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Mindfulness-Based Intervention on Psychological Factors Among Students: A Meta-Analytic Study

Devika M. Lal[1] · **S. Vinod Kumar**[2]

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Abstract

Mindfulness-based interventions have become a popular method for both clinical and non-clinical populations to reduce stress and increase well-being. This study presents the results of a meta-analysis that looked at the efficacy of mindfulness-based intervention in students. Systematic literature search was carried out through PubMed, EBSCO, Proquest, Springer, and Google Scholar and identified 5461 studies. Retrieved 154 full-text articles and performed meta-analysis on 34 studies. The main variables identified to study the effectiveness of the intervention are anxiety, depression, mindfulness, stress, and self-compassion with their mean effect size as 0.48, 0.63, 0.83, 0.60, and 0.61 respectively. Heterogeneity was fairly high due to the wide range of studies. Significant effects of moderating variables such as the age of students, research design, and types of intervention were identified through moderator analysis. Findings from the study indicate that mindfulness-based intervention is effective for students to develop self-compassion and mindfulness at an early age as well as to reduce the symptoms of anxiety, depression, and stress in young adults.

Keywords Mindfulness-based intervention · Meta-analysis · Depression · Anxiety · Stress · Self-compassion · Mindfulness

✉ Devika M. Lal
devikamanulal@gmail.com

S. Vinod Kumar
drsvinodkumar@gmail.com

[1] School of Behavioural Sciences, Kannur University, Mangattuparamba Campus, Kannur, Kerala 670567, India

[2] School of Behavioural Sciences, Mahatma Gandhi University, Kottayam, Kerala 686560, India

Introduction

Childhood and adolescence are essential stages in life when it comes to mental health. The World Health Organization (WHO, 2021) states mental health as "a state of well-being in which the individual realizes his or her abilities, can cope with the normal stresses of life, can work productively and fruitfully, and can make a contribution to his or her community". However, mental illness is still considered a stigma, and millions of people suffer in silence, with no outside treatment or support. 10% of children and adolescents worldwide suffer from mental illness, but the majority of them do not seek help or receive treatment. At the age of 14, half of all mental health issues emerge (WHO, 2021). If children's and adolescents' mental health and psychosocial development are not addressed, it may continue into adulthood, limiting opportunities to live satisfying lives (WHO, 2021). Studies on different samples of undergraduate students around the world have found a moderate to a high prevalence of depression, anxiety, and stress. (Beiter et al., 2015; Singh et al., 2017).

The necessity of incorporating well-being programs as an integral component of education increases, and mindfulness-based courses are becoming more popular, with significant advancement over the last decade. (Bennett & Dorje, 2016). It's become a more common type of intervention in schools to help pupils with their mental health and overall well-being. (Felver et al., 2016; Tan, 2016; Zoogman et al., 2014). While conceding that the existing evidence is quite limited, a recent assessment of mindfulness-based programs for education examined the positive potential of mindfulness in this context. (Meiklejohn et al., 2012). Mindfulness is a meditation technique that originated in Ancient India around 2500 years ago. Mindfulness is the art of concentrating carefully on the present moment while remaining accepting and nonjudgmental. (Tan & Martin, 2015). As learning and prevention can occur simultaneously in schools while addressing varied student needs and unmet skills, mindfulness interventions can be in schools. Mindfulness can improve the skills and abilities sought by modern education, such as empathy, self-regulation, open-mindedness, and problem-solving. (Modi, Joshi, & Narayanakurup, 2018). It prepares children to meet future problems and to become smart, empathetic, and loyal citizens. (Zenner, Herrnleben-Kurz & Walach, 2014). To be considered mindful, a practice must include planned exercises that allow practitioners to focus their attention and regulate their mental and physical activity. (Greenberg & Harris, 2012).

Based on the reviews, it is found that mindfulness-based interventions are effective for both positive psychological variables and also for clinical outcomes. As a result, the goal of this research is to conduct a meta-analysis on mindfulness-based intervention in students. The main objectives of the study are (a) To identify the variables influenced by mindfulness based intervention in students, (b) To determine in which variable the mindfulness based intervention is most studied, and (c) To analyze the strength of the relationship between mindfulness-based intervention and the variables.

The effects of mindfulness-based interventions have been studied on different variables that are listed in the basic characteristics table. From those variables Depression, Anxiety, Stress, Mindfulness, and Self-compassion are selected as the main outcome measures to do meta-analysis as more studies are conducted on these variables than others. As the number of studies increases, the strength of the relationship between the intervention and variable can be more accurately measured statistically.

Method

Search Strategy

A systematic literature search was carried out in PubMed, EBSCO, Proquest, Springer, and Google Scholar, from 2011 to 2021. The search strategy was based on the core theme 'Mindfulness-based intervention in Students'. Following keywords such as 'Mindfulness intervention', 'Mindfulness-based intervention' combined with terms such as 'students', 'children', 'school students', 'classroom', 'college students' were used for the search.

Selection of Studies

The inclusion criteria were as follows: (a) Studies that focus on mindfulness-based intervention (b) Student population ranging from 4 to 25 years (c) Studies in which the age of the students, the sample size of the population, mean and standard deviation of the outcome measures are mentioned.

Data Extraction

Assessment of the methodological quality of the studies was carried out using the Cochrane collaboration's tool for assessing the risk of bias (Ryan, Hill, Prictor & McKenzie, 2013). The scale is having seven criteria: (1) Random sequence generation—Describe in sufficient detail the strategy used to generate the allocation sequence (2) Allocation concealment—Describe in sufficient detail the approach utilized to disguise the allocation sequence. (3) Blinding of participants and personnel– whether the measure used to blind personal and participant from the knowledge about the intervention used is explained (4) Blinding of outcome assessment—the measure used to blind the outcome assessors from the knowledge of which intervention the participant received is explained (5) Incomplete outcome data- completeness of outcome data for each primary outcomes, including the attrition and exclusions from the analysis are described (6) Selective reporting- Describe how the review authors looked at the possibility of selective outcome reporting and what they found. 7) Other sources of bias- Identifying any serious bias concerns not covered in the tool's other sections. Each criterion is rated as High risk (HR) Moderate risk/Unclear (MR) or Low risk (LR). Here, there are 21 studies rated as low risk, 8

