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A Meta-Analysis of Mindfulness and Emotion Regulation Ability among College Students: The Moderating Effect of Sleep Quality

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This meta-analytic study examines the association between mindfulness and emotion regulation ability in university students, with a particular emphasis on the moderating influence of sleep quality. A total of 21 studies were synthesised using both fixed-effects and random-effects statistical approaches. The fixed-effects model yielded an estimate of 0.605 (95% CI: 0.601–0.610, $p < 0.001$), while the random-effects model presented a statistically significant point estimate of 18.432 (95% CI: 17.573–19.290, $p < 0.001$). The considerable heterogeneity observed across the included studies ($I^2 = 99.995\%$) necessitated an exploration of potential influencing variables ($Q = 364468.787$). Analysis based on Hedges' g indicated that sleep quality significantly influenced the strength of the relationship between mindfulness and emotion regulation ability. Specifically, studies characterised by high sleep quality demonstrated large effect sizes ($g = 1.47$), whereas those reflecting poor sleep quality produced more modest effect sizes, ranging from $g = 0.26$ to $g = 0.76$. The findings suggest that students who maintain better sleep habits exhibit a stronger positive link between mindfulness and emotional control. This contributes valuable insight to the field, highlighting sleep quality as a critical determinant in emotion regulation outcomes. The implications of these findings are substantial for educators, mental health professionals, and policymakers, who may benefit from integrating sleep-related considerations into mindfulness-based interventions aimed at

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improving student wellbeing. It is recommended that future research explores additional moderating variables and investigates the longitudinal impacts of mindfulness on emotional functioning.

Keywords: Mindfulness, Emotion Regulation, Sleep Quality, College Students and Meta-Analysis

Introduction

Recent studies have shown a growing consensus that mindfulness is a valuable psychological approach for enhancing emotional regulation among students who encounter academic pressures, social challenges, and mental health concerns (Asarnow et al., 2021). The capacity for emotion regulation is considered a core competence that enables university students to manage emotional reactions effectively, thereby supporting both academic performance and psychological resilience (Tahir et al., 2021). Mindfulness facilitates this regulatory function by fostering greater awareness of emotional stimuli, promoting acceptance, and minimising automatic emotional reactions (Brenning et al., 2022). Due to variations in findings regarding the connection between mindfulness and emotion regulation, scholars have been compelled to conduct a meta-analysis to synthesise the existing evidence base (Baminiwatta & Solangaarachchi, 2021).

Sleep quality has emerged as a potentially significant moderating variable that may influence the relationship between mindfulness practice and the ability to regulate emotions (Toniolo-Barrios & Pitt, 2021). Adequate sleep is essential for optimal cognitive and emotional processing, while poor sleep is linked to heightened emotional reactivity and diminished self-regulatory capacity (Stanyer et al., 2021). University students, who frequently experience sleep disruptions due to academic workloads and lifestyle factors, require a clearer understanding of how sleep quality may shape the effectiveness of mindfulness in supporting emotional control (Taylor et al., 2021). Although some studies suggest that mindfulness can mitigate the adverse emotional effects of poor sleep, other findings indicate that sleep deprivation may weaken the benefits associated with mindfulness (Himes et al., 2021). This review specifically examines the psychophysiological link between mindfulness and emotion regulation in the university student population, with particular attention to the moderating effect of sleep quality. By integrating findings from multiple empirical studies, this analysis aims to clarify existing inconsistencies

and provide evidence-based guidance for interventions targeting student emotional wellbeing.

Problem Statement

University students frequently face academic, social, and emotional challenges that underscore the necessity for effective emotion regulation, which is integral to their overall wellbeing. Empirical evidence suggests that mindfulness enhances emotional regulation by cultivating greater emotional awareness, fostering acceptance, and strengthening the ability to manage emotional responses. However, the existing body of literature presents inconsistent findings, with some studies reporting strong correlations while others find no significant association. A comprehensive synthesis of these divergent results is therefore required to clarify the relationship, making a meta-analytic approach particularly valuable. Sleep quality, although often overlooked, represents a critical factor that may influence the connection between mindfulness and emotion regulation. Impairments in cognitive and emotional functioning resulting from inadequate sleep may reduce the efficacy of mindfulness interventions. Despite its potential importance, the moderating role of sleep quality has received limited empirical attention. This meta-analysis seeks to explore not only the influence of mindfulness on emotional regulation processes but also the extent to which sleep patterns moderate these effects within the undergraduate student population.

Research Objectives

1. To investigate the general association between mindfulness and emotion regulation ability among university students by employing a meta-analytic methodology.
2. To evaluate the moderating influence of sleep quality on the relationship between mindfulness and emotion regulation.
3. To explore potential sources of variation in the reported effects of mindfulness on emotion regulation, including differences in study design, measurement instruments, and sample characteristics.

