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Publication Date

2023-10-01

DOI

10.1016/j.jad.2023.05.036

Peer reviewed

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Journal of Affective Disorders 338 (2023) 92–99

Contents lists available at ScienceDirect

Journal of Affective Disorders

journal homepage: www.elsevier.com/locate/jad

Emotion regulation difficulties and sleep quality in adolescence during the early stages of the COVID-19 lockdown

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ARTICLE INFO

Keywords:
Adolescence
Emotion regulation
Sleep
COVID-19
Lockdown

ABSTRACT

Introduction: Adolescence is a period of vulnerability for emotion regulation and sleep difficulties, risks that might be compounded by intense COVID-19 lockdowns and challenges. The aim of this study was to investigate how sleep quality related to emotion regulation difficulties in adolescents during lockdown in Perú.
Methods: Participants were 2563 adolescents enrolled in Innova school in Perú (11 – –17 years) in May 2020. Hypotheses were derived from exploring one half of the sample, preregistered at https://osf.io/fuetz/, and then confirmed in the second half of the sample. Participants completed subjective surveys of sleep quality (short PSQI) and the Difficulties in Emotion Regulation Scale Short Form (DERS-SF).
Results: Worse sleep quality was robustly associated with more difficulties in emotion regulation across both samples. The association was found particularly for emotion regulation subscales related to the ability to engage in goal directed behavior in the face of distress, emotional clarity and strategies to deal with feeling distressed. In contrast, there was no robust association between sleep and the ability to regulate impulses in the context of negative emotions, and no association with the ability to accept emotions. Girls and older adolescents robustly endorsed worse sleep quality and more difficulties in emotion regulation.
Limitations: The cross-sectional nature of this study prevents us from determining the direction of the association. Data were collected using adolescent self-report which, while informative of adolescent perceptions, might diverge from objective measures of sleep or emotion regulation difficulties.
Conclusions: Our findings with adolescents in Perú contribute to our understanding of the association between sleep and emotion regulation at a broader global scale.

1. Introduction

Mood disorders are on the rise for adolescents (Hawke et al., 2020; Ren et al., 2021; Zhou et al., 2020). There are several underlying mechanisms for mood disorders that undergo transformation in adolescence, including emotion regulation and sleep (Palmer and Alfano, 2017). Even before the pandemic, adolescence was a particular period of vulnerability for many of these factors including emotion regulation difficulties (Young et al., 2019) and sleep disruption (Carskadon, 2011; Vazsonyi et al., 2021). Stressors associated with the pandemic have compounded these issues, with evidence of more difficulties in emotion regulation (Breaux et al., 2021; Kaditis et al., 2021; Silk et al., 2021) and increased problematic sleep (e.g. worse sleep quality) (Gruber et al., 2021).

Emotion regulation in adolescence.

Difficulties in emotion regulation, or emotion dysregulation, refer to deficits in the ability to modulate the intensity or the valence of emotions (Bradley et al., 2011; Gross, 2013), and in turn, control responses or behavior. According to Gratz and Roemer (2004), trait-level perceived emotion regulation difficulties include impact to:

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https://doi.org/10.1016/j.jad.2023.05.036
Received 9 November 2022; Received in revised form 26 April 2023; Accepted 11 May 2023
Available online 23 May 2023

awareness or understanding of emotions, **acceptance** of emotions, ability to control **impulsive** behaviors, ability to behave accordingly to meet **goals** when distressed, and ability to apply appropriate emotion regulation **strategies** when needed. Thus, emotion regulation difficulties might prevent an individual from achieving their goals in the context of negative affect (Hallion et al., 2018).

Emotion regulation develops throughout adolescence, as youth learn to regulate their affective expression in adaptive ways (Gratz and Roemer, 2004). Compared to younger children, adolescents develop more adaptive emotion regulation strategies (Young et al., 2019). However, important age differences emerge *within* the span of adolescence. During mid-adolescence (at ages 13 and 15) there is a reduced range of emotion regulation strategies compared to early adolescents, late adolescents and adults (Zimmerman and Iwanski, 2014). In tandem, there is an increase in applying more maladaptive strategies in mid-adolescence (Sanchis-Sanchis et al., 2020).

Furthermore, there is some evidence that sex can also impact developmental trajectories of emotion regulation difficulties. For example, Bender et al. (2012), reported that girls have more difficulties in emotion regulation than boys. Girls apply different emotion regulation strategies than boys (Aldao et al., 2010; Bender et al., 2012; Silk et al., 2003; Zimmerman and Iwanski, 2014). In contrast, Weinberg and Klonsky (2009) reported no sex differences.

