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The Relationship between Cognitive Emotion Regulation and Problematic Social Media Use among Students: A Three Level Meta-Analysis

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ABSTRACT: Backgrounds: Multiple theoretical models emphasize the role of cognitive emotion regulation (CER) in maladaptive technology-related behaviors, including problematic social media use (PSMU). However, empirical findings regarding the association between CER and PSMU have been inconsistent. Therefore, the present study aimed to systematically synthesize existing evidence on this relationship and to examine potential moderators using a three-level meta-analytic approach. **Methods:** To clarify the overall relationship and examine potential moderators, the present study conducted a three-level meta-analysis. A total of 21 primary studies, comprising 22 independent samples ($N = 19,648$) and 103 effect sizes, were included. **Results:** The results indicated a significant positive overall association between students' CER and PSMU ($r = 0.293$, 95% CI $[0.217, 0.365]$, $t = 7.387$). Moderator analyses showed that CER type significantly moderated the relationship between CER and PSMU. Specifically, maladaptive CER strategies showed a stronger positive association with PSMU ($r = 0.318$, 95% CI $[0.187, 0.437]$) compared to adaptive CER strategies ($r = 0.097$, 95% CI $[0.014, 0.178]$). At the strategy-specific level, acceptance showed a relatively strong positive association with PSMU ($r = 0.359$, 95% CI $[0.278, 0.437]$), whereas maladaptive strategies such as catastrophizing ($r = 0.425$, 95% CI $[0.285, 0.549]$), blaming others ($r = 0.422$, 95% CI $[0.279, 0.547]$), and self-blame ($r = 0.400$, 95% CI $[0.255, 0.528]$) showed particularly strong associations. In addition, grade, sampling method, standardization of PSMU, region, and measurement of PSMU did not significantly moderate the CER-PSMU relationship. The measurement of CER showed a significant moderating effect, with rumination-related measures yielding stronger associations than Cognitive Emotion Regulation Questionnaire (CERQ)-based measures ($F = 21.958$, $p < 0.001$). Notably, this pattern suggests that the overall findings may be disproportionately driven by rumination-related operationalizations of CER, potentially limiting their generalizability across CER dimensions. Additionally, publication type emerged as a significant moderator, with larger effect sizes observed in dissertations and conference papers than journal articles ($F = 5.126$, $p < 0.01$). **Conclusions:** Overall, these findings provide quantitative evidence that the association between CER and PSMU varies across CER types. However, these findings should be interpreted with caution, as the results appear to be disproportionately influenced by rumination-related measures, and may also be affected by publication bias. Future research should further explore the underlying psychological mechanisms linking different CER strategies to PSMU.

KEYWORDS: Cognitive emotion regulation; problematic social media use; students; meta-analysis; three-level modeling

1 Introduction

With the rapid advancement of technology and the widespread use of intelligent electronic devices, social media applications on smartphones have become major platforms for communication worldwide [1–3].

Social media has played an increasingly important role in education by supporting teaching innovation, learning experiences, and educational management, particularly during the COVID-19 pandemic [4–6]. Despite these benefits, excessive engagement with social media may lead to Problematic Social Media Use (PSMU), which is characterized by impaired control over use and negative consequences for daily functioning and well-being [2,7,8]. Notably, adolescents and students account for a substantial proportion of users, highlighting the relevance of social media in student populations. Importantly, PSMU should not be equated with behavioral addiction, as scholars have cautioned against the uncritical application of addiction frameworks to social media use, and PSMU is not formally recognized as a behavioral addiction in current diagnostic classification systems (e.g., ICD-11) [9]. Moreover, PSMU is conceptually distinct from frequent or heavy social media use, as it is defined by impaired control, preoccupation, and functional impairment rather than the mere amount of time spent on social media [10]. Students are considered particularly vulnerable to PSMU due to developmental characteristics and relatively limited self-regulatory capacity, and existing evidence has linked PSMU to a range of adverse psychological and cognitive outcomes among adolescents [11–13]. Accordingly, examining PSMU among students represents an important research priority.

Recent scholarship has increasingly focused on identifying risk factors associated with PSMU, with particular attention to emotion regulation mechanisms [14,15]. Conceptually, cognitive emotion regulation (CER) represents a core cognitive mechanism through which individuals cope with emotional stress [16,17], whereas PSMU reflects a behavioral manifestation of a regulatory failure in digital contexts [18,19]. Across multiple theoretical perspectives, difficulties in CER are consistently identified as a core vulnerability that is associated with a higher likelihood of maladaptive behavioral patterns. Some theoretical models support this view [20]. CER encompasses the mental strategies individuals employ to modulate emotional responses when facing threatening or stressful situations [20], which is widely conceptualized as a multidimensional construct, comprising qualitatively distinct strategies that are often broadly categorized as adaptive or maladaptive and may differ in their functional roles and psychological consequences. The Interaction of Person–Affect–Cognition–Execution (I-PACE) model proposes that individuals who experience negative emotional states but lack effective regulation strategies may be more likely to engage in impulsive, compensatory behaviors [21]. This vulnerability is especially salient among students, who typically exhibit heightened emotional sensitivity alongside still-developing self-regulatory capacities [22]. Emotion regulation therefore represents a central cognitive mechanism enabling students to manage stress and negative experiences, which may be associated with a lower susceptibility to problematic patterns of use [23]. Motivation-based perspectives grounded in Self-Determination Theory, together with pathological use models [24–27], suggest that excessive social media use is conceptualized as a short-term emotion-focused coping strategy that may be associated with temporary relief from distress, but may also be linked to greater psychological strain and reduced self-control over time [20,28–32]. Such behaviors often fail to resolve underlying emotional difficulties, which may be associated with increased anxiety, depressive symptoms, and maladaptive usage patterns over time [33–35].

Established theories tend to highlight the role of CER as a correlate of PSMU. However, the findings of previous studies are conflicting, with some reporting a positive association and others proposing no significant relationship between the two. Ozer reported a non-significant correlation between CER and PSMU among 450 participants ($r < 0.10$) [36], whereas Chai found a strong and significant positive association in a larger sample of 700 participants ($r > 0.50$) [37]. This suggests that discrepancies exist between previous theoretical models and empirical evidence, and even among the empirical findings themselves. If CER is not

significantly correlated with PSMU, the assumptions of these theoretical models may not be fully supported by empirical evidence.

Inconsistent findings in previous studies may stem from treating CER as a single construct, although different CER strategies may have different functions and associations with PSMU. Therefore, it is necessary to test whether the CER–PSMU association varies across CER type [38–41], and other study characteristics, such as grade level [42–45], sampling method [41,42,44,45], standardization of PSMU measures [43,45–47], measurement of PSMU and measurement of CER across studies [48,49], region [41,44,47], and publication type [33,41,44,46,50].

This study employs a three-level meta-analysis model to integrate studies with varying results [51,52]. Based on the research objectives, this study aimed to answer two questions: (1) What is the overall association between CER and PSMU? (2) Do the following variables moderate this relationship: CER type, grade, sampling method, standardization of PSMU, region, and publication type?

