being

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ABSTRACT

Adolescent depression is a highly recurrent and disabling mental health condition affecting a significant proportion of adolescents. Conversely, adolescent well-being is a positive state of health and enhanced quality of life. Depression and well-being are critical metrics of life quality. However, little is known about the biopsychosocial markers that differentiate between these states. Stemming from our extensive longitudinal emotional vulnerability in adolescents ((EVA) research, this study identified potential vulnerability markers by examining associations between a range of biopsychosocial factors and depression and well-being in a relatively homogenous sample of adolescents at baseline. $N = 425$ adolescents (60.5% female and 34.4% male) between 12 and 18 years ($M = 15.06$, $SD = 1.75$) were recruited from 12 state and independent schools. A comprehensive battery of standardized measures was administered to assess various biopsychosocial factors, including background demographic and clinical characteristics, lifestyle factors, neural-cognitive mechanisms, psychological and social stress-related factors, coping style, and personality traits. Multiple Regression analyzes using the backward eliminations indicated that less physical activity, more social media usage, eating disorder risk, greater perceived stress, higher neuroticism, excessive rumination and negative self-reference bias accounted for 68% of depressive symptoms. Lower stress, less social media usage, and positive cognitive interpretation bias were sufficient to account for 51% of well-being scores. The present findings suggest key bio-psycho-social risk and resilience factors that may play a role in predicting adolescent depression and well-being. Upon further examination of our longitudinal follow-up studies, these results will directly contribute to developing preventative intervention strategies.

1 | Introduction

1.1 | Importance of Adolescent Development

Adolescence, a period marked by rapid biological, emotional, cognitive, and social changes, is a precarious developmental phase (World Health Organization WHO 2021). Currently, the world accommodates the largest cohort of adolescents, with an estimated 1.2 billion individuals aged between 10 and 19 (i.e., ~16% of the World's population; UNICEF 2021). Healthy development during this phase is not only crucial for shaping future mental health and well-being, but it also holds the potential for positive outcomes that can inspire and motivate others (UNICEF 2021). Adolescents' experiences during these transitional years profoundly impact their well-being and mental health, with lasting effects extending into adulthood (World Health Organization WHO 2021).

1.2 | Prevalence and Impact of Adolescent Depression

Adolescent depression is a significant mental health concern (World Health Organization WHO 2021; UNICEF 2021), with almost 70% of adolescents reporting depressive symptoms which are likely to recur within a 5-year period (Rikard-Bell et al. 2022; Martinsen et al. 2021). The chance of these adolescents having a persistent depressive disorder is estimated to increase four times during adulthood (Rikard-Bell et al. 2022). Adolescent depression is marked by persistent sadness, low mood, fatigue, loss of interest in pleasurable activities, significant changes in weight and sleeping patterns, and intense feelings of inadequacy and guilt (American Psychiatric Association 2013). These adverse symptoms significantly impact young individuals' daily functioning and social interactions, affecting their interpersonal relationships, academic performance, career prospects and employment opportunities (Chang and Kuhlman 2022; World Health Organization WHO 2021). Additionally, they serve as predictors of more severe and intricate symptomatology, recurring mental health episodes, increased risk of suicide—including ideations, behaviors and attempts—and the development of various psychiatric and physical disorders throughout the lifespan (Chang and Kuhlman 2022; World Health Organization WHO 2021).

1.3 | Defining Adolescent Well-Being

On the contrary, adolescent well-being is described as a positive state of happiness and contentment, with lower levels of distress, overall good physical and mental health and an enhanced quality of life (Jarden and Roache 2023). WHO, in partnership with the United Nations H6+ group and Partnership for Maternal, Newborn, and Child Health (PMNCH), has recently proposed an *Adolescent Well-being Framework* encompassing five interconnected domains young people need to develop to achieve well-being (Ross et al. 2020; World Health Organization 2018). These domains involve good health and optimum nutrition, social connectedness and positive values, a safe and secure supportive environment, learning competencies, education and skills, and a sense of identity, self-esteem and resilience (Ross et al. 2020; World Health Organization 2018).

1.4 | A Holistic Approach to Adolescent Health and Well-Being

Previously, the absence of physical and mental health symptoms was often equated with the presence of health and well-being. However, recent developments have broadened the understanding of well-being as a positive state of happiness and contentment, with lower levels of distress, overall good physical and mental health and an enhanced quality of life (Jarden and Roache 2023). Notably, the WHO defines health not merely as the absence of disease or infirmity but as a comprehensive state including complete physical, mental and social well-being (World Health Organization WHO 2023). WHO, in partnership with the United Nations H6+ group and Partnership for Maternal, Newborn, and Child Health (PMNCH), has recently proposed an *Adolescent Well-being Framework* encompassing five interconnected domains young people need to develop to achieve well-being (Ross et al. 2020; World Health Organization 2018). These domains involve good health and optimum nutrition, social connectedness and positive values, a safe and secure supportive environment, learning competencies, education and skills, and a sense of identity, self-esteem and resilience (Ross et al. 2020; World Health Organization 2018).

This updated definition has emphasized the importance of nurturing a state of well-being where young people can effectively cope with general life stressors to enhance both collective and individual capacities in daily living (World Health Organization WHO 2023). Embracing this holistic perspective, the present study sought to evaluate and quantify risk factors and vulnerability markers associated with both adolescent depressive symptoms and well-being within a unified framework.

1.5 | Biopsychosocial Risk Factors for Adolescent Depression and Well-Being

Both adolescent depression (Patel et al. 2007; Kieling et al. 2011) and well-being (Avedissian and Alayan 2021) are known to be complex and multifaceted and, therefore, require an in-depth exploration of a multifactorial causal model for assessing overall adolescent mental health. The existing evidence has identified a range of interpersonal, social, health and lifestyle, personality, coping, psychosocial, cognitive, and biological factors contributing to adolescent depression and well-being (Patel et al. 2007; Kieling et al. 2011).

Our recent paper has included a comprehensive background of the risk factors associated with adolescent mental health (Tariq et al. 2024). Specifically, among the *Interpersonal and Social risk* factors, research has identified that young people with healthy habits, adequate physical activity, effective coping strategies, adequate problem-solving, and interpersonal and emotion management skills are more likely to experience good health and well-being (World Health Organization WHO 2021; Colizzi et al. 2020; McGorry and Mei 2018). Contrary to this, environmental stressors, poor parenting experiences, deprived social and family environments, and mental health crises within the family are a few of the leading precursors for adolescent depression (World Health Organization WHO 2021; Patrick et al. 2020; Patel et al. 2007).

Similarly, obesity (Kokka et al. 2023; Hoare et al. 2016), unhealthy eating habits, disordered eating attitudes, and poor physical activity (Lindberg et al. 2020) have been widely recognized as significant *Health and Lifestyle-related* risk factors for adolescent depression and poorer well-being. Furthermore, with the advancement in digital technology, emerging evidence has highlighted the negative impacts of increased social media on young people's overall mental health and well-being (Kelly et al. 2018; Chochol et al. 2023). Moreover, risky behaviors, such as substance abuse, tend to increase during adolescence, with a global prevalence of 22% among young people (World Health Organization WHO 2021). These behaviors significantly increase adolescents' vulnerability to depressive symptoms (Marino et al. 2024; World Health Organization WHO 2021). Besides, more than half of the adolescents with depressive

symptoms have a documented history of self-injurious behaviors, highlighting the significant overlap between depressive symptoms and self-harm during this developmental period (Wu et al. 2024).