Emotion regulation difficulties are associated with psychopathology in adolescence (Dahl, 2004; Silk et al., 2003; Weinberg and Klonsky, 2009; Young et al., 2019). Maladaptive emotion regulation strategies, such as rumination, avoidance, and suppression, are associated with psychopathology, especially internalizing symptoms (Aldao et al., 2010). Conversely, adolescents that show higher levels of emotion regulation present fewer symptoms of depression and anxiety (Schäfer et al., 2017; Young et al., 2019).

1.1. Relationship between sleep and emotion dysregulation in adolescence

Adolescents require good and sufficient sleep to promote developmental and mental health (Weinberg and Klonsky, 2009). However, as a result of a "perfect storm" in which biological factors of puberty-induced delayed bedtime interact with psychosocial factors of early school hours and evening social activities (Carskadon, 2011), sleep patterns of adolescents deteriorate with age (Becker et al., 2018, 2021; Madrid-Valero et al., 2017; Ramos Socarras et al., 2021). Over the course of development, adolescents go to bed at increasingly later hours (Carskadon, 2011; Crowley et al., 2018), with steady decreases in sleep duration (Machado et al., 2020). Concurrently, the frequency of sleep problems rises at this stage (Bartel et al., 2015), as inadequate sleep rates increase from age thirteen to seventeen (Dorofaeff and Denny, 2006).

Sleep and emotion regulation are closely associated (Kirwan et al., 2017, 2019). In addition to the fact that emotional states affect sleep, sleep is also essential for regulating emotion. The quantity and quality of sleep affect how an individual responds to emotional events that occur during the day, which in turn affects how they feel overall. Sleep problems are involved in the development of emotional disorders for adolescents (Palmer and Alfano, 2017). Chronic sleep loss in adolescence has an impact on adolescents' mental health (Fairholme and Manber, 2015; Owens et al., 2014). Insufficient sleep on school nights hinders adolescents' ability to regulate their emotions (Baum et al., 2014). Palmer et al. (2018) indicated that adolescent sleep problems are related to emotional disorders probably via maladaptive emotion regulation strategies as adolescents may be more vulnerable to the emotional effects of sleep problems. Female adolescents report having more inadequate sleep than male adolescents, even when taking into account biological maturation (de Matos et al., 2019; Dorofaeff and Denny, 2006).

Relatively more research is focused on how sleep quality impacts emotion regulation difficulties. Yet, it is unclear how specific domains of emotion dysregulation impact sleep. Negative emotions before bedtime are associated with increased sleep difficulties (Vandekerckhove et al., 2011). In addition, daytime problems might impact sleep quality leading to difficulties regulating emotion(s) before bed (Grove et al., 2016). The literature on sleep dysfunction and emotion regulation difficulties has focused more on quantity than quality (Palmer and Alfano, 2017). More research is needed to elucidate the association of emotion regulation difficulties and sleep quality (Becker et al., 2018; Fairholme and Manber, 2015).

1.2. Sleep and emotion regulation during the pandemic

COVID-19 related home confinement altered daily routines, which, along with reduced daylight exposure, have likely disrupted circadian rhythm and sleep patterns, potentially leading to an increase in sleep disturbance, including poor sleep quality and insomnia (Altena et al., 2020; Bacaro et al., 2020; Becker et al., 2021; Bruni et al., 2022; Cellini et al., 2020; Gupta et al., 2020; Morin et al., 2020). In turn, these increased sleep problems were linked to emotional disorders like depression and anxiety during the early stages of the COVID-19 pandemic in adults (Bacaro et al., 2020; Cellini et al., 2020; Gupta et al., 2020; Morin et al., 2020).

Most of the research studies in this regard focused on the adult population; however, adolescents are under greater negative influence of such lockdown measures and school disruptions than adults and children (Altena et al., 2020; Lavigne-Cerván et al., 2021). Adolescents may experience more emotion regulation difficulties in the face of the many challenges of the COVID-19 pandemic (Robillard et al., 2021; Weissman et al., 2021), and are still developing psychological coping skills needed to handle the crisis (Jones et al., 2021). Home confinement had a negative impact on adolescent mental health and sleep (Lavigne-Cerván et al., 2021). However, relatively few studies have described how sleep quality and sleep duration are associated with the domains of emotion regulation difficulties *during* the pandemic (Bacaro et al., 2020; Casagrande et al., 2020; Liu et al., 2020). Furthermore, from a developmental perspective, sex and age differences over the course of adolescence may play a role in the potential vulnerability to the effects of lockdown measures on sleep (Alfonsi et al., 2021; Gualano et al., 2020; Kaditis et al., 2021; Sinha et al., n.d.) and on emotion regulation (Panayiotou et al., 2021).