2 Methodology

2.1 Literature Search

2.1.1 Literature Scope and Selection

The search for this study was conducted up to October 2025. The languages included Chinese and English. The Chinese databases included China National Knowledge Infrastructure (CNKI), Wanfang Data Knowledge Service Platform, and VIP Chinese Journal Service Platform. The English databases included Google Scholar, Elsevier, SpringerLink, SAGE, Wiley, JSTOR, Web of Science, PsycINFO and PubMed. Search terms were constructed using combinations of the following keywords: students, teenagers, adolescents, problematic social media use, excessive social media use, social network addiction, smartphone addiction, mobile social media addiction, compulsive social media use, and cognitive emotion regulation, emotion regulation, adaptive CER, maladaptive CER, self-blame, acceptance, rumination, positive refocusing, refocusing on planning, positive reappraisal, putting into perspective, catastrophizing, other-blame. These keywords were searched in the “topic”, “full text”, or “title” fields.

According to Almeida [53], who used the Ruminative Responses Scale (RRS) to represent MCES, we conducted a search for rumination and included it in our meta-analysis to incorporate as many eligible studies as possible. Meanwhile, during the coding process, we carefully checked the items of the rumination scale to ensure that they were consistent with the concept of rumination in CER and could be classified as the same category. Similarly, this approach was applicable to the other eight dimensions of CER that are parallel to rumination.

Our search included documents up to 2025 and resulted in the identification of 21 primary studies for inclusion in this meta-analysis. The literature search and screening process is shown in Fig. 1.

2.1.2 Literature Inclusion and Exclusion Criteria

Based on the meta-analytic methodology and the requirements of this research topic, the inclusion criteria were as follows:

1. The constructs of CER and PSMU were clearly defined, and standardized or recognized scales or questionnaires were used to measure them.
2. The study population consisted of non-clinical student samples, including elementary, middle, and high school students.
3. The study reported specific correlation coefficients (r values).

4. Sample sizes were explicitly reported. One particular case is that Yang [54] and Yang [55] used the same sample, but the measurement tool of PSMU was different, so they can be calculated separately.
5. The language of publication was Chinese or English.

The exclusion criteria were:

1. Review articles, abstracts, case reports, and other non-empirical papers.
2. Incomplete or missing data for core variables.
3. Ambiguous conceptualization of CER or PSMU-related behaviors.
4. Duplicate publications (e.g., studies based on the same dataset appearing in multiple sources).
5. Samples including special populations, such as students diagnosed with clinical emotional disorders, other mental illnesses, or serious physical conditions.

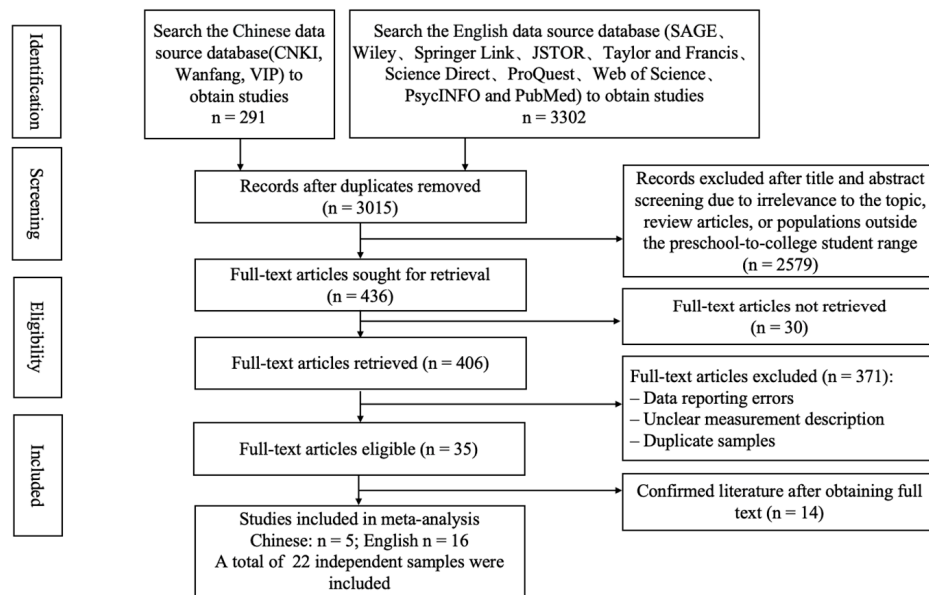


Figure 1: The search process and search results of the present study.

2.1.3 Search Results

A total of 21 original studies were included in the meta-analysis, including 5 Chinese studies and 16 English studies. The number of effect sizes was 103, involving 19,648 participants. The publication years ranged from 2004 to 2025.

2.1.4 Literature Coding

According to the inclusion and exclusion criteria, the included studies were coded (see Table 1). During the coding process, the effect sizes were calculated based on independent samples. If the same study reported multiple independent samples simultaneously, each independent sample was coded separately. The coding process involved several steps. The first step was to formulate the coding plan. Based on the research objectives and questions, the moderating variables listed in Table 2 were selected. The second step was to conduct cross-checks and validations. After the lead author completed the main coding work, the remaining authors rechecked the coding results. Based on the review results, the consistency among the independent coders was 98%, with some differences in data due to subjective biases. When discrepancies occurred, each author would first review the original research, followed by discussion and revision.

Table 1: Basic information of the primary studies included in this meta-analysis.

Author, Year ^a	Effect Size Number	Sample Size	CER Type ^b	Female Ratio	Grade	Country	Measurement Tools of CER ^d	Measurement Tools of PSMU ^e	Publication ^f	Quality Assessment
Almeida, 2023 [53]	2	525	C/R	0.54	College	Portugal	PSWQ/RRS-SF	SNSM	J	16
Aygar, 2025 [38]	9	906	SB/A/R/PR/RoP/ PRE/PP/C/BO	0.75	College	Turkey	CERQ	BSMAS	J	16
Cao, 2022 [40]	4	435	R	0.69	College	China	RRS	SMUDSC	C	17
Cao, 2023 [44]	1	1099	R	0.74	College	China	CRRS	CSMUDS	J	18
Chai, 2024 [37]	6	700	R	0.80	College	China	SMRS	PMSMUS	D	18
Chen, 2022 [41]	1	1153	R	0.76	College	China	CRRS	PMSMUS	J	19
Davila, 2012u1 [56]	2	384	R	0.68	College	USA	RRS	SNS	J	18
Davila, 2012u2 [56]	6	334	R	0.62	College	USA	RRS	SNS	J	18
Dempsey, 2019 [47]	1	291	R	0.58	College	USA	RTSQ	BFAS	J	16
Fu, 2024 [50]	1	430	R	0.60	College	China	CRRS	SMUDS	D	18
Kircaburun, 2018 [46]	1	470	R	0.60	High	Turkey	RTSQ	BSMAS	J	16
Mitra, 2019 [57]	1	264	R	0.62	College	Indian	RRS	SMDS	J	15
Nemat Tavousi, 2018 [45]	1	430	R	0.73	NA	Iran	RRS	SPI	J	17
Onat Kocabiyik, 2021 [58]	2	261	R	0.28	College	NA	RRS-SF	SMAS	J	18
Ozer, 2024 [36]	45	450	SB/A/R/PR/RoP/ PRE/PP/C/BO	0.86	College	Turkey	CERQ	SMAS	J	14
Rahimi, 2024 [39]	3	338	ACER/RoP/A	0.28	NA ^c	Iran	CERQ	SNAS	J	12
Wang, 2018 [43]	1	365	R	0.52	Middle	China	CRRS	FIQ	J	15
Xu, 2024 [42]	1	9407	MCER	0.52	Middle and high	China	CERQ	SCS-R	J	20
Yang, 2019 [54]	2	219	R	0.74	College	USA	RRQ	CIUS	J	17