Relatedly, *personality factor*s such as higher neurotic traits (i.e., Neuroticism; Chan et al. 2007; Liu et al. 2020) and *coping factors* such as poorer resilience (Anderson and Priebe 2021) and elevated stress levels have been identified as significant correlates of adolescent depression and poorer well-being (Thapar et al. 2012). Compared to previous trends, which primarily focus on intervening to alleviate psychiatric symptoms, existing research has highlighted the necessity to equip young people with skills and strategies to foster positive emotions, enhance resilience and promote overall well-being (Navrady et al. 2018).

Considering the intricate interplay of *psychosocial dynamics*, various social determinants have emerged as pivotal factors influencing adolescents' depression and well-being (Vélez et al. 2016). Negative social experiences, including feelings of social withdrawal, rejection and guilt, can profoundly impact young people's well-being (Rosenblat et al. 2019; Parker and Roy 2001). Moreover, inadequate social and peer support, traumatic bullying experiences, and abusive and distressing encounters can exacerbate adolescents' feelings of isolation, rendering them more vulnerable to depression and diminished well-being (Parker and Roy 2001).

In addition to health and lifestyle, psychosocial, interpersonal and personality factors, research has extensively explored *neural-cognitive factors* that significantly contribute towards adolescents' depression and well-being. Notably, negative neural-cognitive biases (Smith et al. 2018; Gotlib and Joormann 2010), poor self-esteem (Sowislo and Orth 2013), heightened self-critical thinking (McIntyre et al. 2018), excessive rumination (Michl et al. 2013), negative attributional biases (Smith et al. 2018), attentional biases (Ho et al. 2018), memory biases (Smith et al. 2018) and dysfunctional attitudes (Yapan et al. 2020) have all been identified as precursors for adolescents' depression.

Finally, the *biological* factor cortisol—also known as the stress hormone—has received considerable attention as a potential biomarker (Guerry and Hastings 2011). Recent meta-analytical evidence suggests that hyperactivity of the hypothalamic-pituitary-adrenal axis (HPA), characterized by elevated morning and nocturnal cortisol levels, serves as a significant risk factor for the onset of depression during adolescence (Zajkowska et al. 2022). However, research on cortisol concentration has yielded mixed findings, with limited evidence indicating fluctuations in cortisol levels produced by the body's stress response system in adolescents experiencing heightened stress and depressive symptoms (Ford et al. 2019; Kische et al. 2021). Furthermore, although existing findings support the role of cortisol in depression, there are limited studies examining its associations with mild depression or mild depressive symptoms in the adolescent population (Leung et al. 2024). Hence, there is a need for more robust research to thoroughly explore the potential effects of cortisol on the development of depressive symptoms. Furthermore, sleep disturbances such as poor sleep quality, another notable biological indicator, have been found to affect as much as 99% of adolescents displaying depressive symptoms, constituting a significant risk factor with insomnia and hypersomnia serving as diagnostic criteria for depression (Fabbri et al. 2023).

1.6 | Rationale of the Present Study

Taken together, the existing literature strongly supports the importance of various psychological, social, neural-cognitive, biological, lifestyle, and personality factors as indicators of vulnerability to symptoms of depression and well-being among adolescents. However, there are limited comprehensive studies that thoroughly evaluate all these factors simultaneously within a relatively homogenous adolescent sample. Addressing these limitations, the *emotional vulnerability in adolescence* (EVA) study was set up, employing a bio-psycho-social framework and a longitudinal design to overcome the methodological limitations of previous research. The overarching goal of this study is to identify key factors and mechanisms underlying risk and resilience for depression and well-being at baseline, 6-month and 60-month follow-up.

The present article focuses on the data collected at baseline. Employing a hypothesis-driven approach, this study sought to address the following research questions:

1. What are the key vulnerability factors and mechanisms evident at baseline that demonstrate significant association with adolescent depression symptoms and overall well-being?
2. To what extent can these identified vulnerability factors and mechanisms individually and collectively account for depressive symptoms and well-being at baseline?

2 | Methods

Comprehensive details of the methods have been reported in our recently published paper (Tariq et al. 2024). The present section will briefly outline the methodological details relevant to the current analyzes.

2.1 | Study Design

The EVA study was conducted as a longitudinal research program, with data collection spanning three-time points. The present analyzes were based on the cross-sectional data collected from the baseline phase, completed between 2018 and 2019.

2.2 | Participants

A sample of 425 adolescents aged between 12 and 18 years (*Mean age* = 15.06, SD = 1.75) from 12 schools in four council areas in Scotland, UK (Edinburgh, East Lothian, Midlothian, and Kinross) were recruited. The target age range was chosen to encompass the years immediately around the typical onset age for adolescent depression and anxiety (i.e., ~15 years; Kessler

et al. 2005; Lewinsohn et al. 1998). The sample mainly comprised female participants ($n = 257$, 60.5%; *Mean age* = 15.10, SD = 1.72). There was a smaller proportion of male participants ($n = 146$, 34.4%; *Mean age* = 14.86, SD = 1.80). Demographic details are reported in full in the Results Section 2.1.

2.3 | Study Procedure

The study was initially approved by the relevant Research Ethics Committee at the University of Edinburgh (Reference: STAFF 115) and educational councils, followed by further approval by the University of Reading upon relocation of the research team (Reference no. UREC 23_22). A researcher (EG) met the participants within the school premises and provided them with a participant information sheet. Participants returned signed informed consent (for those aged 16 +) or assent forms with parental consent (for those below 16 years). Participants were also asked to provide email addresses and/or phone numbers to receive reminders regarding completing the online tasks/measures and future follow-up studies. After completing the study, participants were provided with a full debrief page, including information signposting them to the organizations they could contact to seek mental health support. Participants were reimbursed with a £10 retail voucher for their participation.

2.4 | Measures

Data collection comprised a face-to-face session, in which participants completed the outcome measures of depression, anxiety and well-being, as well as providing a biological hair sample to assess the hair cortisol concentrations and took home an Actigraph (Philips Respironics, Bend, Oregon) watch for an overnight assessment of sleep quality.

Following the face-to-face session, participants completed a comprehensive battery of standardized scales and tasks via our online platform (formerly known as the Bristol Online Survey tool). This included a demographic and background health questionnaire (age, gender, BMI [height/weight], ethnic background, personal and family mental health history, and medication history), lifestyle factors (including social media usage, physical activity, and risk behaviors, including the frequency and amount of smoking, alcohol consumption and cannabis intake), and a range of age-appropriate standardized measures assessing emotional and cognitive, personality, stress, coping, social, and interpersonal variables. Statistical analyzes were conducted to ensure that all the administered measures were reliable for this sample. Table 1 includes the full list of the measures used and their Cronbach alphas in the present sample. Details of the measures have been described in full in our previous paper (Tariq et al. 2024) and are included in the supporting materials.

2.5 | Data Analysis

All statistical analyzes were conducted using IBM SPSS Statistics version 29 (Statistical packages for Social Sciences). Participant data pertaining to a specific measure was excluded if missing values exceeded 10%. Where missing data accounted for 10% or less, we employed data imputation techniques by substituting missing values with the mean score of each respective participant. Additionally, normal distributions of the continuous variables were evaluated using normal distribution curves and measures of skewness and kurtosis. All continuous variables fell within the recommended range for skewness (± 3) and kurtosis (± 10), as specified by Kline (2011). Further, no significant outliers were observed upon examination of box plots for the total scores of the primary study variables.