2. Current study

In summary, over the course of the adolescent years, both emotion regulation and sleep undergo profound transformation, with some evidence for sex and age specific differences. These developing processes impact each other and potentially contribute to the adolescent vulnerability to mood disorders.

In the current study, we investigated the cross-sectional association of sleep duration, sleep quality, and emotion regulation difficulties in a relatively large sample of adolescents (ages 11–17) in low- and middle-income settings in Perú during the early stages of the COVID-19 pandemic (May 2020), a period characterized by a very stringent national lockdown.[1] This study aimed to be an initial investigation of the association between sleep quality and emotion regulation domains in adolescents in the context of the pandemic. We further examined sex- and age-related differences in sleep duration, sleep quality and emotion regulation difficulties. Given the relatively large sample size, we implemented a split-half reliability analysis approach, using an exploratory sample and a confirmatory sample. Based on exploratory analyses, we pre-registered the following hypotheses: 1) There are robust sex differences in sleep and emotion regulation with girls endorsing worse sleep quality and more emotion regulation difficulties. 2) There are

[1] In May 2020, Perú had a country COVID-19 Stringency Index of 94.9 (in a scale where 100 = strictest) (Hale et al., 2021)

robust age-related differences in sleep and emotion regulation with older adolescents endorsing worse sleep quality and more emotion regulation difficulties. In addition, in non-registered analyses, to better characterize these associations, we explored non-linear quadratic age effects on sleep and emotion regulation difficulties. 3) Poor sleep quality is associated with more general emotional regulation difficulties. Specifically, we hypothesized that the effect would be greatest for the Goals subscale.

3. Methods

3.1. Participants

Participants were students from 63 Innova Schools sites across Perú: a fairly homogenous network of low-cost private schools that cater to emerging middle-class urban families with similar socio-economic status. A total of 2563 adolescents (53.5 % girls) between grade 6th and 11th (M_{age} = 13.48, SD = 1.63, range = 10.4–17.4 years) in low- and middle-income urban settings in Perú participated in the study. Data are part of a larger project which delivered a short six-week program designed to promote well-being and healthy technology use during the COVID-19 lockdown (for details see Magis-Weinberg, 2021). All students were subject to the same strict national level lockdowns and school level restrictions: all students were confined at home, were not able to leave and were participating in school remotely. However, due to limited time to administer the survey, we were not able to collect individual level metrics on COVID-19 impacts.

3.2. Procedure

Data were collected on the week of May 11th, 2020 (which corresponds to Week 9 of lockdown in Perú). Questionnaires in Spanish were distributed through Qualtrics as part of the advisory period of the remote regular school curriculum. After providing demographic information, participants completed a battery of self-report surveys on sleep quality and emotion regulation. Passive parental consent and adolescent implicit assent (by choosing to click on the survey link) was employed. Ethics approval was granted by the university human subjects committee.

3.3. Split-half reliability approach

For analyses purposes, we split our sample randomly into two halves. We first conducted exploratory analyses in Sample 1 (n = 1282, 53 % girls). Based on these findings we pre-registered hypotheses (see Open materials and code section), which we then sought to confirm in a holdout Sample 2 (n = 1281, 53.6 % girls). Results were considered robust if effects were statistically significant ($p < .05$) and the coefficient estimates were in the same direction across samples.

3.4. Open materials and code

Detailed information of measures, hypotheses and analyses scripts for cleaning, splitting, analyzing and plotting the data have been posted to the Open Science Framework (https://osf.io/fuetz/).

3.5. Measures

3.5.1. Emotion regulation difficulties

Emotion regulation difficulties were assessed via the eighteen-item Difficulties in Emotion Regulation Scale Short Form (DERS-SF, Kaufman et al., 2016). Participants report on the different 6 subscales of emotion regulation (Clarity, Nonacceptance, Impulse, Goals, Strategies, and Awareness) on a five-point scale (ranging from one for "almost never" to five for "almost always"). Higher scores in DERS-SF refer to more emotion regulation difficulties. We removed Awareness from our analyses as suggested in literature (Hallion et al., 2018; Weinberg and Klonsky, 2009) because it shows poor correlation with other subscales and its inclusion reduces model fit. Cronbach's alpha was 0.81 in both Sample 1 and Sample 2. The DERS-SF measure is a common, well-validated scale use of emotion regulation in adolescent samples in Latin America (Gómez-Simón et al., 2014; Reivan-Ortiz et al., 2020).