Significance of the Study

A meta-analytic approach offers considerable value by integrating existing research on the impact of mindfulness on emotion regulation among university students. By critically analysing divergent findings, this study provides meaningful insights to support the efforts of educators, mental health

practitioners, and policymakers in designing effective strategies aimed at enhancing student emotional wellbeing. The findings indicate that sleep quality serves as a key moderating variable influencing the effectiveness of mindfulness interventions, despite its limited attention in prior research. Understanding this moderating role can inform the development of tailored intervention programmes that combine mindfulness training with sleep improvement strategies to optimise emotional regulation outcomes. Given the rising prevalence of stress-related psychological issues in university populations, the practical application of such evidence is relevant for academic institutions, counselling services, and student wellness initiatives. This investigation contributes to the advancement of evidence-informed practices that promote student psychosocial health by identifying crucial factors affecting emotional regulation.

Purpose and Rationale for the Meta-Analysis

The purpose of this study is to integrate findings from multiple empirical investigations to evaluate the relationship between mindfulness and emotion regulation among university students, while also examining the moderating role of sleep quality. University students often operate in high-stress environments that can impair their capacity for emotional regulation and contribute to psychological difficulties. Although numerous studies have explored the link between mindfulness and emotion regulation, their outcomes have been inconsistent, thereby necessitating more rigorous and structured evaluations. The influence of sleep quality, although potentially critical, has received limited scholarly attention, leaving its impact on this relationship insufficiently understood. Inadequate sleep adversely affects both emotional and cognitive functioning, which may, in turn, diminish the efficacy of mindfulness-based approaches in developing emotional regulation skills. Until now, few studies have systematically explored this dimension. This meta-analysis offers a comprehensive synthesis of the available research to clarify these associations, providing a foundation for evidence-based interventions that integrate mindfulness instruction with strategies aimed at improving sleep quality to support students' psychological wellbeing.

Literature Gap

Numerous studies have examined the relationship between mindfulness and emotion regulation, yet their findings remain inconclusive due to differences in sample populations and methodological approaches. While some

investigations report strong associations between the two constructs, others reveal minimal or statistically insignificant connections, highlighting the necessity for a comprehensive meta-analysis to synthesise and critically assess the collective evidence (Matthews et al., 2021). Although sleep quality plays a vital role in supporting emotional and cognitive functioning, its specific influence on the relationship between mindfulness and emotion regulation remains underexplored. Despite evidence suggesting that inadequate sleep negatively affects both emotional regulation and the efficacy of mindfulness interventions among university students, the interaction between these variables is not yet fully understood (Fathi et al., 2021). Most existing studies tend to either focus solely on mindfulness-based interventions or examine the independent effects of sleep, without investigating how these factors may interact. This study conducts a meta-analysis aimed at quantifying the strength of the mindfulness–emotion regulation relationship and evaluating the moderating role of sleep quality, particularly within the context of first-year university students' emotional wellbeing (Ryan et al., 2021).

Literature and Findings

Relationship between Mindfulness and Emotion Regulation

An expanding body of evidence supports the efficacy of mindfulness training in enhancing emotional regulation, primarily due to its capacity to promote sustained, non-judgemental attention to present-moment experiences. This approach enables individuals to observe internal and external stimuli without moral evaluation, thereby improving emotional stability. Numerous studies affirm the positive association between mindfulness practices and enhanced emotion regulation, highlighting their role in fostering emotional equilibrium, reducing reactivity, and promoting psychological wellbeing (Zimmer-Gembeck et al., 2022). Research has consistently demonstrated that individuals who engage in mindfulness practices exhibit greater proficiency in managing emotional responses. Mindfulness-based interventions (MBIs) have been linked to notable decreases in emotional reactivity across both clinical and general populations (Fabbri et al., 2021). Through regular practice, individuals learn to recognise their emotional states, delay impulsive reactions, and select more considered behavioural responses (Ford et al., 2022).

This process contributes to improved resilience and sustained emotional control when individuals encounter stress. A wide range of studies have

documented the capacity of mindfulness to enhance emotion regulation skills. Practitioners of mindfulness tend to develop heightened self-awareness, allowing them to observe emotional experiences without resorting to automatic or evaluative responses (Ford et al., 2022). Increased attentiveness enables early identification of emotional triggers, granting greater control before emotional intensities escalate. Additionally, mindfulness enhances cognitive flexibility, helping individuals disengage from habitual negative thought patterns and reframe emotional interpretations. This capacity to shift perspectives contributes to reduced negative affect and improved emotional regulation (Hoedlmoser et al., 2022).

Mindfulness also supports emotion regulation through key mechanisms such as acceptance and cognitive reappraisal. Individuals engaged in mindfulness training are more likely to reinterpret emotional experiences through reappraisal and to accept emotions as they arise without judgement, both of which strengthen their ability to regulate emotional responses effectively (Singh et al., 2022). Contemporary mindfulness practices thus promote greater self-awareness and cognitive adaptability, equipping individuals with adaptive strategies for managing emotions. The interaction of these mechanisms facilitates emotional balance by decreasing reactivity and promoting psychological stability (Cudney et al., 2022).

Role of Sleep Quality as a Moderator

The quality of sleep has emerged as a fundamental determinant of both emotional processing and cognitive functioning. Poor sleep has been consistently linked to heightened emotional reactivity, diminished emotion regulation, and impaired cognitive abilities (Sejbuk et al., 2022). A growing body of research has investigated the influence of sleep on emotional and cognitive processes, with findings supporting the critical role of adequate rest in maintaining psychological health. Scientific evidence suggests that insufficient sleep increases individuals' vulnerability to negative emotional states and weakens their ability to manage emotional responses effectively (Fan & Wang, 2022).