Table 1 Quality assessment per study

Study	RSG	AC	BPP	BOA	IOD	SR	OSB	Overall assessment
Djernis et al. (2021)	LR	LR	LR	LR	LR	LR	LR	Low risk
Gómez-Odriozola (2021)	LR	MR	MR	LR	LR	LR	MR	Moderate risk
Johnson (2021)	LR	MR	LR	LR	LR	LR	LR	Low risk
Ritvo et al. (2021)	LR	LR	LR	LR	LR	MR	LR	Low risk
Sousa et al. (2021)	LR	LR	MR	LR	LR	LR	LR	Low risk
Amundsen et al. (2020)	HR	LR	MR	LR	LR	LR	LR	Moderate risk
Ahmad et al. (2020)	LR	LR	LR	MR	LR	LR	LR	Low risk
Corti (2020)	MR	MR	HR	LR	LR	LR	LR	Moderate risk
Ghiroldi et al. (2020)	HR	MR	MR	MR	MR	MR	LR	Moderate risk
Gutman et al. (2020)	LR	LR	LR	LR	LR	LR	LR	Low risk
Kim et al. (2020)	LR	LR	LR	LR	LR	MR	MR	Low risk
Wingert et al. (2020)	LR	LR	LR	LR	LR	LR	LR	Low risk
Carsley (2019)	LR	LR	LR	LR	LR	LR	LR	Low risk
Felver et al. (2019)	LR	LR	MR	LR	LR	LR	LR	Low risk
Vidic (2019)	HR	HR	HR	LR	LR	LR	LR	High risk
Zhang et al., (2018a, 2018b)	LR	LR	LR	LR	LR	LR	LR	Low risk
Modi et al. (2018)	MR	MR	LR	LR	LR	MR	LR	Moderate risk
Ștefan et al. (2018)	LR	MR	MR	LR	LR	LR	LR	Low risk
Zhang et al., (2018a, 2018b)	LR	LR	LR	LR	LR	LR	LR	Low risk
Dvo et al. (2017)	LR	LR	MR	LR	LR	LR	LR	Low risk
Bennett (2016)	MR	HR	MR	LR	LR	LR	MR	Moderate risk
Falsafi (2016)	LR	LR	MR	LR	LR	MR	LR	Low risk
Kuhlmann et al. (2016)	LR	LR	MR	MR	LR	LR	LR	Low risk
Keng et al. (2015)	HR	HR	HR	HR	LR	LR	LR	High risk
Song (2015)	LR	LR	LR	LR	LR	LR	LR	Low risk
Tan (2015)	LR	HR	HR	LR	LR	LR	LR	High risk
Viafora et al. (2015)	HR	HR	HR	LR	LR	LR	MR	High risk
Erogul et al. (2014)	LR	LR	LR	LR	LR	LR	LR	Low risk
Gallego et al. (2014)	LR	LR	LR	MR	MR	HR	LR	High risk
Greeson et al. (2014)	LR	LR	MR	LR	LR	LR	LR	Low risk
Raes et al. (2014)	LR	LR	LR	LR	MR	LR	LR	Low Risk
De Vibe et al. (2013)	LR	LR	LR	LR	LR	LR	LR	Low risk
Kuyken et al. (2013)	MR	LR	HR	LR	LR	MR	MR	Moderate risk
Lau (2011)	HR	MR	MR	LR	LR	LR	MR	Moderate risk

RSG Random sequence generation; *AC* Allocation concealment; *BPP* Blinding of participants and personnel; *BOA* Blinding of outcome assessment; *IOD* Incomplete outcome data; *SR* Selective reporting; *OSB* Other source of bias; *LR* Low risk; *MR* Moderate risk; *HR* High risk

studies rated as moderate risk, and 5 studies rated as high risk. Table 1 provides the quality assessment of studies.

Data Items and Measures

All the analyses were performed using Comprehensive Meta-Analysis software. The software calculates the combined effect sizes. Effect size measures how intense the relationship between two variables is on a numerical scale. It is estimated using the random effect model, which assumes a true difference in the magnitude of effects between studies. Cohen (1988, 1992) established rules for interpreting effect size: Cohen's d and Hedges'g values of 0.20, 0.50, and 0.80 are often used to indicate small, medium, and large effects, respectively. Homogeneity is measured in a meta-analysis using the Q test, which merely indicates the presence or absence of heterogeneity. The I^2 statistics determine the percentage of variation in studies that is due to heterogeneity rather than chance, it assesses the degree of heterogeneity in a study. (Huedo-Medina, Sánchez-Meca, Marin-Martinez, 2006). Low heterogeneity is defined as 0% to 40%, moderate heterogeneity is 30% to 60%, substantial heterogeneity is 50% to 90%, and considerable heterogeneity is 75% to 100% (Siebert, 2018). The following information is extracted from the studies (i) sample size of the student population (ii) Mean age (or the age range if the mean age is not given) and standard deviation (iii)Information about the intervention (Type of intervention, duration of the session and its frequency) (v)outcome measures.

Result

Description of Studies

The flow chart of the selection process is illustrated in Fig. 1. A total of 5461 studies were retrieved from databases. After removing duplicates and title screening received 154 studies. From that, 120 studies were removed as it does not meet the inclusion criteria and does not have sufficient data.

The basic characteristics of the studies included are described in Table 2. The studies assessed a total of 4269 subjects, 2212 in the intervention group and 2057 in the control group. Fourteen studies have a student population in the age range of 4 to 17 years (school students), and twenty studies between the range of 18–25 years (college students). There were 10 studies on Depression, 12 studies on Anxiety, 18 studies on Mindfulness, 15 studies on stress, and 8 studies on self-compassion. Table 3 provides the result overview of all analyses.