Table 1: *Cont.*

Author, Year ^a	Effect Size Number	Sample Size	CER Type ^b	Female Ratio	Grade	Country	Measurement Tools of CER ^d	Measurement Tools of PSMU ^e	Publication ^f	Quality Assessment
Yang, 2021 [55]	1	219	R	0.74	College	USA	RRQ	EFMUS	J	17
Zhang, 2025 [59]	7	781	R	0.82	College	China	CSARS	DSS	J	18
Zou, 2023u1 [60]	1	236	R	0.72	College	China	SMRS	SNS	D	16
Zou, 2023u2 [60]	4	170	R	0.73	College	China	SMRS	SNS	D	16

Notes: ^aTo reduce space, most list only the first author; u1-u2 indicates a study with multiple independent samples; Dempsey [47] and Varona [48] use the same sample, but the Measurement Tool of PSMU is different, so they can be calculated separately. ^bACER = Adaptive CER; MCER = Maladaptive CER; SB = Self-blame; A = Acceptance; R = Rumination; PR = Positive refocusing; RoP = Refocusing on planning; PRE = Positive reappraisal; PP = Putting into perspective; C = Catastrophizing; BO = Blaming others. ^cNA indicates that the paper does not provide the appropriate information. ^dPSWQ = Penn State Worry Questionnaire; RRS-SF = Ruminative Responses Scale–Short Form; CERQ = Cognitive Emotion Regulation Questionnaire; RRS = Ruminative Responses Scale; CRRS = College Ruminative Responses Scale; RTSQ = Ruminative Thought Styles Questionnaire; RRQ = Rumination–Reflection Questionnaire (Rumination subscale); SMRS = Social Media Rumination Scale; CSARS = College Students' Appearance Rumination Scale. ^eSNSM = Nighttime Social Media Use Scale; SNAS = Social Network Addiction Scale; BSMAS = Bergen Social Media Addiction Scale; SMUDSC = Social Media Use Dependency Scale for College Students; CSMUDS = Chinese Social Media Use Dependency Scale; PMSMUS = Problematic Mobile Social Media Use Scale; SNS = Social Networking Survey; BFAS = Bergen Facebook Addiction Scale; SMUDS = Social Media Use Dependency Scale; BSMAS = Bergen Social Media Addiction Scale; SMDS = Social Media Disorder Scale; SPI = Social Phobia Inventory; SMAS = Social Media Addiction Scale; FIQ = Facebook Intrusion Questionnaire; SCS-R = Social Connectedness Scale–Revised; CIUS = Compulsive Internet Use Scale; EFMUS = Entrapment Focused Mobile Use Scale; DSS = Digital Stress Scale. ^fJ = Journal, D = Dissertation, C = Conference.

2.2 Extraction of Potential Moderator Variables

Table 2 presents the basic information of the potential moderating variables extracted from the included studies. Including the specific types of moderator variables, as well as the number of independent samples and effect sizes.

2.3 Coding Process and Coding Confidence

The kappa coefficient was 0.937 after the first author completed the coding and the remaining authors conducted a review. This value indicates a high degree of consistency [61].

2.4 Meta-Analysis Process

2.4.1 Calculation of Effect Sizes

The correlation coefficient (zero-order r) was adopted as the effect size in this study [61]. During the analysis, each r value was first transformed into Fisher's Z score using the formula $Z = 0.5 \times \ln(\frac{1+r}{1-r})$. Subsequently, the Fisher's Z values were converted back to obtain the r using the formula $r = \frac{e^{2z}+1}{e^{2z}-1}$. The variance of Z was calculated as $Vz = \frac{1}{n-3}$, where n represents the sample size, and the standard error of Z was computed as $SEz = \sqrt{Vz}$ [62].

2.4.2 Model Rationale

Because multiple CER strategies are often reported within the same study, multiple effect sizes can be extracted from a single empirical sample. Therefore, a three-level meta-analytic model is methodologically necessary to preserve the hierarchical structure implied by the multidimensional nature of CER [51].

2.4.3 Model Selection

A three-level random effects meta-analytic model was used the present study. level 1 (participants) refers to the sample level, level 2 (effect sizes) refers to the outcome level, and level 3 refers to the study level. The model estimates the intra-cluster effect size within the same cluster using the random effects model, while allowing the same cluster to share the same effect size [51,63]. The variance decomposition further supported the use of this model, as a substantial proportion of variance was observed at both Level 2 (within-study) and Level 3 (between-study), indicating meaningful dependency among effect sizes and heterogeneity across studies.

2.4.4 Homogeneity Test

I^2 and Tau^2 were used to represent the between-study variance in the present study. In general, heterogeneity was categorized into three levels based on value of I^2 : low (25%), moderate (25%), and high (25%) [61]. The overall Tau^2 value is equal to Tau^2 (level2) and Tau^2 (level3) in the three-level model [51].

2.4.5 Publication Bias

Publication bias reflects the tendency for studies reporting statistically significant findings to be more likely to be published than those with non-significant results. In the present study, publication bias was evaluated using multiple approaches, including Funnel plot, Trim and fill method, Rosenthal's Fail-safe N (Nfs), and Egger's regression [62].

Table 2: Basic statistics of Potential moderators included in the current study.

