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The efficacy of compassion and self-compassion training programs for healthcare university students: a systematic review and meta-analysis

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Abstract

Background University healthcare students are exposed to significant levels of stress. The training is highly complex as it requires academic excellence, the development of clinical competencies and strong interpersonal skills. Compassion and self-compassion are considered protective factors against stress in the healthcare context.

Objective The aim of this study was to analyse the effectiveness of programs aimed at cultivating compassion on the variables of self-compassion and compassion in university healthcare students.

Methods The PubMed, CINAHL, WOS and PsycINFO databases were searched for studies with interventions based on the cultivation of compassion or self-compassion in university healthcare students. A meta-analysis was conducted using a random-effects model for the variable of self-compassion and compassion, calculating the effect size and heterogeneity of the studies. For the self-compassion variable, subgroup analyses were performed for participant characteristics, type of control group, and duration of intervention.

Results For the self-compassion variable, a total of 23 articles were included ($N = 1552$), of which 11 were used for the meta-analysis. With regard to the qualitative synthesis, most of the studies showed a significant increase in self-compassion, as well as improvements in other dimensions of the instrument used. Six studies measured compassion, two of which identified a significant increase in this variable post-intervention. The meta-analysis revealed a moderate and significant overall effect of self-compassion interventions ($d = 0.52$; 95% CI $[0.27, 0.78]$; $p < 0.001$), with higher post-intervention scores in experimental groups. Despite moderate heterogeneity ($I^2 = 60.29\%$) and some evidence of publication bias (Egger's test $p = 0.0273$), the findings remained robust across sensitivity analysis. Regarding the compassion variable, despite the limited evidence ($n = 6$), a meta-analysis ($n = 5$) was performed. A medium effect size was obtained with marginal statistical significance ($d = 0.43$, 95% CI $[-0.09, 0.95]$; $p = 0.10$). This indicated that, although the trend is positive and clinically relevant, the extremely high variability ($I^2 = 79\%$) prevents a statistically conclusive statement of efficacy.

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Conclusions This is the first meta-analysis to investigate the effectiveness of interventions based on compassion/self-compassion in university healthcare students. Given that compassion and self-compassion are essential skills for future professionals, and considering the potential benefits of interventions, it is suggested that these programs be tested in undergraduate and postgraduate health education.

Trial registration This study was registered in the International Prospective Register of Systematic Reviews (PROSPERO) under CRD42024529563.

Keywords Compassion, Healthcare Students, Intervention, Program, Self-Compassion

Background

The characteristics of the healthcare environment, such as excessive workload [1], staff shortages [2], and/or witnessing the pain and suffering of patients and their families [3–5] expose healthcare professionals to significant physical, emotional, and spiritual demands [6]. In this regard, the training of undergraduate healthcare students is highly complex as it requires academic excellence, the development of clinical competencies and strong interpersonal skills settings [7]. Initially, undergraduate healthcare training focuses on providing a theoretical foundation that will serve as the basis for successful clinical placements in healthcare settings [8]. This clinical environment can provoke stress and anxiety in these students, as suggested in previous studies [9, 10]. It can also affect their learning, as well as their professional and personal performance [10]. Other studies have also revealed high levels of stress in university healthcare students [7, 11]. The study by Weingartner et al. [12] specifically identifies that medical students reach peak stress levels when they transition from the academic to the clinical setting for placements.

Compassion and self-compassion are considered protective factors against stress in the healthcare context [13]. Providing compassionate care has been linked to benefits such as improved professional-patient relationships [14, 15], emotion regulation [16], reduced burnout, greater well-being and job satisfaction [17], as well as fewer clinical errors among healthcare professionals [18]. These benefits have also been described in healthcare students [16], whose training in sensitive environments [19, 20] can pose a risk to the learning process and care provision [21]. However, traditional training focuses on theoretical knowledge [8, 22, 23] and has underestimated the need to develop human aspects of healthcare such as compassion, empathy, and interpersonal skills [17]. This has promoted the dehumanization of care and a value system focused on technical skills, speed, and efficiency [24].