Publication Bias

Publication bias is addressed using funnel plot, egger's regression intercept, and trim and fill method. The funnel plot is a simple scatter diagram that compares intervention impact estimates from individual studies to some parameters of study size and precision. Anxiety, depression, stress, self-compassion, and mindfulness have asymmetrically distributed funnel plots which indicates that there is publication bias. Egger's regression intercept value indicates publication bias

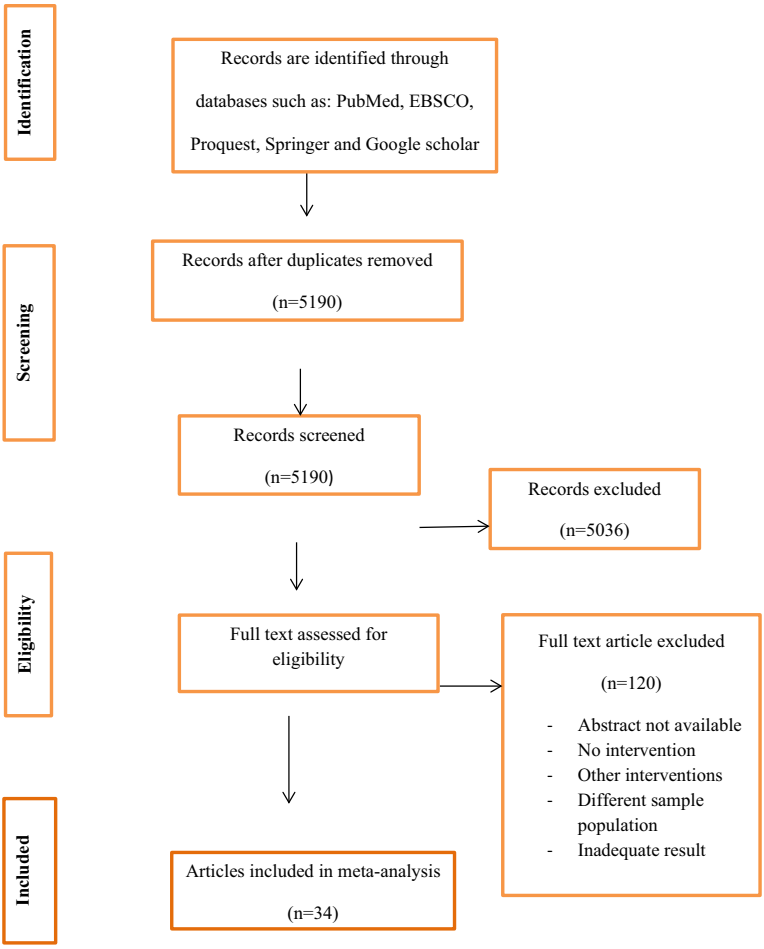

Fig. 1 Flow diagram

for mindfulness (intercept-7.41, t-3.44, df-16, *p*-0.003), anxiety (intercept-3.06, t-3.23, df-10, *p*-0.01), stress(intercept-2.37, t-2.94,df-17,*p*-0.01) and self-compassion (intercept-5.49, t-1.98, df-6, *p*-0.1) but not for depression (intercept-2.64, t-0.82, df-8, *p*-0.43). The trim and fill method modifies the pooled effect size for missing study results while analyzing asymmetry in funnel plots. Using the Trim and Fill method the mean effect sizes of mindfulness, anxiety, stress, and self-compassion are recalculated by imputing the missing studies. For mindfulness, seven studies were imputed and the effect size is adjusted to 0.32 (95% CI – 0.07, 0.72). For anxiety six studies were imputed and the effect size became 0.19 (95% CI – 0.04, 0.42). For stress also six studies were imputed

Table 2 Basic characteristics of studies

Author	Mean Age	Intervention used	Session duration and frequency	Sample size	Outcome measures	Research design
Amundsen et al. (2020)	10.24(0.45)–10.40(0.51)	Living mindfully primary program	6-week mindfulness program	89	Mindfulness, positive and negative affect, life satisfaction, psychological and subjective well being	Non-equivalent control group pre-test post-test mixed design
Ahmad et al. (2020)	24.8(6.5) 24.9(6.4)–25.4(7.3)	Mindfulness virtual community intervention	8-week partial MVC (P-MVC) comprised 12 video-based modules	78	Anxiety, perceived stress, quality of life, life satisfaction, mindfulness	RCT
Bennett (2016)	17.7(0.73)	Mindfulness-based stress reduction program	delivered weekly over 8 weeks at the end of a school day in 2-h sessions	24	Depression, anxiety, stress	Longitudinal non-equivalent group design (non RCT)
Carsley (2019)	10.42(0.82)–10.36(0.93)	Mindfulness coloring activity	15 min	152	Test anxiety, state mindfulness	RCT
Corti (2020)	19.86(0.94)–19.75(0.66)	Mindful Effective Learning (mindfulness-based group coaching)	10 weeks, with a total of 10 modules of 3.5 h	45	Self-awareness, anxiety	Two-group pre-test-post-test design
De Vibe et al. (2013)	23.8 (5.2)	Mindfulness-based stress Reduction program	eight weekly sessions of 2.5 h each, a 7-h session that took place between week six and seven and 45 min of formal mindfulness practice at home	288	Mental distress, student burnout, subjective wellbeing	RCT
Djernis et al. (2021)	31.65(7.45)-28.61(5.91)	Mindfulness-based stress reduction program	5 days	38	Perceived stress, compassion, mindfulness	Pilot RCT

Table 2 (continued)

Author	Mean Age	Intervention used	Session duration and frequency	Sample size	Outcome measures	Research design
Dvo et al. (2017)	18.2 (0.4)	Learning to breathe program	8 sessions over 6 weeks 80 min each	109	Depression, anxiety, life satisfaction, mindfulness, self-compassion, social connectedness, compassion, sleep issue, alcohol peak	Pilot RCT
Erogul et al. (2014)	23.5 (1.7)	Mindfulness-based stress reduction program	75 min, once per week, for 8 weeks supplemented by a program of suggested meditation at home	59	Perceived stress, self-compassion, resilience	RCT
Falsafi (2016)	18	Learned mindfulness practices	8 weeks of training (75 min per week)	44	Depression, anxiety, student life stress, self -compassion, mindfulness	RCT(repeated-measures design)
Felver et al. (2019)	16.39(1.04) 16.15(0.9)–16.74(1.17)	Learning to breathe	six-session version of the L2B curriculum for nine weeks	27	Resilience	Pilot RCT
Gallego et al. (2014)	20.07(3.68)	Mindfulness-based cognitive therapy	8 session weekly one hr session	83	Depression, anxiety, stress	RCT
Ghiroldi et al. (2020)	8.5(1.46) 4.43(1.05)–4.52(1.24)	Mindfulness-based intervention program(body-mind interaction)	a 3-day intensive training course plus a 28-lesson online multimedia training to practice mindfulness in the classroom	400	Depression	Non RCT
Gómez-Odriozola (2021)	16.13(1.80)	Mindfulness-based intervention	six-session version of the L2B curriculum	291	Depression, positive affect	RCT

Table 2 (continued)