3.5.2. Sleep duration

Sleep duration in hours was calculated from self-reported bedtime and risetime.

3.5.3. Sleep quality

Sleep quality was assessed via a shortened version of the Pittsburgh Sleep Quality Index (PSQI, Buysse et al., 1989), in which participants reported sleep quality over the past month, including the following four domains: sleep duration, sleep latency, subjective sleep quality, and daytime dysfunction. The raw data of four domains were converted into a Likert scale of 0–3, with 0 indicating a positive extreme and 3 a negative extreme, based on scoring suggestions established by Buysse et al. (1989). The total score of this shortened version of PSQI is 12 points, where higher scores indicate worse sleep quality. Cronbach's alpha was 0.74 in Sample 1 and 0.73 in Sample 2. The PSQI measure is a common, well-validated scale use of sleep quality in adolescent samples in Latin America (Gelaye et al., 2014).

3.6. Data analyses

3.6.1. Data processing and cleaning

Participants who did not answer one question item of short PSQI or five question items of DERS-SF were excluded (Sample 1: n = 121; Sample 2: n = 120). Individuals who selected the same answer for every DERS-SF item were excluded (Sample 1: n = 3; Sample 2: n = 7). Predictor variables were median centered.

3.6.2. Descriptive analysis

All data analyses were conducted in R 4.0.2 (R Core Team, 2020) using *apaTables* to calculate mean and standard deviations and bivariate correlations between variables (Stanley and Spence, 2018), and *compareGroups* for group comparisons (Subirana et al., 2014). We investigated sex and age differences on sleep duration, sleep quality and DERS-SF subscales.

3.6.3. Hypothesis testing

Using linear regressions, we investigated whether emotion regulation difficulties and its subscales were associated with sleep quality. Sleep quality was the dependent variable in all models. DERS-SF subscales were the main independent variables. Sex and age were included as main effects to control for potential differences between groups.

Model fitting was performed using R 4.0.2 (R Core Team, 2020). Following a split half analysis procedure, for Sample 2 we ran confirmatory analyses with models that were pre-specified and pre-registered at https://osf.io/fuetz/ to test the hypotheses derived from exploratory analyses conducted on Sample 1.

3.6.4. Deviations from pre-registered analyses

We also ran separate models using each DERS-SF subscale as an outcome variable, sex as a covariate and linear and quadratic components of age to test for non-linear age trajectories.

4. Results

4.1. Age and sex differences

We assessed sleep duration, sleep quality (short PSQI total), and emotion regulation difficulties (DERS-SF total and DERS-SF subscales). Mean scores by sex for the two samples are presented in Table S1.

Correlations among variables are presented in Tables 1 and 2.

For *sleep duration*, in Sample 1, participants reported sleep for 8.41 h on average. In Sample 2, participants reported 8.42 h on average. There were no sex differences on sleep duration in either sample (Table S1). However, sleep duration was negatively associated with age across samples (Tables S2 and S3), such that older adolescents had the lowest levels. In terms of *sleep quality*, in both samples, girls (Table S1) and older adolescents (Tables S2 and S3) had worse levels as indicated by higher short PSQI scores. A model including a quadratic effect of age on sleep quality did not outperform the linear model for age in neither Sample 1 ($F(1, 1265) = 0.16$, $p = .68$), or Sample 2 ($F(1,1264) = 0.70$, $p = .40$).

DERS-SF total was higher for girls than boys (Table S1). A robust pattern of higher ER challenges for girls across samples was observed for total ER and for the following subscales: Clarity, Nonacceptance, Goals, and Strategies. However, there were some results that did not replicate across samples. For Impulse, only in Sample 1 did girls have more challenges than boys (Table 3).

Across samples in models controlling for sex, the Goals subscale exhibited a robust quadratic association with age, with relatively stable values until 13 and 14 years, and higher levels of difficulty for 15 and 16 years (Tables S2 and S3, Fig. 1). In addition, across samples, Clarity and Non-acceptance had linear associations with age. In Sample 1, Impulse and Strategies also had linear and quadratic associations with age. However, this did not replicate in Sample 2.