Descriptive statistics were analysed to evaluate the baseline characteristics. Pearson Product Moment Correlational analyzes were performed to evaluate the strength of associations between all biopsychosocial factors and scores related to depression and well-being. Additionally, Point Biserial correlations were utilized to examine the relationships between demographic factors and depression and well-being scores, considering the nominal or ordinal nature of demographic data. Data was further screened for the presence of multicollinearity among the independent variables using correlation coefficients, with none of the correlation statistics above 0.80, the recommended cut-off point for high collinearity (Kline 2011). Furthermore, collinearity was evaluated by analysing tolerance statistics and variance inflation factor (VIF) generated through linear regression in SPSS. Tolerance values below 0.10 and VIF values exceeding 10.0 indicate severe multicollinearity among the variables (Field 2018; Kline 2011). In our data set, all variables exhibited tolerance values > 0.20 and VIF statistics < 10.0, thus signifying the absence of multicollinearity among variables. Benjamini-Hochberg False Discovery Rate (FDR) correction was applied using RStudio (Version 1.2.5001) to account for multiple comparisons.

The study utilized the backward elimination method in multiple regression to assess the predictive associations of biopsychosocial factors with depression and well-being. Demographic and biopsychosocial factors with statistically significant correlations with depression and well-being were included in the analysis. The adoption of the backward elimination method stemmed from its efficacy in systematically eliminating non-significant predictors, thus refining the final model to comprise solely statistically significant variables and has been successfully used in our previous study (Smith et al. 2018). This iterative process ensured a streamlined and robust regression model, focusing exclusively on predictors with discernible associations with the outcomes under investigation. Before inclusion in the regression analysis, demographic variables were dummy-coded to enable a comprehensive assessment of the interplay between various factors and the outcomes of depression and well-being.

3 | Results

3.1 | Descriptive Statistics

Table 2 presents the demographic and background characteristics of the participant's health, mental health, and lifestyle factors. In summary, the majority of the sample self-identified as female (60.5%) and from a White ethnic background (70.6%).

TABLE 1 | Summary of the measures used and the Cronbach alpha's in the current sample.

Outcome/Hypothesized factors	Measures	Assessment parameter	No. of items	Cronbach Alpha's
Outcome measures				
Symptoms of depression	Short mood and feelings questionnaire (Angold et al. 1995)	Assess adolescent depressive symptoms in the past 2 weeks, with scores > 12 indicating the presence of depressive symptoms.	13	0.89
Symptoms of anxiety	Generalized anxiety disorder-7 (GAD-7; Spitzer et al. 2006)	Assesses anxiety symptoms in the past 2 weeks, with scores of > 5, > 10, and > 15 indicating mild, moderate, and severe anxiety.	7	0.87
Well-being	Short Warwick Edinburgh mental well-being scale (Stewart-Brown et al. 2011)	Assesses positive thoughts and feelings in the past 2 weeks	7	0.81
Biological				
Hair cortisol	Cortisol concentration within hair sample	Assess cortisol levels in pg/mg over the past month	N/A	N/A
Quality of sleep	Philips Actigraph Watch-2	Assess the quality of sleep for one night with recorded variables including the number of sleep intervals, sleep duration, sleep onset latency (the time taken to fall asleep), sleep efficiency (the duration of sleep during the resting period), and Wake after sleep onset (WASO, the number of awakenings after sleep onset).	N/A	N/A
Health and lifestyle				
Eating habits	Adolescent food habit checklist (Johnson et al. 2002)	Assess healthy and unhealthy eating behaviors, including food intake and dietary habits such as consumption, purchasing, preparing and snacking habits.	23	0.84
Eating disorder risk	Eating attitudes test (Garner et al. 1982)	Assess the risk of eating disorders based on food-related attitudes, feelings, and behaviors	26	0.90
Personality, stress and coping				
Resilience	Brief resilience scale (Smith et al. 2008)	Assess ability to cope and recover from stress.	6	0.83
Stress	Perceived stress scale (Cohen et al. 1983)	Assess perception of unpredictable, uncontrollable, and overloading experiences in the past month.	10	0.88
Neuroticism	Eysenck's short neuroticism scale (Eysenck et al. 1985)	Assess the personality/temperament trait of neuroticism, underpinning the tendency towards experiencing negative emotions such as anxiety, depression, and moodiness.	12	0.79
Social and interpersonal				
External shame	Other as Shamer (Goss et al. 1994)	Evaluate external shame, characterized by a tendency of perceiving negative judgment by others.	18	0.95

(Continues)

TABLE 1 | (Continued)

Outcome/Hypothesized factors	Measures	Assessment parameter	No. of items	Cronbach Alpha's
Level of emotional support	Level of expressed emotions (Cole & Kazarian 1988)	Measure perceived emotional support in their influential relationships.	38	0.93
Bullying and cyberbullying experiences	Traditional bullying and cyberbullying (Hinduja & Patchin 2010)	Evaluate experiences related to bullying and cyberbullying within their school, peer group, and family environments in the past 30 days.	34	0.82–0.89
Cognitive				
Rumination	Ruminative response scale (Treynor et al. 2003)	Assess tendency to ruminate on two dimensions, i.e., brooding (self-criticism and negative evaluation) and reflection (problem-solving thoughts to overcome stress.	10	0.85
Dysfunctional attitudes	Dysfunctional attitudes scale (Power et al. 1994)	Measure dysfunctional beliefs and attitudes.	24	0.88
Attributional bias	Short form of the ambiguous scenarios test for depression in adolescents (Orchard et al. 2018)	Assess tendency to attribute causes to events or behaviors in a negatively biased manner.	9	0.76
Self-referential effect	Self-reference categorization and recall tasks (Kelvin et al. 1999)	Measure negative biases in processing and remembering self-referenced information.	30	N/A

About half of the sample (49.9%) fell within the CDC's (2021) defined ideal weight limit and reported engaging in physical activity (44.2%). Additionally, almost two-thirds (63.1%) of the sample reported the absence of any personal mental health history, while similar proportions of participants reported having a presence (31%) versus absence (34%) of a family history of mental health issues.

While a significant majority of the sample reported that they abstained from smoking (71.3%) or cannabis consumption (75.5%), almost half (45%) reported regular consumption of alcohol from occasional to weekly. A substantial proportion (40.5%) of our sample used five or more social media platforms, including Facebook, Instagram, Pinterest, Snapchat, Tumblr, Twitter, or YouTube, with 44.5% reporting positive feelings associated with using these platforms (See Table 2).

Furthermore, the descriptive findings on outcome measures of depression, anxiety and well-being, as well as on other behavioral, social, interpersonal, and cognitive factors, are presented in Table 3. The descriptive findings to identify the clinical characteristics of the sample indicate that, on average, our sample had relatively low scores on the depression and anxiety scales. However, using the recommended cutoff points (Table 1), a significant minority of participants (22.6%) did show a depression score that suggests possible depressive symoptoms (Table 1).

3.2 | Correlation Analysis

Table 4 shows the Point Biserial correlations between demographic background characteristics and outcome measures of depressive symptoms and well-being. Significant and strong positive correlations were found between depression and demographic factors of age, gender, personal and family mental health history, physical activity, smoking, alcohol and cannabis consumption, social media usage, and the amount of time spent on these platforms during school and nonschool days. Age, gender, personal mental health history, physical activity, social media usage, and time spent on these platforms were also significantly negatively associated with well-being scores. All these associations were significant at $p < 0.01$ with small effect sizes (See Table 4).