Author	Mean Age	Intervention used	Session duration and frequency	Sample size	Outcome measures	Research design
Greeson et al. (2014)	25.4 (5.7) 25.75(6.84)–24.76(4.15)	Mindfulness training program	4 weekly required 75-min classes	90	Perceived stress, mindfulness, self-compassion	RCT
Gutman et al. (2020)	24.27(2.09)	Multimodal mindfulness program	8-week mindfulness program consisted of one weekly 40-min in-person group session and four weekly 10-min online guided meditations	36	Perceived stress	RCT
Johnson (2021)	13.67(0.42), 15.52(0.37)	Mindfulness-based programs	8-week manualized program Mindfulness Training	434	Depression, anxiety, wellbeing	RCT
Keng et al. (2015)	22.4(0.55)	Mindfulness-based intervention program	weekly 3-h sessions that lasted for 4 weeks	134	Mindfulness, depressive symptom, anxiety, perceived stress, subjective happiness, life satisfaction	non RCT
Kim et al. (2020)	4	Mindfulness-based OM-K program integrated with Nuri curriculum	nine daily mindfulness activities- 2 years	83	resilience	RCT
Kuhlmann et al. (2016)	23.39(3.91) 23.29(2.81)–22.94(3.09)	Mindfulness-based stress prevention training	five weeks with weekly sessions of 90 min	48	Chronic stress	RCT
Kuyken et al. (2013)	14.9(1.5)–14.7(1.4)	Mindfulness in school programme (MiSP curriculum)	3 months	522	Wellbeing, stress, depression	Non RCT

Table 2 (continued)

Author	Mean Age	Intervention used	Session duration and frequency	Sample size	Outcome measures	Research design
Lau (2011)	15.83	Mindfulness-based program	six-week program, two-hour session per week at each school	48	Mindfulness, psychological wellbeing, DAS, perceived stress	Pilot controlled trial
Modi et al. (2018)	12(1.42)	Mindfulness training	weekly basis for ten weeks	100	Self-esteem, psychological wellbeing, self-acceptance, mindfulness	Matched controlled, pre-test post-test intervention study design
Raes et al. (2014)	16.8(4.9)–17.3(4.8)	Mindfulness group training	eight weekly 100-min sessions	408	Depression, anxiety, stress	cluster RCT
Ritvo et al. (2021)	23.1 22.02(5.52)–24.18(9.95)	Mindfulness virtual community program	8-week MVC program	154	Anxiety, perceived stress, mindfulness	RCT
Song (2015)	19.6(1.7)–19.5(2.0)	Mindfulness-based stress reduction	mindfulness meditation for 2 h every week for 8 weeks	44	Depression, anxiety, stress, mindfulness	RCT
Sousa et al. (2021)	24.15(3.56) 24.05(3.76)–24.25(3.55)	Brief mindfulness-based training	30 min a day, totalizing 90 min of intervention	40	State mindfulness	RCT
Ștefan et al. (2018)	18.92(1.04)	Mindfulness-based stress reduction program	6 weeks	71	Social anxiety, perceived stress, self-compassion	RCT
Tan (2015)	15.40(1.55)	Mindfulness-based group intervention	5 weeks	80	Mental health, resilience, psychological inflexibility, mindfulness	RCT
Viafora et al. (2015)	6.68(0.89)	Mindfulness course	8-week mindfulness course, 45 min weekly	48	acceptance and mindfulness, self-compassion	Quasi experimental design

Table 2 (continued)

Author	Mean Age	Intervention used	Session duration and frequency	Sample size	Outcome measures	Research design
Vidic (2019)	21.46(3.33)	Mindfulness-based relaxation course	90 min 2 day class per week for 7 weeks	51	Perceived stress, resilience, self-efficacy	Two-group pre-test-post-test design
Wingert et al. (2020)	19.4(1.8)–18.5(0.9)	Mindfulness based strength practice intervention curriculum	8-week curriculum, one session per week	52	PERMA, happiness, loneliness, negative emotion, health	RCT
Zhang et al., (2018a, 2018b)	18.41 (2.01)	Mindfulness based Tai chi chuan	8-week, 2 days per week, 90-min MTCC intervention for each session	64	Mindfulness attention and awareness, perceived stress	RCT
Zhang et al., (2018a, 2018b)	20.38(1.97)–19.19(1.17)	Mindfulness training	8 weekly 2-h on-campus group sessions	50	Loneliness, mindfulness	Pilot RCT

Table 3 Result overview of all analyses

Outcome measure	No.of studies (n)	No.of subjects (N)	Hedges's g(95% CI)	Heterogenity	Test for overall effect
Anxiety	12	I-635,C-625	0.48***(0.25–0.70)	Q-35.74, df-11, $p < 0.001$, I^2-69.22%, T^2-0.096	Z-4.196
Depression	10	I-1082,C-1003	0.63**(0.21–1.05)	Q-170.24, df-9, $p < 0.001$,I^2-94.713%, T^2-0.405	Z-2.961
Mindfulness	18	I-746,C-664	0.83***(0.47–1.02)	Q-174.60, df-17, $p < 0.001$, I^2-90.26%, T^2-0.535	Z-4.49
Stress	19	I-971,C-945	0.60***(0.41–0.78)	Q-59.59, df-18, $p < 0.001$, I^2-69.793%, T^2-0.103	Z-6.362
Self compassion	8	I-289,C-279	0.61***(0.29–0.94)	Q-24.87, df-7, p-0.001, I^2-71.86%, T^2-0.153	Z-3.700

**Significant at 0.01, ***Significant at 0.001

n = Number of studies, N = Number of subjects, I = Number of subjects in the intervention group, C = Number of subjects in the control group