4.2. Sleep quality and emotion regulation

Worse sleep quality was robustly associated with more difficulties in Clarity, Goals, and Strategies but not with Nonacceptance across both samples (Table 3). Across both samples, Goals was the subscale with the largest effect size (Table 1). In Sample 1, there was also an association between sleep quality and Impulse, which did not replicate in Sample 2.

5. Discussion

We examined associations among sleep and different subscales of emotion regulation difficulties in adolescents during the most stringent stage of COVID-19 lockdowns in Perú. We investigated sex and age-related differences. Using a split-half approach and pre-registered analyses, we investigated this question across exploratory and confirmatory subsets of a sample of low- and middle-income adolescents, which allowed us to test for within-sample replication.

In relation to our first hypothesis, we found that adolescents who showed worse sleep quality had more emotion regulation difficulties, as predicted. This finding is consistent with previous literature. Systematic reviews on sleep and emotion regulation found that poor sleep quality was related to difficulties in regulating emotions both for adults and adolescents (Kirwan et al., 2019; Palmer and Alfano, 2017). A study with adolescents aged 13 to 17 years, demonstrated that adolescents who reported more sleep problems showed worse use of emotion regulation strategies, in addition to being more likely to develop a mood disorder (Palmer et al., 2018). Our results indicate that in pandemic conditions the relationship between sleep quality and emotion regulation difficulties continues to hold.

To further explore the relationship between sleep quality and emotion regulation difficulties, we examined DERS-SF subscales. When controlling for age and sex, more emotion regulation difficulties in terms of Clarity, Goals, and Strategies were robustly associated with worse sleep quality. Clarity, Goals, and Strategies have been previously identified as the specific emotion regulation difficulties explaining unique variance in clinical severity in adults with emotional disorders (Hallion et al., 2018). Taken together, these results point towards the need to consider the three-way interaction between sleep quality, emotion regulation and emotional disorders (Hoag et al., 2016) in future studies.

Our findings regarding the Clarity subscale are consistent with previous research showing that a lack of emotional clarity is bi-directionally associated with insomnia such that sleep disturbances reduce emotional clarity in the daytime, which in turn increases insomnia severity at night (Pickett et al., 2015). Consistent with previous studies (Gruber and Cassoff, 2014; O'Leary et al., 2017), our results indicated that worse sleep quality is associated with limited access to emotion regulation strategies. Use of adaptive and maladaptive emotion regulation strategies is associated with positive and negative affect, which in turn impact sleep quality (Hoag et al., 2016).

The Goals subscale had the biggest effect size across both samples, and aligns with previous research that suggests that DERS-SF Goals predicts treatment outcomes for adults with emotional disorders over the general factor of emotion regulation difficulties (Hallion et al., 2018). The items on the Goals subscale describe the difficulty of engaging in goal-directed behavior when experiencing negative emotions. On the one hand, poor sleep quality can affect concentration and attention which influences the achievement of goals (Paavonen et al., 2010; van der Heijden et al., 2018). On the other, sleep difficulties (such as reduced duration) impact various stages of the emotion regulatory process, including the successful implementation of strategies (Palmer and Alfano, 2017). In turn, the inability to properly regulate goal-directed behavior can also affect sleep (for example, an adolescent

Table 1
Means, standard deviations, and correlations with confidence intervals (Sample 1).

Variables	M	SD	1	2	3	4	5	6	7	8
1. Age	13.49	1.62								
2. Sleep hours	8.42	1.49	−.25 [−0.30, −0.20]							
3. Short PSQI total	4.60	2.30	.15 [0.09, 0.20]	−.44 [−0.48, −0.39]						
4. DERS-SF average total	0.88	4.08	.08 [0.02, 0.14]	−.19 [−0.25, −0.14]	.41 [0.36, 0.46]					
5. DERS-SF Clarity	0.25	0.99	.09 [0.03, 0.14]	−.15 [−0.20, −0.09]	.33 [0.28, 0.38]	.74 [0.71, 0.76]				
6. DERS-SF Nonacceptance	0.36	1.00	.12 [0.06, 0.18]	−.14 [−0.20, −0.08]	.28 [0.23, 0.34]	.82 [0.80, 0.84]	.53 [0.49, 0.57]			
7. DERS-SF Goals	0.39	1.06	.06 [0.01, 0.12]	−.16 [−0.21, −0.10]	.38 [0.32, 0.42]	.81 [0.79, 0.83]	.47 [0.42, 0.51]	.59 [0.55, 0.62]		
8. DERS-SF Impulse	0.08	1.08	.01 [−0.05, 0.07]	−.18 [−0.24, −0.13]	.32 [0.26, 0.37]	.80 [0.78, 0.82]	.43 [0.38, 0.48]	.54 [0.50, 0.58]	.61 [0.57, 0.65]	
9. DERS-SF Strategies	0.13	0.96	.03 [−0.03, 0.09]	−.14 [−0.20, −0.09]	.34 [0.29, 0.39]	.84 [0.82, 0.85]	.54 [0.50, 0.58]	.66 [0.62, 0.69]	.57 [0.53, 0.61]	.60 [0.57, 0.64]