Furthermore, Table 5 shows the findings for Pearson product-moment correlations between the hypothesized bio-psychosocial factors and measures of depressive symptoms and well-being. The findings reveal significant and positive associations between depression symptoms and eating disorder risk, stress, neuroticism, others as shamer, emotional support, bullying offending and victimization, rumination, dysfunctional attitudes, and non-self-reference bias. Besides, resilience, attributional bias, and positive self-reference bias were significantly negatively correlated with depressive symptoms. On the contrary, all these bio-psycho-social factors had opposite associations with well-being scores, such that eating disorder risk, stress, neuroticism, others as shamer, level of emotional support, bullying victimization, rumination, dysfunctional attitude and negative self-reference bias were significantly negatively associated with well-being. All the correlations were significant

TABLE 2 | Demographic and background characteristics on health and mental health, and categorical variables on lifestyle factors ($N = 425$).

Demographic variable	Frequency	Percentage	Mean	Std. deviation
Gender				
Males	146	34.4		
Females	257	60.5		
Other or nonbinary	2	0.5		
Missing data	20	4.7		
Age (12–18 years)	420	98.8	15.05	1.753
Missing data	5	1.2		
Ethnicity				
White	300	70.6		
Nonwhite (Asian, Black, mixed, other)	47	11.1		
Missing data	78	18.3		
BMI[1]				
Underweight	15	3.5		
Ideal	212	49.9		
Overweight	24	5.6		
Missing data	174	40.9		
Personal mental health history				
No	268	63.1		
Yes	67	15.8		
Prefer not to say	5	1.2		
Don't know	2	0.5		
Missing data	83	19.5		
Family mental health history				
No	146	34.4		
Yes	131	30.8		
Prefer not to say	3	0.7		
Don't know	57	13.4		
Missing data	88	20.7		
Current medication history[2]				
No	288	67.8		
Yes	44	10.4		
Prefer not to say	6	1.4		
Don't know	3	0.7		
Missing data	84	19.8		
Current use of psychotropic drugs[3]				
No	324	76.2		
Yes	3	0.7		
Unsure	3	0.7		
Physically active[4]				
No	159	37.4		
Yes	188	44.2		
Missing data	78	18.4		

(Continues)

TABLE 2 | (Continued)

Demographic variable	Frequency	Percentage	Mean	Std. deviation
Smokers				
Never	303	71.3		
Less than once a week	15	3.5		
At least one a week	11	2.6		
Everyday	7	1.6		
Missing data	89	20.9		
Alcoholic intake				
Never	152	35.6		
Hardly ever	71	16.7		
Every month	91	21.4		
Every week	30	7.1		
Missing data	81	19.1		
History of cannabis use				
Never	321	75.5		
Yes	27	24.5		
Missing data	77	18.1		
Number of social media platforms used				
1	13	3.1		
2	22	5.2		
3	63	14.8		
4	79	18.6		
5	110	25.9		
6	44	10.4		
7	14	3.3		
> 7	4	0.9		
Missing data	76	17.9		
Feeling for using social media				
Positive	189	44.5		
Negative	21	4.9		
Mixed	30	7.1		
Neutral	110	25.9		
Missing data	74	17.4		
Time spent on social media during school days			3.25	2.17
15 min	35	8.2		
45 min	52	12.2		
75 min	61	14.4		
105 min	48	11.3		
2.5 h.	43	10.1		
3.5 h.	52	12.2		
4.5 h.	25	5.9		
5.5 h.	21	4.9		
6.5 h.	10	2.4		
Missing values	78	18.4		

(Continues)

TABLE 2 | (Continued)

Demographic variable	Frequency	Percentage	Mean	Std. deviation
Time spent on social media during nonschool days			4.58	2.29
15 min	13	3.1		
45 min	21	4.9		
75 min	38	8.9		
105 min	54	12.7		
2.5 h.	40	9.4		
3.5 h.	46	10.8		
4.5 h.	50	11.8		
5.5 h.	39	9.2		
6.5 h.	45	10.6		
Missing values	79	18.6		

[1]BMI was calculated using https://www.stanfordchildrens.org/en/topic/default?id=childrens-bmi-calculator-41-ChildBMICalc; underweight = less than 18.5; ideal = 18.5–24.9; overweight = 25.0–29.9.
[2]Participants were asked if they were currently taking any medication.
[3]Participants were asked to name the medication they are using currently. Medications names were checked by the research team to determine if they fall into the category of psychotropic drugs.
[4]"Physically active" = If participants stated that they were active 2 or more times a week (frequency) and for at least 2 h a week (duration) in total they were coded as physically active.

at $p < 0.01$, with most effect sizes ranging from medium to large. After applying an FDR correction, all correlations remained statistically significant, indicating that the above-observed relationships were robust (See Table 5).

3.3 | Regression Analysis

3.3.1 | Regression Model for Predicting Adolescent Depression

As seen in Table 6, the final regression model was significant, $F(8, 250) = 67.69$, $p < 0.001$ and accounted for 68% variance in depressive scores ($R^2 = 0.68$). Significant predictors identified in the final model include physical activity ($\beta = -0.11$, $p < 0.01$), time spent on social media during nonschool days ($\beta = 0.10$, $p < 0.05$), eating disorder risk ($\beta = 0.13$, $p < 0.01$), stress ($\beta = 0.16$, $p < 0.05$), neuroticism ($\beta = 0.27$, $p < 0.001$), rumination ($\beta = 0.16$, $p < 0.01$), and non-self-reference bias ($\beta = 0.12$, $p < 0.01$). The findings further highlight that all of these biopsychosocial factors predict depressive scores with similar effect sizes, except for neuroticism, which predicts depression with a significantly larger effect size (See Table 6 for full results).

3.3.2 | Regression Model for Predicting Adolescent Well-Being

Table 7. shows the results of the final regression model for well-being scores. The findings suggest that the final model was statistically significant, $F(3, 255) = 91.17$, $p < 0.001$. The predictors collectively accounted for 51% of the total variance in well-being scores ($R^2 = 0.51$). The elimination method systematically removed the least significant predictors, with the final model suggesting that time spent on social media during school days ($\beta = -0.08$, $p < 0.05$), stress ($\beta = -0.44$, $p < 0.001$), and attributional bias ($\beta = 0.36$, $p < 0.001$) were the most significant predictors for poor adolescent well-being. However, the effect size was minimal for social media usage compared to large effect sizes of attributional bias and stress. The R, R2 and adjusted R2 values remained stable across all the models identified during regression results, suggesting a robust predictive model.

4 | Discussion

The current study empirically explored the associations between a range of biopsychosocial risk factors and adolescent depression symptoms and well-being at the baseline of a larger longitudinal study. Investigating these associations was crucial in formulating hypotheses to be tested in full longitudinal models and eventually help support the development of evidence-based preventative and early interventions based on the identified risk and resilience vulnerability markers.