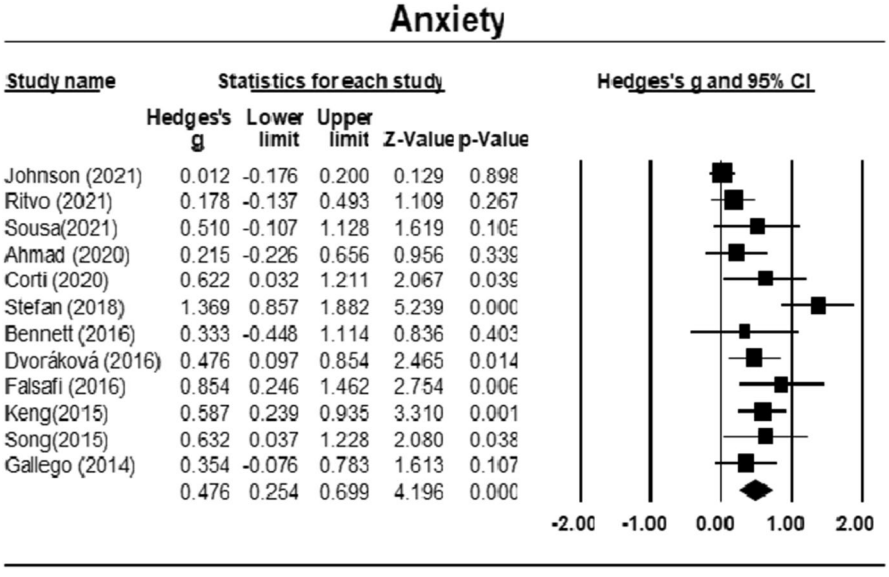

Fig. 2 Pre- test Post- test effect of mindfulness based intervention in anxiety

and the new effect size is 0.38 (95% CI 0.18, 0.58). And for self-compassion two studies were imputed and the effect size is adjusted to 0.43 (95% CI 0.08, 0.77).

Anxiety

The combined effect size of anxiety is found to be 0.476 and is highly significant. There are 12 studies on anxiety with effect sizes ranging from 0.012 to 1.389. It includes six studies with low, four with moderate, and two with high effect size. Figure 2 depicts the forest plot of anxiety.

Moderator Effect on Anxiety

Moderator analyses are performed on the age of students, research design, duration of intervention, and type of intervention in all the variables. Table 4 shows the results of the moderator analysis on anxiety. Mindfulness-based stress intervention (3 studies) has a high effect size (g = 0.83) while mindfulness programmes (7 studies) have a low effect size (g = 0.44) and is highly significant. The effect sizes of randomized control trial (RCT) and non-randomized control trials (non RCT) are estimated to be low (g = 0.47) and moderate (g = 0.55) respectively with high significance. Two group pre-test- post-test designs is having a moderate effect size (g = 0.62) than RCT and non RCT. Interventions duration above six weeks and below six weeks has a low (g = 0.47) and moderate effect size (g = 0.59) respectively with high significance. The intervention is more beneficial for students aged 18 to 25 years and has a moderate effect size (g = 0.54), whereas the effect size for students aged 4 to 17 years is very low (g = 0.03).

Table 4 Moderator analysis on anxiety

Criteria	Subgroup	n	Hedges's g(95% CI)
Age	4–17	2	0.03 (-0.15–0.21)
	18–25	10	0.54***(0.33–0.76)
Research Design	RCT	9	0.47***(0.19–0.73)
	Non RCT	2	0.55***(0.23–0.86)
	Others	1	0.62*(0.03–1.21)
Duration	< 3 weeks	1	0.51(-0.11–1.13)
	< 6 weeks	1	0.59***(0.24–0.94)
	> = 6 weeks	10	0.47***(0.21–0.72)
Type of intervention	Mindfulness training/program/course	7	0.44***(0.18–0.69)
	Mindfulness virtual intervention	2	0.19(-0.07–0.45)
	Mindfulness based stress reduction	3	0.83**(0.20–1.45)

*Significant at 0.05, **Significant at 0.01, ***Significant at 0.001

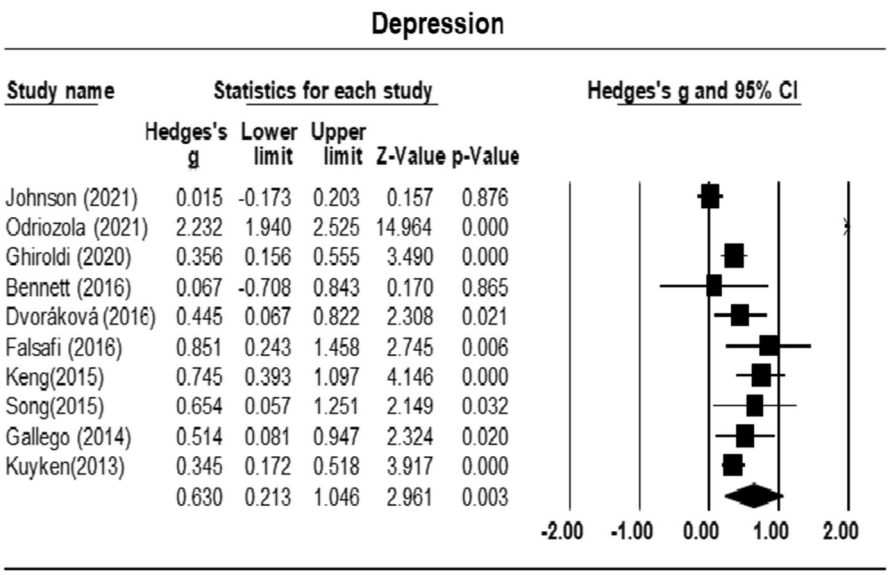

Fig. 3 Pre- test Post- test effect of mindfulness based intervention in depression

Table 5 Moderator analysis on depression

Criteria	Subgroup	n	Hedges's g(95% CI)
Age	4–17	5	0.62(−0.07–1.30)
	18–25	5	0.62***(0.42–0.81)
Research design	RCT	6	0.79(-0.03–1.61)
	Non RCT	4	0.41***(0.23–0.59)
Duration	< 3 weeks	1	0.36***(0.16–0.56)
	< 6 weeks	1	0.75***(0.39–1.10)
	> = 6 weeks	8	0.65*(0.09–1.21)
Type of intervention	Mindfulness training/program/course	7	0.73**(0.14–1.32)
	Mindfulness based stress reduction	2	0.42(−0.15–0.98)
	Mindfulness curriculum based intervention	1	0.35***(0.17–0.52)

*Significant at 0.05. **Significant at 0.01. ***Significant at 0.001

Depression

The overall effect size of depression (10 studies) is 0.630, which is a moderate effect size and is statistically significant. Of the 10 studies included, five studies are having low effect sizes, three with moderate, and two with high effect sizes. Figure 3 shows the forest plot of depression.