Moderator Variable	Category	Independent Sample		Effect Size	
		K1 ^a	%	K2 ^a	%
Overall CER	ACER ^b	21	87.5	33	32.04
	MCER ^b	3	12.5	70	67.96
Specific CER	Acceptance	3	7.32	7	6.8
	Positive refocusing	2	4.88	6	5.83
	Refocusing on planning	3	7.32	7	6.8
	Positive reappraisal	2	4.88	6	5.83
	Putting in to perspective	2	4.88	6	5.83
	Self-blame	2	4.88	6	5.83
	Rumination	20	48.78	50	48.54
	Catastrophizing	3	7.32	7	6.8
	Blaming others	2	4.88	6	5.83
	Mixed	2	4.88	2	1.94
Grade	Middle	1	5	1	1.01
	High	1	5	1	1.01
	Middle and high	1	5	1	1.01
	College	17	85	96	96.97
Sampling method	Random	1	4.55	1	0.97
	Non-random	21	95.45	102	99.03
Standardization of PSMU	Standardized	19	86.36	94	91.26
	Non-standardized	3	13.64	9	8.74
Measurement of PSMU ^c	Problematic Use	14	60.87	84	81.55
	Usage Behavior	7	30.43	17	16.50
	Psychological Factors	2	8.70	2	1.94
Measurement of CER	CERQ	4	18.18	58	56.31
	Rumination-related	18	81.82	45	43.69
Region	Asia	16	72.73	87	86.14
	North America	5	22.73	12	11.88
	Europe	1	4.55	2	1.98
Publication type	Journal	17	77.27	87	84.47
	Dissertation	4	18.18	12	11.65
	Conference	1	4.55	4	3.88
Literature quality	Medium	21	91.3	101	98.06
	High	2	8.7	2	1.94

Notes: ^aK1: number of independent samples. K2: number of effect sizes. Some studies reported several moderator variables simultaneously, other studies reported more than one independent sample, please see Table 1 for details. As a result, subgroup totals may not equal the total number of independent samples. ^bACER = adaptive cognitive emotion regulation; MCER = maladaptive cognitive emotion regulation. ^cThe classification of PSMU measures was based on their primary conceptual focus: (a) problematic or addictive use symptoms (e.g., loss of control, compulsive use), (b) behavioral patterns of social media use (e.g., frequency or nighttime use), and (c) psychological factors associated with use (e.g., social anxiety or perceived entrapment). Problematic Use: BSMAS, SMAS, BFAS, CIUS, PMSMUS, SMUDS, SMUDSC, CSMUDS, SMDS, SNAS, DSS; Usage Behavior: SNSM, SPI, FIQ, SNS; Psychological Factors: SCS-R, EFMUS. SNSM = Nighttime Social Media Use Scale; SNAS = Social Network Addiction Scale; BSMAS = Bergen Social Media Addiction Scale; SMUDSC = Social Media Use Dependency Scale for College Students; CSMUDS = Chinese Social Media Use Dependency Scale; PMSMUS = Problematic Mobile Social Media Use Scale; SNS = Social Networking Survey; BFAS = Bergen Facebook Addiction Scale; SMUDS = Social Media Use Dependency Scale; BSMAS = Bergen Social Media Addiction Scale; SMDS = Social Media Disorder Scale; SPI = Social Phobia Inventory; SMAS = Social Media Addiction Scale; FIQ = Facebook Intrusion Questionnaire; SCS-R = Social Connectedness Scale-Revised; CIUS = Compulsive Internet Use Scale; EFMUS = Entrapment Focused Mobile Use Scale; DSS = Digital Stress Scale.

2.4.6 Assessment of Quality

The quality assessment tool in this study was the Basic Quality Assessment of Primary Study (BQAPS). It consists of 4 categories, low-quality (0–6 score), low-medium level (7–12), medium-high level (13–18), and high-quality (19–24) [64]. The quality assessment was primarily conducted to provide a descriptive overview of study characteristics and to enhance transparency, rather than to serve as a primary source of heterogeneity in the analysis.

2.4.7 Statistical Calculation Tools

All statistical analyses were conducted in the R environment [65]. The three-level meta model was estimated using the metafor package (version 4.8-0) [63,66], while funnel plots were generated with the meta package (version 8.0-2) [51,63,67].

2.4.8 Data Analysis

The results of the meta-analysis were reported using standard statistical indicators, including effect sizes (r), corresponding 95% confidence intervals (95% CI), and test statistics (e.g., t and F values). Heterogeneity indices (Q , I^2 , and Tau^2) and publication bias indicators (e.g., Egger's test, trim-and-fill method, and fail-safe N) were reported to assess variability and potential bias. Meta-regression results were presented using regression coefficients (β), standard errors (SE), and corresponding test statistics. Statistical significance was determined based on p -values, with $p < 0.05$ considered statistically significant.

3 Results

3.1 Characteristics of the Included Literature Included

A total of 21 original studies involving 22 independent samples were included in the meta-analysis (see Tables 1 and 2). The characteristics of the studies and their frequency distribution are shown in Table 2.

3.2 Homogeneity Test

A significant Q -test value was observed ($Q = 2555.181$, $p < 0.001$), and the total I^2 value (96.241%) indicated a high level of heterogeneity (see Table 3). Consequently, moderator analyses were conducted to explore potential sources of variability among the included studies.

3.3 Publication Bias Test

After applying the trim-and-fill method, the adjusted overall effect was $r = 0.106$ (95% CI [0.062, 0.151]). The results showed that, after the addition of 36 effect sizes, the adjusted effect size was smaller than the previously pooled overall effect size ($r = 0.293$, 95% CI [0.271, 0.365]), suggesting that the overall effect may have been somewhat overestimated.

Visual inspection of the funnel plot indicated that the distribution of effect sizes was approximately symmetric (see Fig. 2). However, Egger's regression test yielded an intercept of 5.5994 ($SE = 1.2758$, $t = 4.390$, $p < 0.001$), suggesting potential asymmetry in the funnel plot.

In addition, $Nfs = 97,681$ was substantially larger than the criterion value ($5K + 10 = 120$), indicating that the overall findings are less likely to be fully explained by missing studies alone. Taken together, these results suggest the presence of publication bias or small-study effects, and therefore the overall findings should be interpreted with caution.

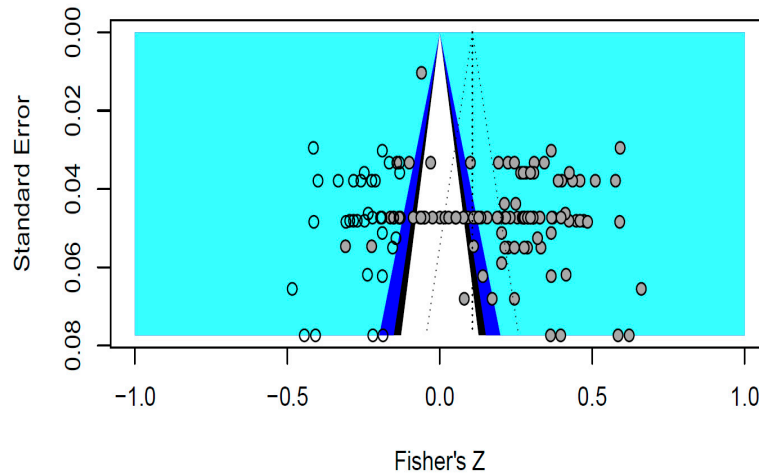


Figure 2: Funnel plot of effect values.

3.4 Moderating Effects of Literature Quality

A meta-regression was performed, with the quality score entered as the predictor and effect size as the outcome variable. The results indicated $F_{(1,101)} = 3.084$; Intercept = -0.337 ; $SE = 0.365$; $p = 0.358$; $\beta = 0.038$; $SE = 0.022$; $t = 1.756$; $p = 0.082$. Overall, the results meant that literature quality was not significantly associated with effect sizes.

3.5 Main Effects

The correlation between CER and PSMU was $r = 0.293$ ($[0.217, 0.365]$), $t = 7.387$, $p < 0.001$ (see Table 3). According to Ellis's criteria [68], the observed relationship between CER and PSMU fell within the category of a moderate positive correlation.