4.1 | Biopsychosocial Risk Factors for Adolescent Depressive Symptoms

The key correlational findings are consistent with previous studies, suggesting that among the demographic characteristics and lifestyle factors associated with adolescent depression symptoms were adolescents' age (Alaie et al. 2023; Kessler et al. 2005), presence of personal or family mental health issues (Schlack et al. 2021), unhealthy lifestyle habits such as smoking, alcohol intake and cannabis use (Schuler et al. 2015), physical inactivity (Gu 2022; Kandola et al. 2020), and excessive social media usage (Vidal et al. 2020). Consistent with previous research, we also found that significantly stronger associations exist between depression scores and eating disorder risk (Calvo-Rivera et al. 2022; Hambleton et al. 2022), higher perceived stress (Braet et al. 2022; Thorsén et al. 2022), more pronounced neurotic traits (Chan et al. 2007; Liu et al. 2020), greater

TABLE 3 | Descriptive results of hypothesized mechanistic variables of the EVA sample ($N = 425$).

Measure	*N*	Mean	Standard deviation	Minimum	Maximum	Range	Theoretical maximum score range
Eating habits	339	11.89	5.11	0	23	23	0–23
Eating disorder risk	325	10.98	11.81	0.00	70.00	70	0–78
Resilience	345	3.05	0.75	1	5	4	1–5
Stress	341	20.17	7.93	0	40	40	10–40
Neuroticism	340	6.94	3.13	0	12	12	0–12
Other as Shamer	337	24.48	15.67	0	72	72	0–72
Level of emotional support	330	78.90	18.23	46.22	134	87.78	38–152
Being a bully	324	2.82	4.40	0	30.22	30.22	0–60
Being bullied	323	6.78	9.21	0	55	55	0–76
Hair cortisol concentration	255	3.26	3.53	0.08	25.96	25.88	N/A
Quality of sleep (sleep efficiency)	287	84.38	6.98	61.10	96.56	35.46	N/A
Rumination	340	21.41	6.32	10	40	30	10–40
Attributional bias	285	5.45	1.25	1.56	8.44	6.89	1–9
Self-reference bias	331	0.50	0.52	−1	1	2	0–12
Nonself-reference bias	331	−0.48	0.66	−1	1	2	0–12
Dysfunctional attitudes	334	89.71	20.18	32.35	141	108.65	24–168
Depression	424	7.61	5.59	0.00	26.00	26	0–26
Well-being	419	21.10	3.79	9.51	35	25.49	9.51–35
Anxiety	414	7.13	5.03	0	21	21	7–21

Note: Measures used to assess: Eating habits = Adolescents food habits checklist; Eating disorder risk = Eating attitudes test; Resilience = Brief resilience scale; Stress = Perceived stress scale; Neuroticism = Eysenck personality questionnaire; Others as Shamer = Other as Shamer scale; Level of emotional support = Level of expressed emotion questionnaire; Being a bully and bullied = Traditional bullying and cyberbullying; Rumination = Ruminative response scale; Attributional bias = Short form of the ambiguous scenarios test for depression in adolescents; Self and non-self-reference bias = Self-reference categorization and recall tasks; Dysfunctional attitudes = Dysfunctional attitudes scale; Depression = Mood and feelings questionnaire; Well-being = Short Warwick-Edinburgh mental well-being scale; Anxiety = Generalized anxiety disorder screener; Range = Highest value – Lowest value; Theoretical maximum score range = provides the range of possible highest and lowest values; Hair cortisol concentration = level of cortisol hormone in pg/mg; Sleep efficiency = otal minutes of sleep during the resting period.

external shame (i.e. apprehensions regarding negative self-judgment) (Rosenblat et al. 2019), poor emotional support (Vélez et al. 2016), increased bullying victimization and offending behaviors (Ye et al. 2023), excessive rumination (Roberts et al. 2021), dysfunctional attitudes (Li et al. 2023) and non-self-bias (Smith et al. 2018).

In addition to replicating previous findings, our study extended our mechanistic understanding by exploring all these risk factors together within one sample. Specifically, when the full range of biopsychosocial risk factors were considered together, the most robust predictors for adolescent depression were identified as low physical activity (Kandola et al. 2019), excessive social media usage (Azem et al. 2023), eating disorder risk (Momen et al. 2022), stress (Thorsén et al. 2022), neuroticism (He et al. 2021; Liu et al. 2020), rumination (Pedersen et al. 2022) and non-self-reference bias (LeMoult et al. 2017).

Our findings on physical activity are aligned with previous meta-analytical findings, which indicate that higher physical activity decreases the odds of adolescents developing depression symptoms by 17% (Schuch et al. 2018). Research further suggests that physical activity stimulates biological and psychosocial processes involved in the pathophysiology of adolescent depression, reduces brain inflammation and enhances resilience to physiological stress (Kandola et al. 2019). Additionally, being active helps improve adolescents' self-esteem, social support and self-efficacy (Kandola et al. 2019). Based on these findings, it can be inferred that exercise and physical activity could have antidepressant effects and hence be potentially incorporated as effective intervention strategies to maximize treatment response in adolescent depression (Kandola et al. 2019).

Recent years have also seen an increasing concern over social media use in adolescents. with a recent survey highlighting that 99% of teenagers in the UK report excessive social media usage, spending approximately 21 h per week on platforms such as YouTube, Facebook, Instagram, Twitter, Snapchat, Tumblr and Pinterest (OFCOM 2023). Our findings, along with those from previous research, suggest that higher social media use does indeed appear to be associated with a higher likelihood of

TABLE 4 | Point biserial correlations between demographic characteristics and symptoms of depression and well-being ($N = 425$).

Demographic variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Age	—																
2. Gender	0.04	—															
3. Ethnicity	0.18**	−0.13**	—														
4. Personal MH	0.09	0.13*	−0.06	—													
5. Family MH	−0.02	0.08	0.03	0.24**	—												
6. BMI	−0.02	0.11	0.05	−0.18**	0.03	—											
7. Medication	0.09	0.092	−0.09	0.14*	0.12*	0.05	—										
8. Smoking	0.20**	−0.15**	0.76**	0.15**	0.09	−0.10	0.03	—									
9. Alcohol intake	0.40**	−0.11*	0.74**	0.16**	0.02	0.01	0.10	0.77**	—								
10. Cannabis usage	0.22**	−0.18**	0.84**	0.18**	0.03	−0.14*	−0.03	0.88**	0.84**	—							
11. Physical activity	−0.12*	−0.19**	−0.04	−0.05	−0.03	−0.05	−0.01	−0.11**	−0.12**	−0.06	—						
12. SM platforms	0.30**	0.24**	0.04	0.16**	0.05	−0.06	0.04	0.10	0.24**	0.06	−0.05	—					
13. SM feeling	0.02	−0.01	0.02	−0.06	−0.10	0.01	−0.02	0.04	0.07	0.01	0.00	0.03	—				
14. Time SM (School)	0.28**	0.15**	0.06	0.09	0.06	−0.12	0.03	0.13*	0.21**	0.09	−0.12*	0.28**	0.12*	—			
15. Time SM (nonschool)	0.29**	0.15**	0.10	0.13*	0.07	−0.14*	0.06	0.13*	0.22**	0.08	−0.15**	0.32**	0.15**	0.83**	—		
16. Depression	0.21**	0.28**	0.05	0.38**	0.25**	−0.10	0.04	0.14**	0.17**	0.12*	−0.19**	0.27**	0.02	0.25**	0.26**	—	
17. Well-being	−0.19**	−0.24**	−0.01	−0.22**	−0.11	−0.00	0.01	−0.05	−0.03	−0.02	0.16**	−0.19**	−0.02	−0.23**	−0.22**	−0.62**	—

Note: ** significant at 0.01 level; * significant at 0.05 level; cells shaded in yellow indicate a small effect size ($0.10 \leq |r| < 0.29$), cells shaded in green indicate a medium effect size ($0.30 \leq |r| < 0.49$), and cells shaded in red indicate a large effect size ($|r| \geq 0.50$). Ethnicity was dummy coded, with White = 1 and Nonwhite = 2, and positive correlations reflect higher scores for Nonwhite participants. Gender was dummy coded as male = 0 and female = 1, with positive correlations reflecting higher scores for females. Personal and family mental health history were coded as no = 0 and yes = 1, with positive correlations indicating a greater likelihood of reporting mental health history. Physical activity was coded as no = 0 and yes = 1, with positive correlations indicating higher engagement in physical activity.