Moderator Effect on Depression

Table 5 denotes moderator analysis results on depression. Both the age group, 18–25 years, and 4–17 years have the same moderate effect size (g = 0.62) with the 18–25 years student group being highly significant. Mindfulness training program (7 studies) is found to be effective for depression as it is statistically significant with a moderate effect size (g = 0.73). Randomized control trial is having a high effect size (g = 0.79) with not much significance whereas non-randomized control trial is having a low effect size (g = 0.41) with high significance. Duration of intervention with less than six weeks and more than six weeks with moderate effect sizes of 0.75 and 0.65 respectively. Mindfulness training programs and curriculum-based intervention are found to be highly significant for depression with mindfulness training having moderate (g = 0.73) and curriculum having a low effect size (g = 0.35).

Mindfulness

The attribute mindfulness itself is used as one of the outcome measures to assess the efficacy of a mindfulness-based intervention. Here, the combined effect size of mindfulness is found to be 0.827, which is a high effect size and is statistically significant. Mindfulness consists of 18 studies with six studies having a low effect size, seven with a moderate, and five with a high effect size. Figure 4 presents the forest plot on mindfulness.

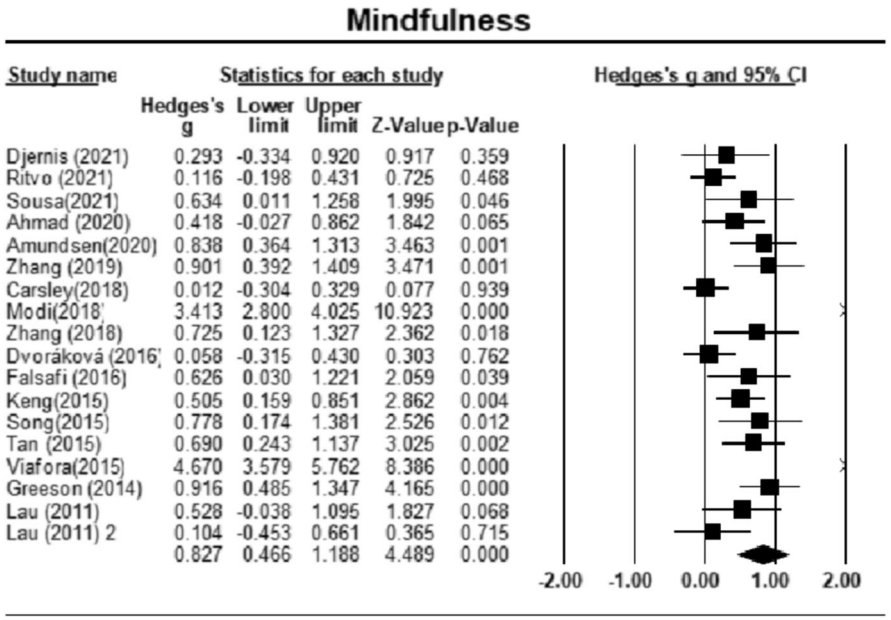

Fig. 4 Pre- test Post- test effect of mindfulness based intervention in mindfulness

Table 6 Moderator analysis on mindfulness

Criteria	Subgroup	n	Hedges's g(95% CI)
Age	4–17	7	1.40**(0.43–2.36)
	18–25	10	0.52***(0.31–0.73)
	> 25	1	0.29(-0.33–0.92)
Research design	RCT	12	0.48***(0.27–0.68)
	Non RCT	1	0.51**(0.16–0.85)
	Others	5	1.86**(0.43–3.29)
Duration	< 3 weeks	4	0.45(-0.02–0.92)
	< 6 weeks	2	0.57***(0.30–0.85)
	> = 6 weeks	12	1.03***(0.47–1.58)
Type of intervention	Mindfulness training/program/course	14	0.97***(0.51–1.43)
	Mindfulness virtual intervention	2	0.23(-0.06–0.51)
	Mindfulness based stress reduction	2	0.54*(0.07–1.02)

*Significant at 0.05, **Significant at 0.01, ***Significant at 0.001

Moderator Effect on Mindfulness

Table 6 represents the moderator analysis result on mindfulness. The mindfulness-based intervention seemed to be more effective for school students which can be understood from the high effect size (g = 1.40) which is also highly significant. It is also significant for college students with a moderate effect size (g = 0.52). All the research designs RCT, non RCT, and Other categories of designs are found to be statistically significant, in that matched control pre-test- post-test design and quasi-experimental design which comes in the others category of research design is having a very high effect size(g = 1.86). Duration of mindfulness intervention below six weeks and above six weeks is found to be highly significant with the duration above six weeks having a high effect size (g = 1.03). Mindfulness training programs and mindfulness-based stress reduction interventions both show a high significance rate with mindfulness training programs having a high effect size (g = 0.97).

Stress

The combined effect size for all 19 studies on stress is 0.598, which is found to be a moderate effect size with high significance. Studies include ten with low effect size, four with moderate, and five with high effect size. Figure 5 presents forest plot on stress.

Moderator Effect on Stress

Table 7 shows moderator analysis results on stress. Mindfulness-based intervention on stress is found to be highly significant in the 18 to 25 age group and has a moderate