Note. M and SD are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95 % confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014). Short PSQI = Short Pittsburgh Sleep Quality Index. DERS-SF = Difficulties in Emotion Regulation Scale Short Form. *$p < .05$. **$p < .01$.

Table 2
Means, standard deviations, and correlations with confidence intervals (Sample 2).

Variables	*M*	*SD*	1	2	3	4	5	6	7	8
1. Age	13.47	1.43								
2. Sleep hours	8.42	1.50	−.33 [−0.38, −0.28]							
3. Short PSQI	4.68	2.24	.19 [0.13, 0.24]	−.45 [−0.49, −0.40]						
4. DERS-SF average total	0.72	3.97	.13 [0.07, 0.18]	−.17 [−0.23, −0.11]	.42 [0.37, 0.46]					
5. DERS-SF Clarity	0.20	0.96	.07 [0.02, 0.13]	−.13 [−0.18, −0.07]	.27 [0.22, 0.32]	.71 [0.68, 0.74]				
6. DERS-SF Nonacceptance	0.32	0.97	.13 [0.07, 0.18]	−.14 [−0.20, −0.08]	.30 [0.25, 0.35]	.81 [0.79, 0.83]	.50 [0.45, 0.54]			
7. DERS-SF Goals	0.38	1.06	.14 [0.08, 0.20]	−.18 [−0.24, −0.13]	.41 [0.36, 0.46]	.81 [0.79, 0.83]	.43 [0.38, 0.48]	.57 [0.53, 0.61]		
8. DERS-SF Impulse	0.35	1.04	.03 [−0.03, 0.09]	−.09 [−0.15, −0.03]	.28 [0.22, 0.33]	.79 [0.77, 0.81]	.42 [0.37, 0.47]	.52 [0.47, 0.56]	.57 [0.53, 0.61]	
9. DERS-SF Strategies	0.13	0.97	.12 [0.06, 0.18]	−.14 [−0.20, −0.09]	.38 [0.33, 0.42]	.85 [0.83, 0.86]	.51 [0.47, 0.55]	.64 [0.61, 0.67]	.62 [0.58, 0.65]	.61 [0.57, 0.64]

Note. M and SD are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95 % confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014). Short PSQI = Short Pittsburgh Sleep Quality Index. DERS-SF = Difficulties in Emotion Regulation Scale Short Form. *p <.05. **p <.01

Table 3
Parameter estimates by sample.

Predictors	Sample 1			Sample 2			Replicated finding?
	Coefficient (SE)	*t*-Value	*p*	Coefficient (SE)	*t*-value	*p*	
Intercept	1.62 (0.50)	3.22	.001	1.83 (0.48)	3.77	<.001	Yes
Age	0.19 (0.04)	5.11	<.001	0.18 (0.04)	5.03	<.001	Yes
Sex	0.19 (0.12)	1.52	.13	0.23 (0.12)	1.90	.06	Yes
DERS-SF Clarity	0.32 (0.08)	4.10	<.001	0.20 (0.07)	2.67	.008	Yes
DERS-SF Nonacceptance	−0.14 (0.09)	−1.56	.12	−0.04 (0.09)	−0.44	.66	Yes
DERS-SF Goals	0.46 (0.08)	5.76	<.001	0.56 (0.08)	7.25	<.001	Yes
DERS-SF Impulse	0.17 (0.08)	2.12	.03	−0.03 (0.08)	−0.38	.70	No
DERS-SF Strategies	0.31 (0.10)	3.22	.001	0.39 (0.09)	4.25	<.001	Yes
Degree of freedom		1140			1133		
R^2/R^2 adjusted		0.204/0.199			0.221/0.216		

Note. Dependent variable: overall sleep quality (short PSQI total). *p < .05. **p < 0.01. ***p <.001.