Abbreviations: BMI, body mass index; Family MH, family mental health history; Personal MH, personal mental health history; SM Feeling, perceived feeling for using social media; SM Platform, number of social media platforms used; Time SM (school), time spent on social media during school days; Time SM (non-school), time spent on social media during nonschool days.

TABLE 5 | Pearson product moment correlations between hypothesized biopsychosocial factors and symptoms of depression and well-being ($N = 425$).

Factors	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1. Eating habits	—																					
2. Eating disorder	0.25**	—																				
3. Resilience	−0.01	−0.31**	—																			
4. Stress	−0.04	0.36**	−0.64**	—																		
5. Neuroticism	−0.05	0.31**	−0.64**	0.74**	—																	
6. Others as Shamer	−0.07	0.38**	−0.53**	0.72**	0.69**	—																
7. Emotional support	−0.11*	0.26**	−0.27**	0.44**	0.35**	0.46**	—															
8. Bullying offender	−0.27**	0.21**	0.00	0.09	0.06	0.13*	0.21**	—														
9. Bully victimization	−0.06	0.34**	−0.27**	0.34**	0.28**	0.46**	0.26**	0.48**	—													
10. Hair cortisol	0.01	0.06	−0.03	0.08	0.01	−0.06	−0.10	−0.01	0.10	—												
11. N. Sleep intervals	0.09	−0.06	−0.01	−0.07	−0.17	−0.07	0.03	−0.07	−0.05	−0.03	—											
12. Sleep duration	0.17	−0.04	0.00	−0.09	−0.03	−0.10	−0.16	−0.01	0.05	0.03	−.010	—										
13. Sleep on latency	−0.08	−0.01	0.09	−0.05	−0.08	−0.02	0.01	0.02	−0.02	−0.02	−0.17**	−0.05	—									
14. Sleep efficiency	0.12	0.06	−0.02	−0.01	0.00	−0.04	−0.11	−0.09	−0.04	0.04	0.14*	0.24**	−0.68**	—								
15. Sleep wakening	0.08	−0.03	−0.03	−0.02	0.02	−0.02	0.01	0.12	0.07	0.05	−0.22*	0.55**	−0.05	0.22**	—							
16. Rumination	0.01	0.28**	−0.50**	0.65**	0.61**	0.63**	0.29**	0.11*	0.27**	−0.06	−0.08	−0.09	−0.10	0.01	-0.03	—						
17. Dys. attitudes	−0.02	0.36**	−0.42**	0.47**	0.47**	0.52**	0.40**	0.22**	0.31**	0.03	0.06	−0.08	−0.04	−0.09	0.03	0.45**						
18. Attribution bias	0.10	−0.30**	0.45**	−0.48**	−0.47**	−0.51**	−0.42**	−0.12	−0.28**	−0.04	0.13	−0.03	−0.06	0.04	−0.09	−0.36**	−0.35	—				
19. Self-reference	0.08	−0.15**	0.37**	−0.38**	−0.38**	−0.49**	−0.27**	0.00	−0.17**	0.07	0.06	0.06	0.07	−0.02	−0.01	−0.30**	−0.42**	0.40**	—			
20. Non-self-refer	−0.07	0.20**	−0.27**	0.34**	0.32**	0.41**	0.22**	0.04	0.19**	−0.05	−0.01	−0.07	0.02	−0.02	0.01	0.28**	0.29**	−0.29**	−0.37**	—		
21. Depression	−0.03	0.45**	−0.56**	0.67**	0.64**	0.71**	0.39**	0.17**	0.39**	0.08	−0.12	−0.07	−0.01	−0.00	0.02	0.58**	0.45**	−0.47**	−0.43**	0.40**	—	
22. Well-being	0.12*	−0.28**	0.52**	−0.62**	−0.56**	−0.52**	−0.36**	−0.07	−0.22**	−0.08	0.16	0.00	−0.05	−0.00	−0.03	−0.39**	−0.38**	0.58**	0.35**	−0.27**	−0.62**	—

Note: **Significant at 0.01 level; *significant at 0.05 level; measures used to assess: Eating habits = Adolescents food habits checklist; Eating disorder risk = Eating attitudes test; Resilience = Brief resilience scale; Stress = Perceived stress scale; Neuroticism = Eysenck personality questionnaire; Others as Shamer = Other as Shamer scale; Level of emotional support = Level of expressed emotion questionnaire; Being offending and bullying victimization = Traditional bullying and cyberbullying; Rumination = Ruminative response scale; Attributional bias = Short form of the ambiguous scenarios test for depression in adolescents; Self and non-self-reference bias = Self-reference categorization and recall tasks; Dysfunctional attitudes = Dysfunctional attitudes scale; Depression = Mood and feelings questionnaire; Well-being = Short Warwick-Edinburgh mental well-being scale; Cells shaded in yellow indicate a small effect size ($0.10 \leq |r| < 0.29$), cells shaded in green indicate a medium effect size ($0.30 \leq |r| < 0.49$), and cells shaded in red indicate a large effect size ($|r| \geq 0.50$).

TABLE 6 | Multiple regression analysis using backward elimination predicting adolescent depression symptoms (SMFQ), ($N = 425$).

	Unstandardized coefficient--B	Standard error--B	β	R	R^2	Adjusted R^2	F-value (df)	*p*
Predictors for depression				0.83	0.68	0.67	67.69 (8, 250)	< 0.001
Physical activity	−1.18	0.41	−0.11**					
Time spent on social media during nonschool days	0.23	0.09	0.10*					
Eating disorder risk	0.06	0.02	0.13**					
Stress	0.11	0.04	0.16*					
Neuroticism	0.29	0.10	0.17**					
Others as Shamer	0.10	0.02	0.27***					
Rumination	0.14	0.05	0.16**					
Nonself-reference bias	1.00	0.33	0.12**					

Note: ***significant at 0.001 level; **significant at 0.01 level; *significant at 0.05 level. SMFQ = Short mood and feelings questionnaire (Angold et al. 1995).

TABLE 7 | Multiple regression analysis using backward elimination predicting adolescent well-being (SWEMWBS), ($N = 425$).