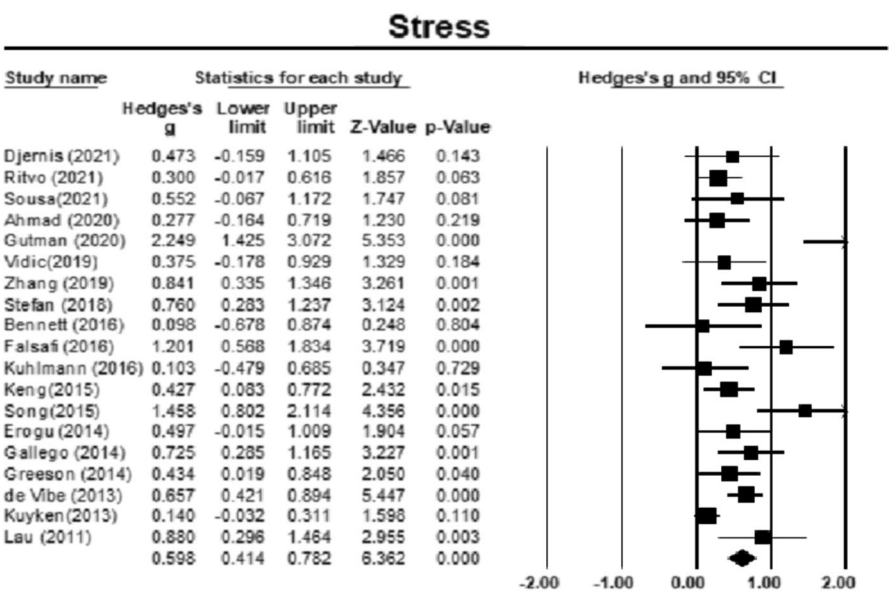

Fig. 5 Pre- test Post- test effect of mindfulness based intervention in stress

Table 7 Moderator analysis on stress

Criteria	Subgroup	n	Hedges's g(95% CI)
Age	4–17	3	0.35(-0.13–0.83)
	18–25	15	0.65***(0.45–0.85)
	> 25	1	0.47(-0.16–1.11)
Research design	RCT	14	0.68***(0.47–0.90)
	Non RCT	3	0.20*(0.03–0.38)
	Others	2	0.62**(0.13–1.11)
Duration	< 3 weeks	3	0.47**(0.17–0.77)
	< 6 weeks	2	0.34*(0.05–0.64)
	> = 6 weeks	14	0.68***(0.44–0.92)
Type of intervention	Mindfulness training/program/course	9	0.78***(0.49–1.06)
	Mindfulness virtual intervention	2	0.29*(0.04–0.55)
	Mindfulness based stress reduction	7	0.59***(0.33–0.87)
	Mindfulness curriculum based intervention	1	0.14(-0.03–0.31)

*Significant at 0.05, **Significant at 0.01, ***Significant at 0.001

effect size (g = 0.65). Randomized control trials and pilot control trials (other) are highly significant with a moderate effect size of 0.68 and 0.62 respectively. Duration of intervention (14 studies) with more than six weeks is having a moderate effect size

(g = 0.68) with high significance.. From this, it can be understood that an increase in the duration of intervention can cause a significant change in stress. Mindfulness training programmes and mindfulness-based stress reduction interventions have a moderate effect size of 0.78 and 0.59, respectively, and are highly significant.

Self- Compassion

The total effect size of studies on self-compassion is 0.612, which is a moderate effect size and is highly significant. It includes eight studies, with three studies having a low effect size, two with moderate, and three with high effect size. Figure 6 depicts the forest plot of self-compassion.

Moderator Effect on Self-Compassion

Table 8 shows moderator analysis results on self-compassion. Mindfulness intervention is found to be essential and highly significant in both age groups, with a high effect size for the 4 to 17 age group (g = 1.01) and a moderate effect size for the 18 to 25 age group (g = 0.61). Randomized control trials and quasi-experimental design are considered highly significant with a high effect size for quasi-experimental design (g = 1.01), which comes in the others category in the types of intervention. Duration above six weeks and below 3 weeks is found to be statistically significant and has a moderate effect size of 0.65 and 0.55 respectively. Here also mindfulness training program (g = 0.55) and mindfulness stress-based intervention (g = 0.72) is found to be statistically significant with a moderate effect size.

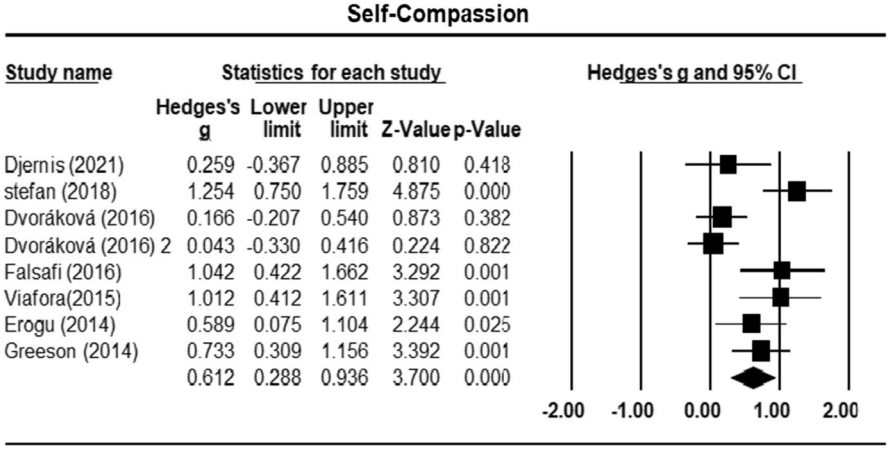

Fig. 6 Pre- test Post- test effect of mindfulness based intervention in self- compassion

Table 8 Moderator analysis on self-compassion

Criteria	Subgroup	n	Hedges's g(95% CI)
Age	4–17	1	1.01***(0.41–1.61)
	18–25	6	0.61**(0.22–0.99)
	> 25	1	0.26(-0.37–0.89)
Research design	RCT	7	0.56***(0.22–0.91)
	Others	1	1.01***(0.41–1.61)
Duration	< 3 weeks	2	0.55**(0.10–1.00)
	> = 6 weeks	6	0.65**(0.23–1.07)
Type of intervention Course	Mindfulness training/program/ 5	0.55**(0.15–0.95)	
	Mindfulness based stress reduction	3	0.72**(0.15–1.29)

*Significant at 0.05, **Significant at 0.01, ***Significant at 0.001

Discussion

The main objective of this analysis is to evaluate the effectiveness of mindfulness-based interventions in students. This meta-analysis includes 34 studies with a total of 4269 subjects. The result shows that mindfulness intervention has a significant influence on the outcome measures with effect sizes ranging from moderate to high. The mean effect size of anxiety is 0.48, stress is 0.596, self-compassion is 0.62, depression is 0.63 and mindfulness is 0.827.

Twelve studies were analyzed in anxiety with effect sizes ranging from 0.012 to 1.389. Mindfulness-based stress intervention (MBSR) is found to be effective in reducing anxiety in undergraduate students. The effectiveness of MBSR is largely determined by the right intervention dosage and homework routines. MBSR is more effective than other mindfulness programs that merely include various forms of meditation; this could be because MBSR is a more clinically based strategy that employs standard techniques and manuals. Face-to-face sessions are included, as well as the use of internet resources such as video materials and daily practice monitoring sheets. Because young adults are more familiar with online resources and information, this method might be beneficial. A study by Johnson (2021) suggests that mindfulness-based treatments aimed at lowering anxiety in early and middle adolescence may be less effective. Mindfulness-based stress reduction is more helpful for students in late adolescence and early adulthood. Students between the ages of 18 and 25 are more likely to be affected by anxiety difficulties, and after getting the intervention, they demonstrate a reduction in anxiety levels. According to a study of college students (18–25 years) in India, 6.14 percent of the students showed potentially dangerous levels of anxiety (Shah & Pol, 2020). College students have to undergo lots of stressful situations in their personal life, professional life and from outside as they step into adulthood from the adolescent stage.