To examine the robustness of the main effect, a sensitivity analysis was conducted. when four studies using the overall CERQ scale were included, The results showed that: $r = 0.051$ ($[-0.092, 0.191]$), $t = 0.709$, $p < 0.481$. Overall effect size was non-significant. This pattern may reflect the uneven distribution of CER strategies across the included studies, with certain strategies being more extensively represented than others. Overall, the sensitivity analysis suggests that the main effect is influenced to some extent by the composition of CERQ dimensions, but becomes more stable when a broader set of studies is included.

Table 3: Main effects of the relationship between CER and PSMU.

K2	Fisher's Z/SE	Zero-Order r (95%CI)	t	Tau ² /Percentage in Total Variance	
				Level 2	Level 3
103	0.302/0.041	0.293 ($[0.217; 0.365]$)	7.387	0.017 37.286	0.027 58.955

Notes: K2 = number of effect sizes. Variance in level 2 = within-study variation; Variance in level 3 = between-study variation; SE = standard error.

3.6 Moderating Effects Analysis

3.6.1 CER Type

The overall CER type had a significant moderating effect ($F_{(1,101)} = 65.924$, $p < 0.001$). The specific CER type had a significant moderating effect ($F_{(9,93)} = 34.232$, $p < 0.001$). (see Table 4) ACER had an r -value of 0.097 (95% CI $[0.014, 0.178]$). The MCER group had an r -value of 0.318 (95% CI $[0.187, 0.437]$).

Acceptance, Putting into perspective, Self-blame, Rumination, Catastrophizing, and Blaming others were positively associated with PSMU with r values of 0.359 (95% CI [0.278, 0.437]), 0.251 (95% CI [0.094, 0.398]), 0.400 (95% CI [0.255, 0.528]), 0.319 (95% CI [0.169, 0.456]), 0.425 (95% CI [0.285, 0.549]), 0.422 (95% CI [0.279, 0.547]). The r -values of Positive refocusing, Refocusing on planning, Positive reappraisal, and Mixed were not significant.

3.6.2 Grade

The moderating effect of grade was not significant ($F_{(3,95)} = 1.569$, $p = 0.202$). The r -values were 0.310 (95% CI [-0.049, 0.598]), 0.390 (95% CI [-0.445, 0.862]), -0.060 (95% CI [-0.736, 0.676]), and 0.312 (95% CI [-0.399, 0.789]) for middle school, high school, middle and secondary combined, and college, respectively. There were no significant differences between the r values for the subgroups of grade.

3.6.3 Sampling Method

The moderating effect of sampling method was not significant ($F_{(1,101)} = 3.221$, $p = 0.076$). The r values for the random sampling method was -0.060 (95% CI [-0.436, 0.334]). The r value for the non-random sampling method was 0.305 (95% CI [-0.468, 0.813]). The r values for the two subgroups of sampling method were not significantly different.

3.6.4 Standardization of PSMU

The moderating effect of standardization of PSMU was not significant ($F_{(1,101)} = 0.267$, $p = 0.607$). The r -values for standardized of PSMU was 0.286 (95% CI [0.202, 0.365]). The r value for non-standardized PSMU was 0.343 (95% CI [0.025, 0.597]). The r -values for the two subgroups of PSMU standardization were not significantly different.

3.6.5 Measurement of PSMU

The moderating effect of measurement of PSMU was not significant ($F_{(2,100)} = 2.232$, $p = 0.113$). The r -values were 0.279 (95% CI [0.187, 0.368]) for Problematic Use, 0.370 (95% CI [0.117, 0.579]) for Usage Behavior, and 0.049 (95% CI [-0.344, 0.428]) for Psychological Factors.

3.6.6 Measurement of CER

The moderating effect of measurement of CER was significant ($F_{(1,101)} = 21.958$, $p < 0.001$). The r -values for CERQ was 0.054 (95% CI [-0.062, 0.168]), which was not significant. The r value for Rumination-related was 0.352 (95% CI [0.118, 0.548]).

3.6.7 Region

The moderating effect of region was not significant ($F_{(2,98)} = 0.642$, $p > 0.05$). The r -values were 0.324 (95% CI [0.229, 0.412]) for Asia, 0.218 (95% CI [-0.093, 0.490]) for North America, and 0.227 (95% CI [-0.280, 0.634]) for Europe.

3.6.8 Publication Type

The moderating effect of publication type were significant ($F_{(2,100)} = 5.126$, $p = 0.008$). The r -values was 0.234 (95% CI [0.160, 0.305]), 0.469 (95% CI [0.249, 0.644]), and 0.423 (95% CI [0.076, 0.678]) for the journal group, the dissertation group, and the conference group, respectively.

Table 4: Test results of moderating effect.

Moderator Variable	Subgroup ^a	k2	Intercept/Fisher's Z (95% CI)	r ^b (95% CI)	F	Tau ² Level 2 Variance	Level 3 Variance
Overall CER	ACER ^d	33	0.097 (0.014, 0.180)	0.097 (0.014, 0.178)	65.924*** ^c	0.009	0.019
	MCER ^d	70	0.232 (0.175, 0.288)	0.318 (0.187, 0.437)			
Specific CER	Acceptance	7	0.376 (0.285, 0.468)	0.359 (0.278, 0.437)	34.232*** ^c	0.002	0.024
	Positive refocusing	6	−0.214 (−0.286, −0.142)	0.161 (−0.001, 0.315)			
	Refocusing on planning	7	−0.317 (−0.386, −0.248)	0.059 (−0.101, 0.217)			
	Positive reappraisal	6	−0.300 (−0.372, −0.228)	0.076 (−0.087, 0.235)			
	Putting in to perspective	6	−0.119 (−0.191, −0.047)	0.251 (0.094, 0.398)			
	Self-blame	6	0.048 (−0.024, 0.120)	0.400 (0.255, 0.528)			
	Rumination	50	−0.045 (−0.114, 0.024)	0.319 (0.169, 0.456)			
	Catastrophising	7	0.078 (0.008, 0.149)	0.425 (0.285, 0.549)			
	Blaming others	6	0.074 (0.002, 0.146)	0.422 (0.279, 0.547)			
	Mixed	2	−0.341 (−0.497, −0.184)	0.035 (−0.209, 0.277)			
Grade	Middle ^c	1	0.321 (−0.049, 0.690)	0.310 (−0.049, 0.598)	1.569	0.017	0.015
	High ^c	1	0.091 (−0.429, 0.612)	0.390 (−0.445, 0.862)			
	Middle and high ^c	1	−0.381 (−0.893, 0.132)	−0.060 (−0.736, 0.676)			
	College	96	0.002 (−0.374, 0.379)	0.312 (−0.399, 0.789)			
Sampling method	Random	1	−0.060 (−0.467, 0.347)	−0.060 (−0.436, 0.334)	3.221	0.017	0.025
	Non-random	102	0.375 (−0.040, 0.790)	0.305 (−0.468, 0.813)			
Standardization of PSMU	Standardized	94	0.294 (0.205, 0.383)	0.286 (0.202, 0.365)	0.267	0.017	0.029
	Non-standardized	9	0.063 (−0.180, 0.306)	0.343 (0.025, 0.597)			
Measurement of PSMU	Problematic Use	84	0.287 (0.189, 0.386)	0.279 (0.187, 0.368)	2.232	0.017	0.025
	Usage Behavior	17	0.102 (−0.071, 0.275)	0.370 (0.117, 0.579)			
	Psychological Factors	2	−0.238 (−0.548, 0.072)	0.049 (−0.344, 0.428)			
Measurement of CER	CERQ	58	0.054 (−0.062, 0.169)	0.054 (−0.062, 0.168)	21.958*** ^c	0.017	0.009
	Rumination-related	45	0.314 (0.181, 0.447)	0.352 (0.118, 0.548)			
Region	Asia	87	0.336 (0.233, 0.438)	0.324 (0.229, 0.412)	0.642	0.017	0.032
	North America	12	−0.114 (−0.326, 0.098)	0.218 (−0.093, 0.490)			
	Europe	2	−0.105 (−0.521, 0.310)	0.227 (−0.280, 0.634)			
Publication type	Journal	87	0.238 (0.161, 0.315)	0.234 (0.160, 0.305)	5.126*** ^c	0.018	0.016
	Dissertation	12	0.271 (0.093, 0.450)	0.469 (0.249, 0.644)			
	Conference	4	0.213 (−0.085, 0.511)	0.423 (0.076, 0.678)			