	Unstandardized coefficient--B	Standard error--B	β	R	R^2	Adjusted R^2	F-value (df)	*p*
Predictors for well-being				0.72	0.52	0.51	91.17 (3, 255)	< 0.001
Time spent on social media during school days	−0.14	0.08	−0.08*					
Stress	−0.20	0.02	−0.44***					
Attributional bias	1.07	0.15	0.36***					

Note: ***significant at 0.001 level; **significant at 0.01 level; *significant at 0.05 level. SWEMWB = Short Warwick Edinburgh mental well-being scale (Stewart-Brown et al. 2011).

experiencing depression symptoms (Vidal et al. 2020; Kelly et al. 2018). This is in line with a scoping review of 43 empirical studies, which suggested that social media exacerbates depressive tendencies among adolescents, both directly and indirectly (Azem et al. 2023). Directly, constant exposure to carefully curated images and information, and the pressure to conform to unrealistic standards fosters negative emotions and depression (Vidal et al. 2020; Kelly et al. 2018). Indirectly, social media has been suggested to contribute to decreased outdoor and physical activity, excessive emotional eating driven by poor self-esteem and body image issues, reduced quantity and quality of sleep, increased internet addiction and cyberbullying experiences (Azem et al. 2023). These direct and indirect effects encompass a range of biopsychosocial factors discussed in this study that can cumulatively lead to increased depression symptoms over time (Azem et al. 2023).

Additionally, previous literature suggests comorbidity between depressive disorders and eating disorders (Calvo-Rivera et al. 2022; Hambleton et al. 2022), with a meta-analytical estimate from 42 empirical longitudinal studies indicating that eating disorders and depressive disorders are concurrent risk factors for each other (Puccio et al. 2016). While the present cross-sectional findings alone cannot be interpreted to suggest causal relationships, they align with broader research suggesting a bidirectional relationship between depression and eating disorders. Specifically, adolescents eating disorder concerns stemming from maladaptive food-related attitudes, feelings, and behaviors are likely to contribute to the development of depressive symptoms (Kenny et al. 2022). Conversely, depressive symptoms may also exacerbate or predict eating concerns, such as loss of appetite, dietary restraints, or binge eating behaviors (Kenny et al. 2022). These findings highlight the unidirectional aspects of this association observed in the current study, while future research is needed to disentangle and further explore these bidirectional pathways.

Among the personality and coping risk factors, stress and neuroticism have been widely identified as dependent and reciprocal risk factors towards adolescent depression (Morken et al. 2024; Metts et al. 2021). A recent longitudinal study suggested that neurotic adolescents with heightened negative emotions are likely to experience stress more intensely (Metts et al. 2021). In turn, higher stress levels make these adolescents more prone to experiencing greater negative emotional states (Metts et al. 2021). Our findings further corroborate this, identifying both stress and neuroticism as significant predictors of adolescent depression.

Finally, rumination and negative self-reference bias were the only cognitive risk factors identified as significant predictors of adolescent depression in the present study. Aligned with previous research, these findings suggest that higher ruminative responses towards low mood make adolescents vulnerable to the onset of depressive disorders (Smith et al. 2018; Wilkinson et al. 2013). These findings suggest that adolescents who frequently engage in repetitive thinking about personal problems, particularly through passive comparisons of their current situations with more desirable and unattainable ones, are at risk of developing depression symptoms (Pedersen et al. 2022). Similarly, this is in line with cognitive theories of depression, which have largely emphasized the role of negatively biased self-referential cognitions across different cognitive domains in contributing to the onset, maintenance, and recurrence of depressive symptoms (LeMoult et al. 2017; Beck 1967). Our findings further support the value of interventions that focus on helping adolescents develop more adaptive ways of processing information in response to low mood (LeMoult et al. 2017).

4.2 | Adaptive Factors Promoting Adolescent Well-Being

Contrary to the risk factors identified for adolescent depression, the present study highlights several protective and resilience factors that can help promote well-being in this critical developmental phase. Among the range of demographic and lifestyle factors studied in relation to well-being, our findings are consistent with previous research in suggesting that adolescents who experience fewer personal mental health crises (Department of Health 2017), engage in regular physical activity (Costigan et al. 2019; McMahon et al. 2017), and limit their time on social media (Twenge 2019) are more likely to achieve greater well-being. In addition, our findings are consistent with previous research in suggesting that biopsychosocial factors such as eating disorder risk (Bucchianeri et al. 2016), stress (Branson et al. 2019), neuroticism (Fadda and Scalas 2016), others as Shamer (Mendes et al. 2022), level of emotional support (Wang et al. 2019), bullying victimization (Andreou et al. 2020), rumination (Arnarson et al. 2016), dysfunctional attitudes (Smith et al. 2018; Stein and Grant 2014) and negative self-reference bias (Smith et al. 2018) are all associated with adolescent well-being.

It should be noted that, amongst all, a relatively small subset of factors (namely social media usage, attributional bias, and stress) can account for over half of the variance in poor well-being. Theoretically, stress has been proposed as influencing adolescents within a multilevel framework, permeating physiological, emotional and behavioral domains (Sigfusdottir et al. 2017). These multifaceted effects of stress impact adolescents' health, directly and indirectly, such that stress manifests in physiological responses that disrupt mood regulation, sleep patterns and overall physical health, contributing to a decline in overall well-being (Sigfusdottir et al. 2017). Indirectly, stress interacts with various biopsychosocial factors, exacerbating issues such as eating disorders, negative cognitions and emotional support deficits, all of which can significantly impact adolescent's well-being (Branson et al. 2019). Understanding the complex interplay between stress and these factors is crucial for developing comprehensive strategies to support adolescents' well-being. As discussed earlier, well-being involves optimum health and happiness across various domains. Stress, on the other hand, affects multiple domains simultaneously. Therefore, addressing and managing stress across all these domains is essential to cultivate a comprehensive sense of well-being.

Moreover, attributional bias is a neural-cognitive factor which involves individuals' tendency to attribute positive situations to *internal, stable and global* causes while attributing negative situations to *external, unstable and specific* causes (Sanjuán and Magallares 2014). The findings, consistent with previous literature, suggest that with positive attributional bias, adolescents

are likely to interpret events positively, believing that these situations arise from within, will persist in the future and apply across different domains (Smith et al. 2018; Sanjuán and Magallares 2014). As a result, young people are likely to experience a greater sense of well-being, satisfaction and happiness (Margolis and Lyubomirsky 2018; Sanjuán and Magallares 2014). This indicates that how adolescents interpret and evaluate life events can be a protective and adaptive mechanism, significantly influencing their overall happiness and health (Rueger and George 2017).

Finally, social media usage also demonstrated significant negative associations with well-being in the present sample. While these findings align with current research (Guo and Cheung 2023), the effect size reported here was relatively small. Nevertheless, the growing body of evidence has collectively suggested that excessive social media usage has led young people towards social displacement, i.e., time spent on social media has replaced face-to-face interactions with friends and family (Hall and Liu 2022). Excessive social media could also lead to other mental and physical health crises, such as low self-esteem, eating disorder concerns, anxiety and depressive conditions, and sleep disturbances, that could directly target the overall quality of life and well-being among adolescents (Guo and Cheung 2023). Despite the potential harms associated with social media, recent research highlights its potential benefits, particularly in providing young people with a positive sense of community and connection with others with similar identities, abilities and interests (Office of the Surgeon General OSG 2023; O'Reilly 2020). Furthermore, research suggests that social media-based psychoeducation and other digitally delivered mental health interventions can be effective in helping young people access support and resources without the fears or concerns often associated with mental health stigma (Office of the Surgeon General OSG 2023; O'Reilly 2020).

Interestingly, our analysis revealed that biological factors, such as sleep and stress hormone levels, did not emerge as significant predictors of outcomes in adolescents. These findings stand in contrast to studies in adults, where these factors have been shown to play a crucial role (James et al. 2023; Li et al. 2023). These discrepancies suggest that risk and resilience may vary across developmental phases, likely due to different bio-psychosocial functioning (Agnafors et al. 2017). It might be possible that unique developmental dynamics and social contexts during adolescence overshadow the impact of biological factors that are more prominent in adulthood (Agnafors et al. 2017).