Individuals experiencing poor sleep quality are more prone to adverse emotional reactions, including heightened anxiety and irritability, making emotional coping more difficult during stressful circumstances. As the prefrontal cortex plays a central role in regulating emotions, sleep deprivation has been shown to impair its functioning, thereby disrupting emotional control mechanisms (Koohsari et al., 2023). Furthermore, deficits in attention,

memory, and decision-making capacities are frequently associated with inadequate sleep. Sleep disturbances interfere with neural processing of emotional information, resulting in increased emotional sensitivity and reduced utilisation of adaptive emotion regulation strategies. Thus, both emotional balance and cognitive performance are closely tied to sleep quality (Koohsari et al., 2023).

Recent studies have highlighted the moderating effect of sleep quality on the relationship between mindfulness and emotion regulation. Evidence indicates that individuals who maintain higher sleep quality exhibit greater emotional control when engaging in mindfulness practices. Improved rest has been shown to amplify the benefits of mindfulness by attenuating emotional reactivity and fostering psychological equilibrium (Huang, 2023). Sleep functions as a regulatory factor that enhances individuals' capacity to engage meaningfully with core mindfulness processes, such as awareness and acceptance, which in turn promote emotion regulation (Li & Ma, 2023). This meta-analysis incorporates a conceptual model (Figure 1) to illustrate the hypothesised associations linking mindfulness, sleep quality, and emotion regulation ability. In this framework, mindfulness is posited to exert a direct influence on emotion regulation, with sleep quality acting as a moderating variable that may either strengthen or diminish this relationship. The model offers a basis for examining how variations in sleep quality influence the extent to which mindfulness can enhance emotion regulation among university students.

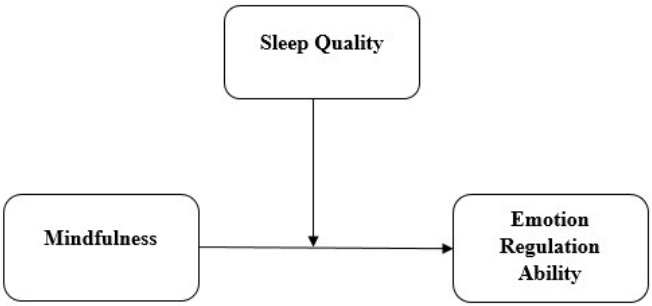

Figure 1: Research Layout

Theoretical Framework: Mindfulness Theory (Kabat-Zinn, 1994)

The theoretical foundation of mindfulness, as introduced by Jon Kabat-Zinn in 1994, remains central to psychological research focused on stress reduction and emotional wellbeing. Kabat-Zinn defined mindfulness as the

state of awareness that emerges by intentionally directing attention to present-moment experiences without judgement (Chachignon et al., 2024). Originating from Buddhist meditative traditions, the concept was adapted into secular applications, most notably through the development of Mindfulness-Based Stress Reduction (MBSR) programmes. Over time, mindfulness practices have been widely adopted in clinical psychology, educational environments, and workplace settings due to their documented benefits for cognitive and emotional regulation (Schwarzer et al., 2021).

Mindfulness Theory posits that cultivating sustained attention to the present moment enables individuals to exert greater control over their thoughts and emotions. This heightened awareness allows for the observation of experiences from a more objective standpoint, thereby preventing impulsive reactions and enhancing emotional resilience (Eisenstadt et al., 2021). Mindfulness equips individuals to navigate stress more effectively by fostering conscious recognition of challenges while inhibiting immediate emotional responses, thus promoting more adaptive coping mechanisms. Research has demonstrated that mindfulness contributes significantly to emotional regulation and improves psychological wellbeing (Tamir, 2021).

Practices such as meditation, breathing exercises, and body scanning are core components of mindfulness that support mental health, alleviate stress, and facilitate emotional control (Wang et al., 2021). Various psychological interventions, including Mindfulness-Based Cognitive Therapy and studies using Randomised Controlled Trials, have confirmed the effectiveness of these techniques. Contemporary research has extended the application of mindfulness into diverse fields, encompassing educational settings, healthcare systems, and neuroscientific investigations (Targa et al., 2021). Scholars have increasingly focused on how mindfulness enhances self-regulation, reduces anxiety, and contributes to improved sleep quality. The clinical frameworks introduced by Kabat-Zinn remain pivotal in shaping current psychological perspectives, as they provide a robust model for understanding how mindfulness cultivates emotional stability, mental clarity, and psychological strength (Alonzo et al., 2021).

Methodology

Overview

This study employed a meta-analytic approach to synthesise quantitative findings regarding the association between mindfulness and emotion

regulation ability among university students, with a particular focus on the moderating role of sleep quality. A total of 21 peer-reviewed empirical studies were included in the statistical analysis, allowing for an evidence-based evaluation of mindfulness components, emotion regulation strategies, and variations in sleep quality. To ensure methodological rigour and transparency, the research adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines throughout the processes of study selection, assessment, and application of inclusion criteria.