Notes: ^aReference group in multiple regression in the three-level model. ^bZero-order r values of the reference group were computed using the following formula, zero-order $r = (e^{(2 \times \text{Fisher's } Z)} - 1) / (e^{(2 \times \text{Fisher's } Z)} + 1)$. Other groups must get their real Fisher's Z before using this formula above. The real Fisher's Z value of a nonreference group can be retrieved by adding the value of reference group into the value listed in its cell. For example, the real Fisher's Z value of MCER = $0.097 + 0.232 = 0.329$. The value of lower- and upper-limit of 95% CI can be computed similarly. ^cSubgroups with $k = 1$ are descriptive only and not suitable for statistical inference. ^dACER = adaptive cognitive emotion regulation; MCER = maladaptive cognitive emotion regulation. *** $p < 0.01$; ** $p < 0.001$.

4 Discussion

To examine the overall relationship between CER and PSMU, the present study conducted a meta-analysis of 21 primary studies and explored a range of potential moderators, including CER type, grade level, sampling method, region, publication type, and PSMU standardization. Among these variables, CER type and publication type showed significant moderating effects, whereas the other variables did not demonstrate statistically significant moderation.

4.1 Main Effects of the Relationship between CER and PSMU

Regarding the first research question, the present study found a moderate positive correlation between students' CER and PSMU ($r = 0.293$). This finding is consistent with previous theoretical models. According to the I-PACE model, difficulties in managing negative affect are associated with impaired cognitive control and a greater tendency toward compulsive digital behaviors [23]. Similarly, the Risk Behavior Prediction Model [28,29] and the Self-Regulatory Depletion Model [69] suggest that strong negative emotions combined with insufficient regulation skills are associated with heightened impulsive tendencies, which may be associated with excessive social media use as an easily accessible—yet potentially ineffective—coping strategy. The Self-Defense Mechanism Model [20] and Self-Determination Theory [24] further suggest that maladaptive CER strategies (e.g., rumination, self-blame, avoidance) are associated with lower levels of psychological need satisfaction and a greater tendency to rely on social media as a form of emotional escape. Collectively, these frameworks converge on the idea that poorer CER is associated with a higher likelihood of engaging in PSMU, particularly among students with still-developing self-regulatory systems.

Beyond this pattern, several other models describe a potential reciprocal association in which emotional distress and PSMU are associated over time. Compensatory Internet Use Theory [31] and the Social-Emotional Model [70] suggest that individuals may turn to online environments when experiencing negative emotions, and such patterns may be associated with greater psychological strain over time. Relatedly, the Pathological Use Model [26,71] and Socio-Psychological-Physiological [34,72,73] perspectives indicate that although social networking may provide temporary relief, prolonged overuse is associated with poorer offline relationships, lower life satisfaction, and higher levels of anxiety or depressive symptoms. These patterns may, in turn, be associated with reduced CER capacity, forming a mutually reinforcing association between emotional dysregulation and problematic social media behaviors. The present study's results align with this perspective, showing that individuals with poorer CER tend to report higher levels of PSMU.

The results of the sensitivity analysis provide further context for interpreting this overall pattern. Specifically, when studies using the overall CERQ scale were included, the association between CER and PSMU became non-significant. This finding suggests that the relationship between CER and PSMU may not be uniform across all CER strategies [49]. One possible explanation is that the existing literature is characterized by an uneven representation of different CER strategies, with rumination-related measures being disproportionately represented across studies. As a result, the overall association may be more strongly influenced by specific regulatory processes, rather than reflecting all CER dimensions equally. Therefore, these findings highlight the importance of considering strategy-specific differences when examining the relationship between CER and PSMU, rather than treating CER as a unitary construct. Accordingly, the overall effect size should be interpreted with caution, as it may not fully capture the associations across all CER strategies.

4.2 Moderating Effects of CER Types

With respect to the second research question, this study found that CER type significantly moderated the relationship between CER and PSMU. ACER ($r = 0.097$) and MCER ($r = 0.318$) were significantly and positively associated with PSMU. Specifically, Acceptance ($r = 0.359$), Putting into perspective ($r = 0.251$), Self-blame ($r = 0.400$), Rumination ($r = 0.319$), Catastrophizing ($r = 0.425$), and Blaming others ($r = 0.422$) were positively associated with PSMU. Notably, acceptance, although typically classified as an adaptive CER strategy, was positively associated with PSMU ($r = 0.359$), with an effect size substantially larger than that of adaptive CER overall (ACER; $r = 0.097$). This finding is noteworthy and appears counterintuitive. One possible explanation lies in the context-dependent nature of acceptance [74]. In digital environments, particularly among adolescents, acceptance may reflect a more passive coping tendency (e.g., tolerating distress without active behavioral adjustment), which may be associated with greater reliance on social media as a means of emotional relief [75]. Importantly, this pattern suggests that acceptance may function differently from other adaptive CER strategies. Rather than reflecting effective emotional processing, acceptance in certain contexts may be more closely aligned with disengagement or passive coping, which may help account for its relatively stronger association with PSMU compared to other adaptive strategies. The r -values of Positive refocusing, Refocusing on planning, Positive reappraisal, and Mixed were not significantly associated with PSMU.