World Health Organization estimates, 322 million individuals, or 4.4 percent of the global population, suffer from depression (WHO, 2017). 10 studies were statistically analyzed for depression and has a moderate effect size. In older adolescents, mindfulness-based intervention has been demonstrated to be more beneficial in reducing depressive symptoms than in younger adolescents (Gomez-Odriozola & Calvete, 2021). It can be understood that the effectiveness of a mindfulness-based intervention may differ depending on the participants' developmental stages (Roeser & Pinela, 2014; Roeser & Zelazo, 2012). In a study conducted to determine the prevalence of depression in adolescent students at a public school, 15.2 percent of the adolescents showed indicators of distress, with 18.4 percent being depressed. (Bansal et al., 2009). As a result, more clarity is required to figure out the appropriate program modifications for each student group, including preadolescents, early adolescents, mid-adolescents, and late adolescents. Mindfulness-based interventions can be tailored to meet the requirements of different ages by including creative activities and games.

Mindfulness consists of 18 studies with a high effect size. The intervention appears to be most beneficial for students in the early stages of adolescence. Because of their potential for abstract thinking before the surge of social and scholastic stresses in middle and late adolescence, mindfulness-based interventions are best suited for early adolescents. (Broderick & Metz, 2009; Kuyken et al., 2013). Adding more activities in a shorter mindfulness intervention session will be more suitable for early adolescents because adolescents' attention spans are shorter than adults therefore the intervention must be carefully prepared. As a result, participants' interest can be maintained by beginning with shorter meditations and progressively increasing the length of time until they feel comfortable with the exercises. (Modi et al., 2018). The mindfulness programme provided as part of the regular school curriculum has been demonstrated to be useful for children aged 9 and 10. (Amundsen., 2020).

Nineteen studies were analyzed in the variable stress and has a moderate effect size. The Multimodal mindfulness program is found to be highly effective for professional students in reducing stress. This intervention includes physically active mindfulness activities, as opposed to non-active mindfulness methods such as guided imagery, body scanning, and sitting meditation. Students were given the freedom to choose any sort of meditation they wanted and to practice it at any time during the week. Students were allowed to choose any type of meditation they want and to practice it at any time during the week. Due to the high degree of stress experienced by graduate healthcare students as a result of exams, work schedules, and family responsibilities, intervention must be designed carefully for them to have active participation. The goal of the multimodal mindfulness program is to provide students with the ability to modify mindfulness activities to their requirements and preferences. This would help them to practice effectively and to implement it in daily life. Mindfulness programs in school students can act as a preventive intervention to stress. Students can strengthen their resilience by participating in mindfulness programs at times of increased stress, allowing them to deal with stressful situations and recover more rapidly. (Bennett, 2016).

Self-compassion comprises eight studies and has a moderate effect size. Mindfulness-based stress reduction is found to be effective in enhancing self-compassion in college students. Subclinical depression is linked to an increase in self-criticism and a lack of self-compassion (Krieger et al., 2013; Ying, 2009). It can be understood from this study that an increase in the level of self-compassion leads to a reduction in depression. Mindfulness is considered a component of self-compassion which entails showing compassion to one's self in case of failure, perceived inadequacies, or general suffering (Neff, 2011). As a result, the mindfulness intervention given to school students will aid in the development of self-compassion at a young age and may serve as a preventative for future mental health issues.

In this meta-analytic study, students in the age group 18 to 25 years are found to have a moderately strong effect size in all the study variables than students in the 4 to 17 years which indicates that mental health issues are more common in early adulthood stage compared to adolescents and children except for depression, therefore the interventions given to this group yields more positive results whereas school students have significant effectiveness in the area of mindfulness and self-compassion. Quasi-experimental designs, matched control pre-test- post-test design, and randomized control trial designs are considered as most suitable research designs with high effect sizes. When compared to individual randomized controlled trials (RCTs) or cluster randomized trials, quasi-experimental studies can be used to measure the efficacy of large-scale interventions, are less expensive, and need fewer resources. It assesses the effectiveness of a participant-led intervention rather than the efficacy of a researcher-led intervention under controlled conditions and has more external validity than an RCT. (Harris et al., 2004; Schweizer et al., 2016). Duration of the intervention (above six weeks, below six weeks, less than three weeks) does not show much difference in the outcome variables. For subgroup analyses, interventions are grouped into categories such as mindfulness training/programs which include mindfulness relaxation courses, meditation, colouring activity, multimodal mindfulness intervention, learn to breathe, mindfulness-based Tai chi chuan, mindfulness program, mindfulness-based cognitive therapy, etc. And about the effectiveness of the intervention, mindfulness training/program, and mindfulness stress-based intervention is found to be most significant in reducing the effect of clinical outcomes in students. All types of intervention produced a good result in their ways according to the problem for which the intervention was implemented and the age group it addressed.

Strength and Limitation

This meta-analysis offers an almost complete statistical analysis of the effectiveness of mindfulness intervention in students. Studies are selected based on specific inclusion and exclusion criteria. And the extraction of studies is done based on Prisma guidelines. The quality of each study is assessed with the help of Cochrane collaboration's tool for assessing the risk of bias. The analysis incorporated all the significant mindfulness studies in students between the years 2011 and 2021. The Moderator effect is identified by using subgroup analysis of certain main moderating variables such as the age of students, research design used for the study, duration of

the intervention, and intervention types. The study has certain limitations, for example, the follow-up effect which shows the lasting effect of intervention and variation in the effectiveness of intervention according to the gender difference is not analyzed. The studies are not specified to RCT alone. And also Interventions and activities in the control group are not considered for statistical analysis. More studies could have been extracted by literature search from more databases.

Conclusion

This meta-analysis indicates that mindfulness intervention is effective in students to enhance their mindfulness and self-compassion from an early age itself and also reduces the symptoms of anxiety, depression, and stress in young adults. Therefore mindfulness interventions and practices can be implemented in the daily lives of students by learning mindfulness as part of the school curriculum and through home practices.

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Data Availability The studies included in this meta-analysis are openly available and can be downloaded.

Declarations

Conflict of interest There is no competing interest to declare.

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