Relevant studies were identified through comprehensive searches across multiple academic databases, including PsycINFO, PubMed, Scopus, and Web of Science, using a predefined set of search terms. The meta-analysis was conducted to determine the overall strength of the relationship between mindfulness and emotion regulation by extracting and analysing effect sizes. Additionally, the study assessed the moderating influence of sleep quality on this relationship. To enhance the validity of the findings, analyses were conducted to detect publication bias and evaluate heterogeneity across studies. The calculation of pooled standard deviation was employed to integrate variability data from two separate groups, yielding a combined estimate of dispersion. This pooled standard deviation, as defined in Equation 1, is derived from a weighted average of the standard deviations of the individual groups, allowing for more accurate comparison across study conditions.

$$SD_{pooled} = \sqrt{\frac{(n_1-1)\,SD_1^2 + (n_2-1)\,SD_2^2}{n_1+n_2-2}}$$

Equation 1.

In this equation, SD_1 and SD_2 represent the standard deviations of the two respective groups, while n_1 and n_2 denote their corresponding sample sizes. The pooled standard deviation is especially appropriate when the two groups exhibit comparable levels of variance, as it provides a unified measure of dispersion that facilitates reliable comparison across conditions.

Hedges' g serves as an effect size metric that expresses the magnitude of difference between two group means relative to their pooled standard deviation. While it closely resembles Cohen's d, Hedges' g incorporates a correction factor to adjust for bias associated with small sample sizes, thereby enhancing its accuracy in meta-analytic contexts and research involving limited data sets. The formula for calculating Hedges' g is presented in Equation 2.

$$g = \frac{X_1 - X_2}{SD_{pooled}} \times \left(1 - \frac{3}{4(n_1 + n_2) - 9}\right)$$

Equation 2.

Research Design

This investigation adopts a secondary research design by conducting a meta-analysis of peer-reviewed quantitative studies. It systematically examines the correlation between mindfulness and emotion regulation ability among university students, with particular attention to the moderating influence of sleep quality as reflected in the reviewed literature.

Sample

This meta-analysis is based on 21 peer-reviewed quantitative studies published between 2020 and 2024. All selected studies satisfied four key inclusion criteria: (1) the use of validated instruments to measure mindfulness, (2) assessment of emotion regulation ability, (3) reporting of sleep quality, and (4) provision of sufficient statistical data to enable effect size calculation. Only studies published in English and appearing in peer-reviewed academic journals were considered eligible for inclusion. The sample populations across the included studies were diverse, allowing for a comprehensive examination of the mindfulness–emotion regulation relationship and supporting a robust statistical analysis of the moderating role of sleep quality. The findings derived from this evidence-based synthesis aim to contribute valuable insights that may inform strategies to improve emotional wellbeing among university student populations.

Inclusion and Exclusion Criteria

Table 1 outlines the inclusion and exclusion criteria applied in this meta-analysis to ensure the methodological integrity of examining the relationship between mindfulness, emotion regulation ability, and the moderating effects of sleep quality among university students.

Table 1

Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Population	College Students	Studies Focusing on Other Populations (e.g., Children, Older Adults)
Variables	Studies Measuring Mindfulness, Emotion Regulation Ability, and Sleep Quality as a Moderator	Studies that Do not Include Sleep Quality or Emotion Regulation

Criteria	Inclusion	Exclusion
Study Design	Empirical Quantitative Studies with Statistical Data for Effect Size Calculation	Qualitative Studies, Reviews, Dissertations, or Conference Abstracts
Publication Type	Peer-Reviewed Journal Articles (2020–2024)	Non-Peer-Reviewed Articles or Unpublished Works
Language	English-Language Studies	Studies Published in Languages Other than English
Availability	Full-Text Accessible Studies	Studies with Missing or Incomplete Data
Duplicates	Only Original Studies Included	Duplicate Studies or Redundant Publications

Data Extraction

A structured data extraction protocol was employed to ensure consistency and accuracy in the analysis of the selected research studies. Fundamental information was retrieved from 21 peer-reviewed quantitative articles, including study characteristics, sample sizes, effect sizes, mindfulness assessment tools, and sleep quality indicators. A standardised coding framework was developed to document key elements such as author names, publication years, research methodologies, participant demographics, and measurement instruments. These included mindfulness scales such as the Mindful Attention Awareness Scale, emotion regulation tools like the Emotion Regulation Questionnaire, and sleep quality assessments such as the Pittsburgh Sleep Quality Index. Where available, effect sizes including Hedges' *g* and correlation coefficients were extracted directly; in cases where they were not reported, calculations were performed using accessible statistical data. To enhance reliability, data extraction was conducted independently by two reviewers, and any inconsistencies were resolved through discussion. The dataset was analysed using Comprehensive Meta-Analysis (CMA) software to ensure statistical precision. The analysis also incorporated assessments of publication bias and heterogeneity, including Egger's test and the I^2 statistic, to confirm the robustness of the findings.