The present three-level meta-analysis showed that CER type significantly moderated the association between CER and PSMU. Subgroup estimates indicated that the magnitude of the CER–PSMU association varied across regulation strategies, with a significant positive association observed for maladaptive CER overall (MCER; $r = 0.318$) and a smaller but significant association for adaptive CER overall (ACER; $r = 0.097$). At the strategy level, several maladaptive strategies (e.g., self-blame, rumination, catastrophizing, and blaming others) showed relatively stronger positive correlations with PSMU, whereas several adaptive strategies (positive refocusing, refocusing on planning, and positive reappraisal) and the mixed category were not significantly related to PSMU. These findings indicate that CER type functions as a significant moderator of the association between CER and PSMU and helps explain part of the heterogeneity observed across studies. However, it should be noted that the observed pattern may be influenced by the disproportionate representation of rumination-related measures, and therefore may not equally reflect all CER dimensions.

To further interpret these patterns, from a functional perspective, maladaptive CER strategies and PSMU may share a common regulatory function. Maladaptive strategies such as self-blame, rumination, and catastrophizing are characterized by dysfunctional cognitive patterns that are associated with heightened negative emotional experiences and difficulties in emotional resolution [16,76]. PSMU, in turn, has been widely conceptualized as a compensatory behavioral response to stress and emotional distress [31]. When adolescents rely on maladaptive cognitive regulation strategies, they may be more likely to report higher levels of social media use as an avoidant or emotion-relief-oriented coping pattern, which may help explain the stronger associations observed for maladaptive CER strategies.

A complementary explanation can be derived from a risk-oriented perspective. According to the Risk Behavior Prediction Model, maladaptive behaviors tend to be observed under conditions of intense emotional arousal combined with insufficient regulatory resources [28,29]. Maladaptive CER strategies are associated with higher levels of emotional reactivity, impulsivity, and psychological distress, thereby being linked to greater vulnerability to problematic digital behaviors. In contrast, adaptive CER strategies may be better understood as protective resources whose associations with PSMU may be context-dependent and

less readily observable in general adolescent samples. As a result, maladaptive strategies are more likely to show robust and consistent associations with PSMU in meta-analytic analyses.

Finally, the observed pattern can be understood from a mechanistic or hierarchical perspective. Maladaptive CER strategies are conceptually closer to proximal self-regulatory difficulties, such as impaired inhibitory control and impulsive coping tendencies, which have been linked to PSMU [77,78]. These strategies are associated with heightened negative affect and reduced self-control, which may in turn be associated with greater engagement with rewarding digital behaviors. In contrast, adaptive strategies such as positive reappraisal or refocusing on planning may operate through more indirect pathways—such as improved academic coping or reduced stress accumulation—rather than showing strong direct associations with PSMU [79].

Taken together, these findings indicate that maladaptive CER strategies play a more central role in the association between CER and PSMU than adaptive strategies. The significant moderating effect of CER types underscores the importance of distinguishing between different regulatory strategies when examining PSMU and suggests that interventions targeting maladaptive CER may be particularly relevant for reducing PSMU among adolescents.

4.3 Moderating Effects of Other Variables

With respect to the second research question, the moderating effects of other variables showed mixed results and should be interpreted with caution.

The present meta-analysis showed that the moderating effect of grade was not significant and should therefore be interpreted with caution. Some subgroup estimates (e.g., middle and high school groups) were based on only one effect size ($k = 1$), and therefore do not allow for meaningful statistical comparison across groups. The distribution of samples across grade levels was highly uneven, with limited representation of certain subgroups. Under such conditions, subgroup estimates may be less stable, and potential differences across grade groups may be difficult to detect [62,80]. Therefore, the non-significant finding should not be interpreted as evidence of the absence of grade differences, but rather as a reflection of limited statistical power.

The present meta-analysis showed that the moderating effect of sampling method on the relationship was not significant. Among the 22 independent samples, most employed convenience sampling, whereas only a small number adopted random sampling. This imbalance in sampling approaches may have constrained variability between sampling categories and reduced the comparability of sampling groups, making it more difficult to identify systematic differences across sampling methods [62].

The present meta-analysis showed that the moderating effect of standardization of PSMU on the relationship was not significant. One possible explanation relates to the distribution of measurement approaches across the included studies. Among the 22 independent samples, the majority employed standardized scales, whereas only a small number relied on self-report measures or self-designed instruments. This pattern may have limited variability across measurement categories and reduced the sensitivity of comparisons across different types of measures [80].

The present meta-analysis further examined whether differences in the measurement of PSMU would influence the observed association with CER. The results indicated that the moderating effect of measurement of PSMU was not statistically significant, suggesting that the association between CER and PSMU is relatively stable across different measurement approaches. In the current study, PSMU measures were categorized into three types based on their primary conceptual focus: problematic or addictive use, usage behavior, and psychological factors. Although these categories reflect different operationalizations, they share

common underlying dimensions, such as excessive engagement, loss of control, and negative emotional or social consequences. This conceptual overlap may contribute to the convergence of effect sizes across measurement types [81]. Additionally, the uneven distribution of measurement types across studies may have limited the statistical power to detect more nuanced differences.

The present meta-analysis further showed that the measurement of CER significantly moderated the association between CER and PSMU. Specifically, studies using the CERQ yielded a non-significant association, whereas rumination-related measures showed a significantly stronger effect. One possible explanation is that these two types of measures differ in their conceptual scope. The CERQ assesses multiple CER strategies within a multidimensional framework, whereas rumination-related measures focus more narrowly on a specific maladaptive regulatory process that has been more consistently linked to psychological maladjustment. Previous research has similarly suggested that different emotion regulation strategies may show varying degrees of association with maladaptive outcomes, rather than reflecting a uniform effect across all strategies [49]. Therefore, the present finding suggests that the association between CER and PSMU may be better understood from a multidimensional rather than a unitary perspective.

The present meta-analysis found that region did not significantly moderate the association between CER and PSMU. Although cultural and regional contexts have been theorized to be associated with differences in self-regulation and emotional processing (e.g., He et al.) [82], such patterns were not observed in the current synthesis. One possible explanation is that region represents a relatively broad contextual indicator that may not adequately capture more proximal sociocultural mechanisms relevant to CER and PSMU. In addition, the distribution of studies across continents was highly uneven, with a large proportion of samples drawn from Asia (predominantly China) and relatively limited representation from North America and Europe, which may have limited cross-regional comparability.

The present meta-analysis found that publication type significantly moderated the association between CER and PSMU, indicating that effect sizes varied across publication types. As noted by Card [61], one approach to assessing potential publication bias is to compare effect sizes across publication types. The moderation effect of publication type in the present study was statistically significant, suggesting that the magnitude of the reported associations differed systematically across journals, theses, and other dissemination formats. When considered alongside the trim-and-fill results, these findings together suggest that publication-related factors may have substantially influenced the observed overall effect. The trim-and-fill analysis indicates that smaller or non-significant effects may be underrepresented in the literature, while the larger effect sizes observed in dissertations and conference papers point to systematic differences across publication types. Taken together, these results suggest that the pooled effect size may have been overestimated and should not be interpreted as relatively robust. Furthermore, this finding may also reflect underlying differences in methodological rigor and reporting consistency across publication types. Studies published in peer-reviewed journals are typically subject to more stringent evaluation processes, whereas other formats may show greater variability in research quality. This highlights the importance of carefully considering publication sources in future meta-analytic and primary research. Accordingly, the overall association should be interpreted with caution, as it may be influenced by multiple sources of bias.