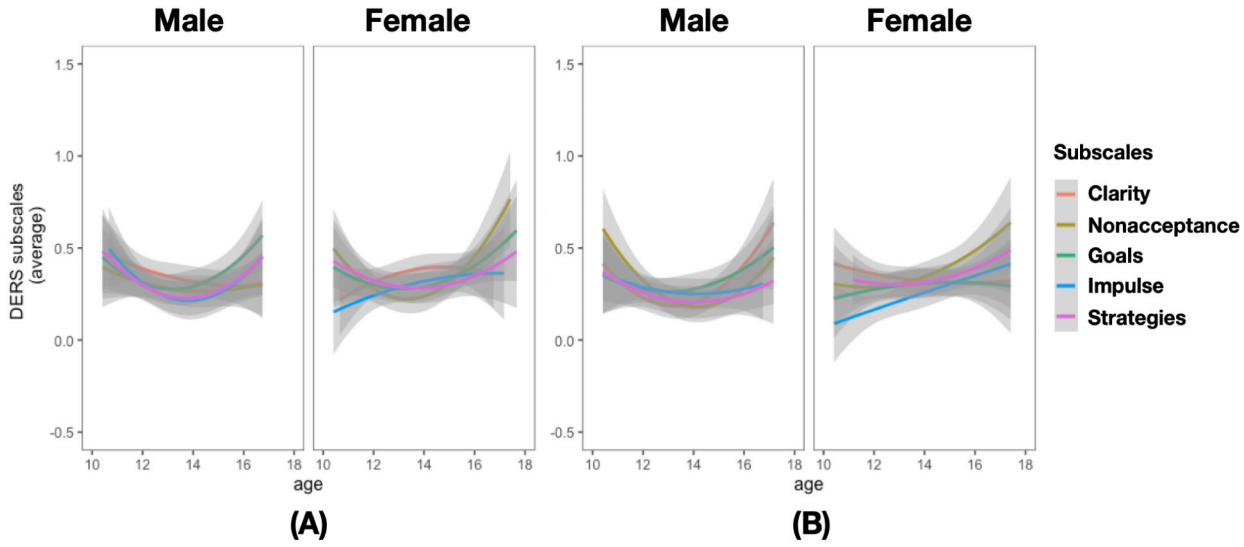

Fig. 1. Emotion regulation difficulties subscales plotted against age in years facetted by sex in Sample 1 (A) and Sample 2 (B). Solid colored lines represent the quadratic component of age. Ribbons represent 95 % confidence intervals.

who has not managed to study enough for an exam may have trouble falling asleep). Finally, this result allows us to theorize that helping adolescents engage in goal-directed behaviors may improve their sleep quality and that, in turn, improving sleep quality can help them deal with increased challenges in the lockdown context during a pandemic.

In this study, there was no association of sleep quality with Nonacceptance emotion regulation difficulties in either sample. While greater acceptance of emotions has been related to better quality of sleep in

some research (Ong et al., 2012; Voinescu and Sandru, 2014), evidence is mixed (Kirwan et al., 2017). In addition, none of these previous studies have used DERS-SF to measure Nonacceptance, which makes it difficult to compare the outcomes. The association with DERS-SF Impulse was only found in one of the samples but did not replicate. This non-robust finding is consistent with other studies on sleep and emotion regulation difficulties in adolescents that have also found that impulsivity was not related to inadequate sleep (Baum et al., 2014; Beebe et al., 2008, 2010).

5.1. Sex- and age-related differences

Our second hypothesis was confirmed for both sex and age. There were sex differences in sleep quality but not in sleep duration. We found that girls had worse sleep quality than boys across both samples. These studies align with a documented female vulnerability to poor sleep quality before the pandemic (de Matos et al., 2019; Dorofaeff and Denny, 2006). Girls also robustly endorsed more emotion regulation difficulties than boys. These results are consistent with previous research. Female adolescents had more problems regulating their emotions than boys in studies before the pandemic (Bender et al., 2012; Hallion et al., 2018). This has been compounded by the impact of the pandemic on sleep and emotions (Alfonsi et al., 2021; Kaditis et al., 2021). Moreover, isolation seems to have a more negative effect on girls than on boys (Casagrande et al., 2020; Wang et al., 2020; Wang et al., 2021).

In addition, we observed age-related differences on sleep and emotion regulation difficulties. Sleep quality exhibited a linear association with age: we found evidence that older adolescents had less and worse sleep than younger adolescents, in line with previous findings (Becker et al., 2018, 2021; Madrid-Valero et al., 2017; Ramos Socarras et al., 2021). These results align with the "perfect storm" model (Carskadon, 2011), which poses that sleep is particularly challenged in adolescence by a convergence of biological, psychological, and sociocultural influences.