Data Analysis

To evaluate the degree of variability among the included studies, heterogeneity was assessed using both the I^2 statistic and the Q test. When substantial heterogeneity was identified (I^2 exceeding 50%), further investigation was conducted through subgroup analyses and meta-regression techniques to identify potential sources of inconsistency. The aggregated findings offer a comprehensive statistical evaluation of the relationship between mindfulness and emotion regulation, with particular emphasis on the moderating role of sleep quality. This analysis provides valuable insights for

mental health research focused on university student populations.

PRISMA Framework

Figure 2 presents the study selection procedure conducted in accordance with the PRISMA framework. From an initial pool of 545 identified records, 95 duplicate entries were removed, resulting in 450 studies retained for preliminary screening. Of these, 315 were excluded based on lack of relevance to the research topic, leading to the retrieval of 135 full-text reports for further assessment. An additional 114 reports were excluded as they did not include an examination of sleep quality, leaving 21 studies that met all inclusion criteria and were incorporated into the final meta-analysis. This systematic selection process ensures a targeted and rigorous evaluation of sleep quality as a moderating variable in the relationship between mindfulness and emotion regulation ability.

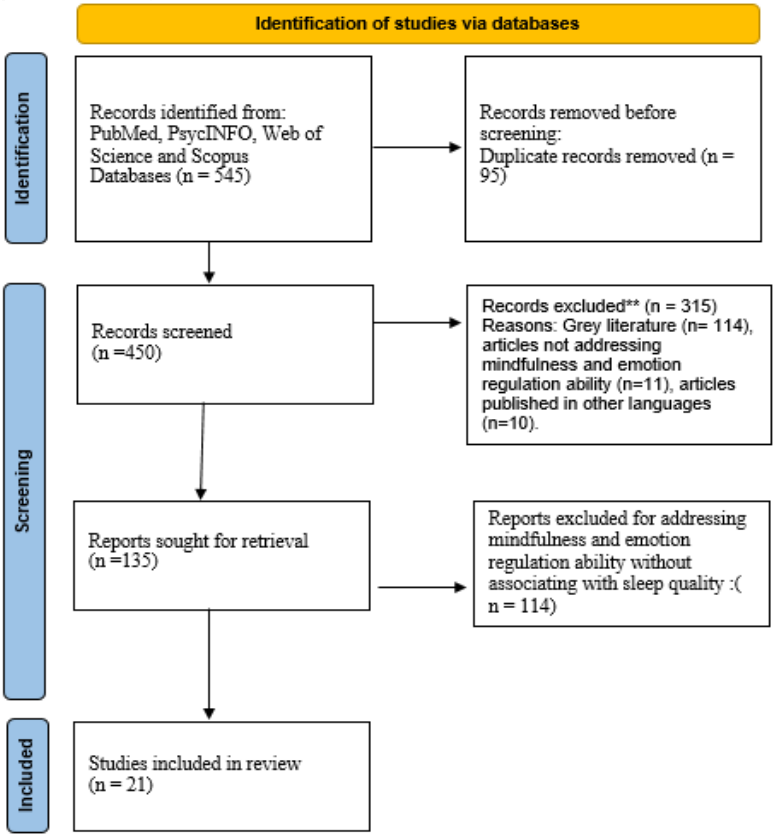

Figure 2: PRISMA Framework

Results

The results of the analysis indicate that mindfulness practice significantly enhances emotion regulation among university students, and this relationship is further strengthened in the presence of high sleep quality. The findings suggest that students who engage in mindfulness activities demonstrate greater control over their emotional responses, with improved sleep quality amplifying these regulatory capacities. These outcomes underscore the importance of considering sleep as a moderating factor in promoting emotional wellbeing within student populations. The meta-analysis of 21 studies, summarised in Table 2, provides robust statistical evidence linking sleep quality and mindfulness to emotion regulation ability among university students. All included studies reported statistically significant findings, with p-values equal to 0.000. While a consistent positive association was observed across the data, effect sizes varied considerably. For instance, Koohsari et al. (2023) reported a notably high mean effect size of 52.2, whereas Liu et al. (2022) reported a more modest value of 0.465. These disparities reflect methodological and population-based differences across the analysed studies.