4.4 Theoretical and Practical Implications

In terms of theoretical implications, the present study offers several important contributions to the literature on CER and PSMU.

First, this study represents one of the first three-level meta-analyses to quantitatively synthesize the association between CER and PSMU over the past decades. By integrating evidence from multiple independent samples and accounting for both within- and between-study variance, the present findings provide more stable and integrative estimates than individual studies, contributing to a clearer understanding of previously inconsistent empirical results. Importantly, the present study also reveals a notable imbalance in the existing literature, with rumination receiving relatively greater empirical attention compared to other CER strategies. This pattern suggests that current evidence on CER and PSMU may be disproportionately informed by a limited subset of regulatory processes. Rather than treating CER as a unitary construct, the present findings highlight the importance of adopting a multidimensional perspective and distinguishing between specific regulatory strategies when examining their associations with PSMU. In this sense, the present meta-analysis contributes not only by synthesizing existing evidence, but also by clarifying the structural characteristics of the literature and identifying directions for future research.

Second, the findings highlight that CER should not be treated as a single, uniform construct when examining its relationship with PSMU. Although existing theoretical models generally emphasize emotion regulation difficulties as a risk factor for problematic media use, the present meta-analysis demonstrates substantial variability across CER types. Specifically, different regulation strategies show markedly different associations with PSMU, indicating that the heterogeneity observed in prior research may be partly attributable to differences in the specific CER strategies assessed. This strategy-level differentiation refines existing theoretical frameworks by emphasizing the functional heterogeneity of CER processes.

Third, the strategy-specific results provide further theoretical insight by showing that not all strategies traditionally classified as adaptive or maladaptive function equivalently in the context of social media use. The robust associations observed for several maladaptive strategies, as well as the significant association for acceptance, suggest that the effectiveness and consequences of CER strategies may be context-dependent. These findings underscore the need for more fine-grained theoretical models that move beyond broad categorical distinctions and consider the distinct psychological roles of individual CER strategies in shaping problematic digital behaviors.

In terms of practical implications, this study's findings also have important implications for the prevention and intervention of PSMU among adolescents.

First, the results suggest that practical efforts aimed at reducing PSMU should avoid adopting an undifferentiated approach to emotion regulation. Rather than focusing solely on enhancing general emotion regulation skills, intervention programs may be more effective if they prioritize the identification and reduction of specific maladaptive CER strategies, particularly rumination-related processes, that show consistently strong associations with PSMU. Helping adolescents recognize habitual patterns such as rumination, self-blame, or blaming others may be especially important for understanding vulnerability to problematic use.

Second, the strategy-level findings highlight the value of targeted assessment and early identification. Assessments that capture adolescents' reliance on specific CER strategies may provide useful information for identifying individuals at higher risk of PSMU. Such an approach may support more focused and individualized prevention efforts in educational and school-based settings.

Finally, the present results suggest that PSMU should be understood not merely as a matter of excessive use, but as a behavior closely linked to underlying cognitive and emotional coping processes. From a practical perspective, interventions that promote greater awareness of cognitive coping styles and encourage more adaptive emotion regulation may be associated with healthier and more balanced patterns of social media use among adolescents.

From an applied perspective, these findings also provide more concrete guidance for educators and clinicians. For example, school-based programs may incorporate brief cognitive-behavioral components that help students identify and modify maladaptive CER strategies such as rumination or self-blame. Similarly, clinicians may focus on training adolescents to shift from passive or maladaptive cognitive responses toward more active and problem-oriented coping strategies, which may be associated with reduced reliance on social media as a primary means of emotional regulation.

4.5 Research Limitations and Future Directions

Several limitations of the present meta-analysis should be acknowledged, which also point to directions for future research.

First, although the three-level meta-analytic model accounted for both within- and between-study heterogeneity, the distribution of primary studies across certain moderators was uneven. Some subgroups were represented by a relatively small number of studies, and publication outlets contributed unequally to the pooled estimates. Such imbalances may be associated with reduced statistical power for detecting more fine-grained moderation effects and therefore call for cautious interpretation of subgroup findings. Moreover, the uneven representation of different CER strategies across studies, with rumination-related measures being disproportionately represented, may have influenced the overall effect size. This imbalance means that the findings may not fully represent all CER dimensions, and therefore should be interpreted with caution, particularly given the potential influence of publication bias and variation across publication types. In addition, some potential sources of heterogeneity, such as age, could not be further examined due to limited and inconsistent reporting across primary studies. Future meta-analyses would benefit from a more balanced accumulation of high-quality primary studies across publication formats, cultural contexts, and study designs.

Second, differences in how PSMU was measured across studies represent an additional limitation. Although the standardization of PSMU measures did not emerge as a significant moderator in the present analysis, primary studies relied on diverse instruments, dimensional structures, and scoring approaches. This variability may be associated with additional noise and reduced sensitivity for examining more detailed, dimension-specific associations. Future research using more theoretically aligned and psychometrically comparable measures may facilitate clearer interpretation and support more refined evidence synthesis.

Third, the present meta-analysis focused on synthesizing associations between CER and PSMU and therefore cannot directly address underlying psychological mechanisms. While the findings demonstrate substantial variability across CER types and specific strategies, the processes through which these regulatory strategies are associated with maladaptive social media use remain insufficiently understood. Future primary studies are encouraged to investigate potential mediating and moderating mechanisms—such as motivational, cognitive, or contextual factors—to clarify how and under what conditions different CER strategies are linked to problematic digital media behaviors.

Fourth, a related limitation concerns the uneven regional distribution of the included studies. Although region was examined as a potential moderator, a considerable proportion of the included samples were drawn from Asia (primarily China), with relatively limited representation from North America and Europe. This imbalance may have reduced the ability to detect potential regional or cultural differences. Importantly, this pattern likely reflects the current distribution of available research rather than limitations in the search or inclusion process. Future primary studies should include more geographically and culturally diverse samples to better examine the role of contextual factors in the relationship between CER and PSMU.

Taken together, addressing these limitations through more methodologically rigorous, theoretically informed, and culturally diverse primary research may help strengthen the empirical foundation of this field and improve the explanatory value of future research.

5 Conclusions

Based on this meta-analysis of 21 primary studies, a positive association was observed between CER and PSMU. The moderating effect of CER type was significant, with maladaptive strategies (e.g., self-blame, rumination, catastrophizing, and blaming others) showing stronger associations with PSMU than adaptive strategies. In addition, measurement of CER and publication type were identified as significant moderators, whereas grade, sampling method, measurement of PSMU, standardization of PSMU, and region did not show significant moderating effects. These findings should be interpreted with caution, as the observed associations may be influenced by the disproportionate representation of rumination-related measures and potential publication bias, which may limit the generalizability of the results across different CER dimensions. Future research is needed to further examine how different CER strategies are associated with PSMU through distinct underlying mechanisms.

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