4.3 | Clinical Implications

Our findings highlight critical gaps in the current diagnostic and treatment approaches to adolescent depression, which heavily relies on adult depressive criteria (Axelsdóttir et al. 2021; Bernaras et al. 2019). Additionally, current mainstream interventions predominantly prioritize alleviating the outward symptoms of depression rather than addressing and targeting the underlying biopsychosocial factors and mechanisms (Rikard-Bell et al. 2022; Axelsdóttir et al. 2021). These adult-centric and symptom-focused treatments lead to significant clinical limitations, including treatment confusion, inadequate conceptualization of adolescent depression and suboptimal differentiation from adult depressive disorder (Rikard-Bell et al. 2022). These limitations highlight the need for interventions tailored to the unique vulnerability markers and modifiable risk factors associated with adolescent depressive symptoms.

The identified predictors for adolescent depression—physical activity, social media usage, stress, rumination, negative reference bias, neuroticism, and eating disorder risk—offer actionable targets for prevention and treatment. While neuroticism, a stable personality trait, may not be easily modified through direct interventions, the other factors are modifiable and can be effectively addressed through evidence-based strategies. *Stress management training* and school-based resilience programs are critical tools to equip adolescents with skills to manage stress and build resilience, reducing their vulnerability to depressive symptoms (Kallianta et al. 2021; Pinto et al. 2021). *Psychoeducation programs* focusing on healthy social media usage, body image, and eating habits can help mitigate the negative effects of excessive social media usage, reduce maladaptive eating behaviors, and improve self-esteem (Alleva et al. 2015). These strategies address specific risk factors and promote balanced digital engagement and healthier self-perceptions.

Programs integrating *Cognitive Behavioral Therapy (CBT)* and *Acceptance and Commitment Therapy (ACT)* may provide additional support by addressing maladaptive thought patterns, enhancing problem-focused coping, and reducing ruminative thinking style (Pickerell et al. 2023). Additionally, although *mindfulness-based interventions* have shown mixed efficacy in recent studies (Phan et al. 2022), specific mindfulness techniques can still enhance emotional regulation, reduce stress reactivity, and foster resilience in managing depressive symptoms (Fulambarkar et al. 2023). Incorporating physical activity into treatment plans is equally crucial, as regular exercise offers well-documented mental health benefits, and protects against depressive symptoms and improves well-being (Blumenthal and Rozanski 2023).

Furthermore, recognizing the importance of supporting mental health beyond the absence of symptoms, the present study highlights stress, attributional bias, and social media usage as key predictors of adolescent well-being. By integrating these findings, clinicians can devise targeted prevention and intervention strategies that address the underlying causes and outward symptoms of poor mental health. This holistic approach moves beyond symptom reduction to enhance overall well-being, equipping young people with effective coping strategies to build resilience and better manage the challenges of everyday life stress, ultimately promoting sustained mental health over the long term.

4.4 | Limitations and Future Directions

Several limitations of the present study need to be considered when interpreting the findings. First, despite the high reliability of the measures we found in the current sample, they were primarily self-reported measures that are subject to common biases such as social desirability and recall bias. Secondly, given

the large battery of measures, we could not conduct a detailed assessment of all the variables; for instance, The actigraph-based sleep assessment was limited to a single night. Additionally, only cortisol concentrations were assessed as the sole biological marker for depression. Future research should explore detailed sleep assessments and additional hormones—such as estrogen, progesterone and testosterone—to provide a comprehensive understanding of the biological mechanisms contributing to adolescent depression and its gender disparities. Longitudinal sleep assessment would further offer deeper insights into sleep disturbances and their relationship with adolescent depressive symptoms. Future studies could enhance objectivity by incorporating additional real-time behavioral data or caregiver/guardian reports as collateral information to strengthen the validity of findings.

Third, although missing data were dealt with appropriately, the presence of missing data potentially reduced the statistical power of some of the analyzes/variables, leading to underestimation or overestimation of the relationship between variables. Future research should explore advanced imputation techniques or incorporate a large sample size to minimize this limitation.

Fourth, TikTok, a popular social media platform, could not be assessed as it was relatively new and not widely known when the study was designed and launched in 2018–2019. Future research should include emerging digital behaviors and social media usage patterns to understand their impact on adolescent mental health.

Fifth, the present study was based on cross-sectional data, which limits the ability to make causal inferences and robust predictive conclusions. To overcome this limitation, the current project has employed a longitudinal design, and future research outputs will provide more robust findings to test causal inferences. However, the findings reported here are necessary for informing hypotheses to be tested in the longitudinal follow-up. Additionally, the present findings rely on regression analyzes, which, while effective in identifying direct linear pathways and significant links, do not capture advanced mechanistic pathways such as indirect effects, bidirectional relationships, or causal inferences. Future research employing advanced statistical techniques, such as SEM, path analysis or mediation analysis, would be beneficial in understanding the mechanisms underlying these links.

Finally, the sample consisted of only Scottish participants and, like many studies, there was an over-representation of female and ethnically White participants, which may limit the generalizability of the findings. Future research should include more diverse and representative samples to enhance the external validity and explore sociocultural differences in mental health outcomes.

Furthermore, future research should prioritize investigating the underlying features of depression, including cognitive impairments and its comorbidity with conditions such as ADHD and other neurodevelopmental disorders, which can obscure accurate diagnosis and complicate treatment strategies. Additionally, research should explore depression within diverse clinical contexts, emphasizing the interaction between comorbid conditions to better inform targeted interventions for adolescent depression.

5 | Conclusion

The present findings have offered novel insights into the associations between a wide range of biopsychosocial risk and resilience factors and adolescent depressive symptoms and well-being within a single study. Our findings indicate that low physical activity, excessive social media usage, eating disorder risk, neuroticism, rumination, and negative self-reference bias were significant correlates of adolescent depressive symptoms (albeit within a one-time point). Conversely, attributional bias and low stress have emerged as significant resilience factors for well-being. These results underscore the importance of addressing these factors in early intervention to improve adolescent mental health and overall well-being.

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Conflicts of Interest

Author C, Alice Gregory, is an advisor for a project initially sponsored by Johnson's Baby. She was a consultant for Perrigo (2021+). She receives royalties for two books, Nodding Off (Bloomsbury Sigma, 2018) and The Sleepy Pebble (Flying Eye, 2019) and a sleep gift (The Gift of Sleep, Lawrence King Publishers, 2023). She was previously the CEO of Sleep Universal LTD (2022). She regularly contributes to BBC Focus Magazine and other outlets (such as The Conversation, The Guardian and Balance Magazine). She occasionally receives sample products related to sleep (e.g. blue light-blocking glasses) and has given a paid talk to a business (Investec). She is a specialist subject editor at JCPP (sleep), for which she receives a small honorarium. She has contributed a paid article to Neurodiem. Authors Asnea Tariq, Elaine Gray and Stella W. Y. Chan declare no conflicts of interest.

Data Availability Statement

Open Science Framework: Emotional Vulnerability in Adolescents (EVA), https://doi.org/10.17605/OSF.IO/EKMAH.

This project contains the following underlying data

- EVA--Baseline Data. sav.

Peer Review

The peer review history for this article is available at https://www.webofscience.com/api/gateway/wos/peer-review/10.1002/mhs2.70010.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.