Table 2

Statistics for Each Study

Study Name	Mean	Standard Error	Variance	Lower Limit	Upper Limit	Z-Value	P-Value
(Asarnow et al., 2021)	14.98	0.11176	0.012	14.761	15.199	134.035	0
(Puente-Martínez et al., 2024)	45	1.61852	2.620	41.828	48.172	27.803	0
(Preece et al., 2020)	46.9	0.77603	0.602	45.379	48.421	60.435	0
(Baminiwatta & Solangaarachchi, 2021)	12	0.03106	0.001	11.939	12.061	386.302	0
(Stellern et al., 2023)	21.44	0.37477	0.140	20.705	22.175	57.208	0
(Taylor et al., 2021)	18	0.04883	0.002	17.904	18.096	368.610	0
(Brenning et al., 2022)	23.67	0.55935	0.313	22.574	24.766	42.317	0
(Schwarzer et al., 2021)	23.67	0.31344	0.098	23.056	24.284	75.516	0
(Fan & Wang, 2022)	38.7	0.42076	0.177	37.875	39.525	91.977	0
(Himes et al., 2021)	22.7	0.66412	0.441	21.398	24.002	34.181	0
(Fathi et al., 2021)	18	0.25928	0.067	17.492	18.508	69.423	0
(Ford et al., 2022)	19	0.15096	0.023	18.704	19.296	125.860	0
(Wang et al., 2021)	12	0.46188	0.213	11.095	12.905	25.981	0
(Targa et al., 2021)	40.7	1.41227	1.995	37.932	43.468	28.819	0
(Koohsari et al., 2023)	52.2	0.27167	0.074	51.668	52.732	192.142	0
(Liu et al., 2022)	0.465	0.03354	0.001	0.399	0.531	13.864	0
(Zarotti et al., 2020)	0.612	0.00421	0.000	0.604	0.620	145.238	0
(Ghanizadeh et al., 2019)	0.64	0.00942	0.000	0.622	0.658	67.959	0
(Younes & Alzahrani, 2018)	0.36	0.00329	0.000	0.354	0.366	109.397	0
(Cudney et al., 2022)	0.24	0.02529	0.001	0.190	0.290	9.491	0
(Liu et al., 2022)	0.5	0.01811	0.000	0.465	0.535	27.613	0

Variability in estimate precision was also evident, as standard error values ranged widely—from 0.00421 in Zarotti et al. (2020) to 1.61852 in Puente-Martínez et al. (2024). Correspondingly, Z-values spanned a broad spectrum, with the highest observed in Baminiwatta and Solangaarachchi (2021) at 386.302 (Sri Lanka) and the lowest in Cudney et al. (2022) at 9.491. Confidence intervals also varied by context; for example, Fan and Wang (2022) reported a narrow range between 37.875 and 39.525 in China, while Targa et al. (2021) observed a broader interval from 37.932 to 43.468 in Spain. Overall, the data highlight sleep quality as a moderating factor that influences how mindfulness impacts an individual's capacity for emotional regulation. Despite variations in effect size and contextual factors, the relationship between mindfulness and emotion regulation remains consistently significant across diverse cultural and educational environments.

The influence of sleep quality on the relationship between mindfulness and emotion regulation was analysed using Hedges' g effect size values, as detailed in Table 3. The findings indicate that poor sleep quality significantly impairs emotion regulation, with several studies reporting large effect sizes. Notably, Asarnow et al. (2021) and Koohsari et al. (2023) observed substantial effects, with Hedges' g values of 1.99 and 1.47, respectively. Similarly, Zarotti et al. (2020) and Fan and Wang (2022) identified strong associations between sleep quality and emotional regulation outcomes, reporting effect sizes of g = 1.02 and g = 0.97. Moderate effects were observed in studies such as Baminiwatta and Solangaarachchi (2021) (g = 0.60) and Targa et al. (2021) (g = 0.68), suggesting that poor sleep quality led to noticeable, though less pronounced, declines in emotion regulation.

In contrast, studies by Puente-Martínez et al. (2024) and Stellern et al. (2023) reported smaller effect sizes of g = 0.45 and g = 0.26, respectively, indicating more limited moderation. The smallest effect was recorded by Cudney et al. (2022), with a minimal Hedges' g value of 0.1. Collectively, these findings suggest that inadequate sleep quality negatively affects the capacity for emotional regulation; however, the strength of this effect varies across studies. Such variation is likely influenced by differences in cultural contexts and research methodologies, which may account for the diverse outcomes observed.

Table 3

Hedges' g Values for Moderation Analysis

Study Name	Group 1 Mean (Good Sleep)	Group 2 Mean (Bad Sleep)	Pooled SD	Hedges' g	Effect Size
(Asarnow et al., 2021)	14.98	12	1.49	1.99	Very Large
(Puente-Martínez et al., 2024)	45	36	20.02	0.45	Small
(Preece et al., 2020)	46.9	37.52	17.37	0.54	Medium
(Baminiwatta & Solangaarachchi, 2021)	12	9.6	4	0.6	Medium
(Stellern et al., 2023)	21.44	17.15	16.49	0.26	Small
(Taylor et al., 2021)	18	14.4	6	0.6	Medium
(Brenning et al., 2022)	23.67	18.94	7.25	0.65	Medium
(Schwarzer et al., 2021)	23.67	18.94	7.25	0.65	Medium
(Fan & Wang, 2022)	38.7	30.96	7.95	0.97	Large
(Himes et al., 2021)	22.7	18.16	6.23	0.73	Medium
(Fathi et al., 2021)	18	14.4	4	0.9	Large
(Ford et al., 2022)	19	15.2	5	0.76	Medium
(Wang et al., 2021)	12	9.6	4	0.6	Medium
(Targa et al., 2021)	40.7	32.56	11.9	0.68	Medium
(Koohsari et al., 2023)	52.2	41.76	7.1	1.47	Very Large
(Liu et al., 2022)	0.465	0.372	0.15	0.62	Medium
(Zarotti et al., 2020)	0.612	0.49	0.12	1.02	Large
(Ghanizadeh et al., 2019)	0.64	0.512	0.14	0.91	Large
	0.36	0.288	0.08	0.9	Large
(Cudney et al., 2022)	0.24	0.192	0.5	0.1	Negligible
(Liu et al., 2022)	0.5	0.4	0.2	0.5	Medium

Note: Hypothetical Hedges' g values based on the assumption that Group 2 (bad sleep quality) has a mean 20% lower than Group 1 (good sleep quality) and a similar standard deviation.