Overall, we found robust indication that older adolescents have more emotion regulation difficulties than younger adolescents, which accords with the results found by Zimmerman and Iwanski (2014). There was a linear association between age and all emotion regulation difficulties subscales except for Impulse (which did not replicate across samples). In addition, we observed a positive quadratic association between age and the Goals subscale in both samples. In Sample 1 only, Nonacceptance, Impulse, and Strategies subscales also exhibited a similar trend. Taken together, these findings are suggestive of relative stability in emotion regulation until ages 13–14, with more pronounced increases in difficulties in late adolescence. At a psychological and neurobiological level, adolescence is a period of heightened emotional reactivity (Dahl and Gunnar, 2009), and in which emotion regulation abilities are in development (Young et al., 2019). In tandem, adolescents navigate social environments and stressors that are in fluctuation (McLaughlin et al., 2015). Thus, some evidence suggests that emotion regulation development is non-linear in adolescence (Silvers, 2022) as different emotion regulation strategies mature at different rates (Nolen-Hoeksema and Aldao, 2011; Zimmerman and Iwanski, 2014), and adolescents face different challenges. For example, at about ages 14 to 16, there is less use of adaptive emotion regulation strategies such as cognitive reevaluation or distraction, and there is also an increase in maladaptive strategies such as rumination (Gullone et al., 2010; Sanchis-Sanchis et al., 2020; Theurel and Gentaz, 2018; Zimmer-Gembeck and Skinner, 2011).

Adolescence is a period characterized by flexibility in goal-related behavior, where "hot" or affectively charged contexts may challenge behavior and goal pursuit (Crone and Dahl, 2012). In our data, the Goals subscale had the highest levels of endorsement, the most pronounced worsening for older age groups, and the strongest association with sleep quality. Thus, our results suggest that goal-related emotion difficulties might be particularly challenged by sleep dysfunction. Alternatively, it might be that the tasks/goals that need to be completed for adequate sleep are particularly disrupted by emotions in adolescence. Our findings of linear and quadratic associations of age and emotion regulation difficulties as well as variability across subscales merits further investigation.

5.2. Limitations and future directions

Strengths of this study include a large sample of Peruvian adolescents, who are traditionally under-represented in research on sleep and emotion regulation, and data collected in the context of a particularly stringent COVID-19 lockdown. Methodological strengths include preregistered analyses and replication on a holdout sample. However, there are limitations to this study. Given the cross-sectional nature of our data, and the lack of individual-level information on COVID-19 impacts, we are unable to investigate potential effects of the pandemic, or investigate directional effects between sleep quality and emotion regulation. Future studies should use longitudinal designs that allow to determine which emotional difficulties impact sleep quality, and on the contrary, which emotion regulation difficulties are affected by sleep quality. Additionally, it is important to follow up the potential long-term repercussions of these disruptions on adolescent psychopathology (Dahl, 2004). Future research should extend our findings using self-report measures on sleep quality and emotion regulation by using different informants, such as parents, and incorporating objective measures of sleep to increase the validity of the results.

6. Conclusion

Poor sleep quality was robustly associated with more emotion regulation difficulties, especially those related to the ability to enact goal-related behavior in the face of negative emotions, lack of emotional clarity, and lack of strategies to feel better when distressed. This question was explored with a sample of adolescents in Perú during the early and particularly stringent COVID-19 lockdown. Girls and older adolescents endorsed worse sleep quality and more emotion regulation difficulties. At an applied level, exploring which difficulties in regulation strategies are associated with adolescent sleep may help guide specific intervention and prevention programs.

Funding

We have no known conflicts of interest to disclose. The research presented in this article was supported, in part, by Carlos Rodríguez Pastor. The funder had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

CRediT authorship contribution statement

CCY: Methodology, Formal Analysis, Visualization, Writing (original draft preparation). YAB: Literature review. DLD: Writing (original draft preparation). RC: Supervision. RED: Supervision. LMW: Supervision, Conceptualization, Methodology, Formal Analysis, Writing (review & editing).

Declaration of competing interest

The research presented in this article was supported, in part, by Carlos Rodríguez Pastor. We have no known conflicts of interest to disclose. We are grateful to all study participants—and their families—for their continued participation over the many years of this investigation.

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their continued participation over the many years of this investigation.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jad.2023.05.036.

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