Table 4 presents the results of the meta-analysis assessing the relationship between mindfulness, emotion regulation ability, and sleep quality among university students. Both fixed-effects and random-effects models were employed to analyse variations in effect sizes across the included studies. The fixed-effects model revealed a statistically significant moderate positive association, with an estimated effect size of 0.606, a standard error of 0.0024, and a variance of 0.0000060, indicating minimal uncertainty. The model's reliability was further supported by a Z-value of 247.442, a P-value of 0, and a narrow confidence interval (0.601–0.610), reflecting high precision. In contrast, the random-effects model produced a substantially larger effect size of 18.432, reflecting greater heterogeneity across studies. This model yielded a standard error of 0.438 and a variance of 0.192, indicating increased variability in outcomes. The confidence interval (17.573–19.290) reflected a broader range of possible effects. Despite this variability, statistical significance remained evident with a Z-value of 42.059 and a P-value of 0.

The analysis demonstrated considerable between-study variation, as evidenced by a Q-statistic of 364,468.787 (df = 20, P = 0) and an I^2 value of 99.995%, suggesting that true heterogeneity far exceeded what would be expected by chance. Additional heterogeneity indicators included a tau-squared (τ^2) value of 3.788, a standard error of 4.045, and a tau (τ) value of 1.946, further confirming substantial dispersion across study outcomes. These findings suggest that study-specific factors meaningfully influence the relationship between mindfulness and emotion regulation, as moderated by sleep quality. Accordingly, future research should prioritise the development of tailored intervention strategies designed to enhance emotional wellbeing in university student populations through optimised mindfulness-based and sleep-related programmes.

Table 4

Mata-Analysis Results of the Study

Model		Effect Size and 95% Confidence Interval					Test of Null (2-Tail)	
Model	Number Studies	Point Estimate	Standard Error	Variance	Lower Limit	Upper Limit	Z-Value	P-Value
Fixed	21	0.605	0.0024	0.0000060	0.601	0.610	247.442	0
Random Effects	21	18.432	0.438	0.192	17.573	19.290	42.059	0

Model		Heterogeneity				Tau-Squared			
Model	Number Studies	Q-Value	df (Q)	P-Value	I-Squared	Tau Squared	Standard Error	Variance	Tau
Fixed	21	364468.787	20	0	99.995	3.788	4.045	16.363	1.946
Random Effects	21								

Discussion

The findings offer important insights into the role of mindfulness in enhancing emotion regulation ability among university students, particularly when moderated by sleep quality. Individuals with higher levels of mindfulness consistently demonstrate stronger emotional control, as reflected in the statistically significant positive association between mindfulness and emotion regulation. The fixed-effects model revealed a highly precise effect size of 0.605 (95% CI: 0.601–0.610), while the random-effects model yielded a substantially

larger effect size of 18.432 (95% CI: 17.573–19.290), highlighting both the consistency and variability across studies. Existing psychological research underscores the connection between mindfulness and key psychological traits such as resilience and emotional adaptability, particularly within academic settings.

The moderating role of sleep quality contributes meaningfully to the understanding of these relationships. Students who maintain high-quality sleep exhibit stronger correlations between mindfulness and emotion regulation than those with poor sleep patterns. For instance, the study by Koohsari et al. (2023) conducted in Japan reported the largest effect size of 52.2, whereas Liu et al. (2022) documented the smallest observed effect at 0.465. These disparities are reflected in the considerable heterogeneity observed across studies, as shown by a Q-value of 364,468.787 ($p = 0.000$) and an I^2 value of 99.995%. Such results suggest that poor sleep acts as a limiting factor in the effectiveness of mindfulness practices by impairing regulatory processes. Neurocognitive evidence supports this claim, indicating that emotional stability and executive functioning, primarily governed by the prefrontal cortex, are adversely affected by insufficient sleep. Consequently, individuals who obtain adequate rest are better positioned to benefit from mindfulness-based interventions due to enhanced emotional regulation and cognitive flexibility.

The robustness of the statistical associations is reinforced by the high Z-values of 247.442 (fixed-effects) and 42.059 (random-effects), alongside p-values of 0.000, confirming strong significance. Moreover, the presence of heterogeneity across the sample is evidenced by the τ^2 value of 3.788 and τ value of 1.946. These indicators point to considerable inter-study variation, influenced by factors such as sample characteristics, intervention duration, and methodological approaches. This variability necessitates further investigation to identify underlying moderators that can refine theoretical models and improve practical applications. The elevated Q-value also suggests that factors beyond mindfulness practice contribute to the variation in emotion regulation outcomes, reinforcing the importance of incorporating sleep quality as a core component in mindfulness-based interventions. Programmes targeting emotional regulation should integrate sleep education and behavioural strategies, such as cognitive-behavioural therapy for insomnia and structured sleep management, to maximise effectiveness—particularly among students with disrupted sleep patterns.

These findings highlight the critical need for higher education institutions

to formulate policies aimed at supporting student wellbeing. Universities should recognise the influence of sleep in fostering emotional resilience and mindfulness and, therefore, embed sleep-focused modules within their MBSR programmes. Future research should employ longitudinal designs to investigate the long-term interaction between sleep quality and mindfulness in shaping emotional regulation, enabling the establishment of clearer causal relationships. Overall, this meta-analysis confirms that mindfulness plays a pivotal role in improving emotional regulation among university students, though its effectiveness is significantly mediated by sleep quality. Educational institutions and mental health professionals are thus encouraged to integrate sleep optimisation strategies alongside mindfulness training to enhance student mental health and contribute to a more supportive academic environment.

Conclusion

This analysis offers a comprehensive examination of the relationship between mindfulness and emotion regulation among university students, prior to assessing the moderating influence of sleep quality. Empirical evidence supports the view that mindfulness interventions contribute positively to emotional self-regulation, reinforcing their value in psychological well-being. Several studies report a broad spectrum of outcomes, underscoring the importance of sleep quality as a critical factor shaping this association. The fixed-effects model produced a significant average effect size of 0.605 (95% CI: 0.601–0.610), supported by a highly robust Z-value of 247.442 ($p < 0.001$), indicating strong consistency across the pooled studies. However, the extremely high I^2 statistic (99.995%) and the significant Q-value of 364,468.787 ($p < 0.001$) signal substantial heterogeneity, suggesting that effect sizes are not uniformly distributed. Consequently, the random-effects model was adopted to accommodate between-study differences, producing an elevated effect size of 18.432 (95% CI: 17.573–19.290). This increase reflects the inclusion of studies with diverse methodologies, populations, and intervention conditions. The findings illustrate that mindfulness does not exert a uniform impact on emotion regulation across contexts; rather, its effectiveness varies depending on specific study-level variables. Higher sleep quality has been shown to strengthen the positive effects of mindfulness, as evidenced by Hedges' *g* values in studies reporting large effect sizes under conditions of adequate rest. In contrast, insufficient sleep appears to impair emotional regulation, thereby

diminishing the benefits derived from mindfulness training. Sleep deprivation may heighten emotional reactivity and cognitive disruption, reducing the efficacy of self-regulatory processes facilitated by mindfulness. The heterogeneity analysis further substantiates the role of study design, measurement tools, and participant characteristics in producing outcome variability. Disparities across studies may also be attributed to contextual factors such as geographical location, cultural background, and methodological frameworks. These influences collectively contribute to the observed inconsistencies and highlight the need for more nuanced, context-sensitive research designs to explore the intersection of mindfulness, sleep quality, and emotion regulation.

Implications

The evidence generated from this meta-analysis carries significant implications for both future research and practical application. The findings underscore the necessity of incorporating sleep quality assessments into the design and delivery of mindfulness-based interventions aimed at enhancing emotional regulation. As mindfulness programmes continue to gain prominence within student mental health initiatives, the inclusion of sleep hygiene education within such curricula is likely to optimise intervention outcomes. Further investigation is warranted to explore the combined influence of mindfulness training and sleep duration on broader psychological constructs, which may offer a more comprehensive understanding of self-regulatory mechanisms. While the analysis affirms that mindfulness contributes to the development of emotional regulation skills, the extent of this influence is demonstrably moderated by the quality of sleep. The variation in effect sizes across studies highlights the role of environmental and contextual factors in shaping intervention efficacy. This research enhances theoretical insights and offers actionable recommendations for refining psychological support strategies. Specifically, it advocates for tailored intervention protocols that account for individual differences in sleep patterns and mindfulness responsiveness, thereby improving the relevance and effectiveness of mental health support services in university settings.

Limitations and Future Research Recommendations

This meta-analysis highlights several limitations that must be addressed in future research. The substantial variability in experimental conditions across

the included studies presented difficulties in establishing standardised procedures, as differences in research design, participant characteristics, and intervention duration influenced the resulting effect sizes. Although the application of the random-effects model partially accommodated this heterogeneity, further investigations should incorporate subgroup analyses to explore the influence of contextual factors such as cultural background, academic stress, and the specific modalities of mindfulness instruction. A notable limitation of the current synthesis is the reliance on self-reported data, which may compromise accuracy due to potential discrepancies between perceived and actual psychological or cognitive functioning. To enhance diagnostic precision, future studies should incorporate objective assessments, including biological indicators, behavioural outcome measures, and validated sleep monitoring instruments.

Additionally, while sleep quality has been established as a significant moderating factor, further exploration of alternative moderators is necessary to gain a comprehensive understanding of the conditions that influence the mindfulness–emotion regulation relationship. Longitudinal research designs and controlled trials are recommended to examine the long-term development of mindfulness practices and their effects on emotional regulation. Future research should also consider the integration of emerging technologies, such as mobile-based mindfulness interventions and artificial intelligence-supported meditation platforms, to increase accessibility and personalise intervention delivery. Expanding the cultural diversity of participant samples and improving methodological rigour will enhance the generalisability and efficacy of mindfulness-based strategies designed to support emotional resilience and psychological well-being among university students.

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