Compassion and self-compassion are interrelated concepts that play complementary roles in healthcare education. On the one hand, self-compassion is defined as the self-attitude that involves treating oneself with warmth and understanding in difficult times and recognising

that making mistakes is part of being human [25]. On the other hand, compassion is defined as the feeling that arises in witnessing another's suffering and that motivates a subsequent desire to help [26]. Self-compassion, according to Neff's theoretical model [25], identifies three components: self-kindness, shared humanity, and mindfulness. The component of self-kindness refers to being kind to oneself in painful moments, as opposed to being self-critical. Shared humanity is defined as understanding suffering as part of being human, whose experience connects us to others. Finally, mindfulness refers to maintaining suffering in a balanced awareness without being completely absorbed by negative feelings [25]. Alternatively, Gilbert et al. [27] propose a multidimensional model of compassion with three interrelated orientations or flows. These include compassion towards others, which involves recognizing and responding to the suffering of others with care and concern; compassion received from others, which reflects an individual's openness to receiving kindness, support, and understanding from those around them; and self-compassion, the ability to extend the same care and understanding toward oneself during times of personal suffering or failure. By framing compassion in these three directions, the model emphasizes that compassionate experience is not unidimensional, but rather encompasses both giving and receiving care, as well as cultivating an internal supportive stance. In addition, these authors distinguish between compassionate engagement and compassionate action. Compassionate engagement refers to the capacity to recognize distress in oneself or others and to respond with sensitivity, empathy, and a genuine willingness to connect, rather than avoiding or denying suffering. Compassionate action, on the other hand, involves the application of wisdom, skills, and practical strategies to alleviate suffering effectively, ensuring that engagement is translated into meaningful intervention. This distinction highlights that compassion is not only an emotional or attitudinal state, but also a dynamic process that integrates awareness, motivation, and action. Understanding these components is crucial for research and practice, as it provides a framework for developing interventions that enhance both personal and interpersonal well-being.

In healthcare education, both compassion and self-compassion are essential skills [28] and that can be learned and practised [29, 30]. While compassion fosters empathic care and professional identity formation, self-compassion supports emotional regulation, resilience, and well-being, protecting students from stress and burn-out during training [31]. Although interventions focused on compassion and those focused on self-compassion are often presented as distinct approaches, both derive from the same theoretical framework that conceptualizes compassion as a sensitivity to suffering in oneself and others, coupled with a commitment to alleviate it [25, 27]. Compassion training has begun to feature in the training of undergraduate healthcare students [32]. However, there is no consensus on how to implement compassion training, and there is a lack of existing evidence-based programs [14]. Compassion-based interventions refer to psychotherapies or other programs that focus on cultivating compassion for oneself and others [33]. Compassion-based interventions typically involve affiliative processing to regulate negative emotions and nurture connections with others [34]. These include meditation sessions and discussions based on Buddhist practices [35, 36]. The main programs based on the cultivation of compassion are Compassion Cultivation Training (CCT) [37]; Mindfulness Self-Compassion (MSC) [38]; Compassion Based Cognitive Training (CBCT) [39] and Loving Kindness Meditation (LKM) [40].

Although compassion and self-compassion interventions have demonstrated benefits in healthcare professionals [41] there is limited and inconsistent evidence regarding their effectiveness in healthcare students, particularly in terms of both self-compassion and compassion towards others. Therefore, the aim of our study was to analyse the effectiveness of programs aimed at cultivating compassion on the variables of self-compassion and compassion in university healthcare students.

Methods

Design

A systematic review and meta-analysis were carried out following the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [42]. This study was registered

in the International Prospective Register of Systematic Reviews (PROSPERO) under CRD42024529563.

Databases and search strategy

A search for studies with interventions based on compassion training was conducted from September 2023 to June 2024 using the following databases specialised in health sciences: PubMed, CINAHL, Web of Science (WOS) and PsycINFO. Given the potential availability of recent studies published after this date, an update of the search was performed in March 2025.

The references of the articles were checked to find potential studies that had not been identified in the search. Medical Subject Headings (MeSH) were used, such as “student, health occupations” and “self-compassion”, as well as other terms, including “nursing student”, “medical student”, “physiotherapy student”, “psychology student”, “intervention”, “program(me)”, “compassion” and “self-compassion”. Similar descriptors were combined using the “OR” operator, while the “AND” operator was used to combine intersection concepts. The PIO strategy was used for the formulation of the research question (Table 1). The search formula used in PubMed was: ((((((“Students, Health Occupations”[Mesh]) OR (nurs* student[Title/Abstract])) OR (medical student[Title/Abstract])) OR (physiotherapist student[Title/Abstract])) OR (psychological student[Title/Abstract])) AND ((program[Title/Abstract]) OR (intervention[Title/Abstract])) AND (((self-compassion[Title/Abstract]) OR (Self-Compassion[MeSH Terms])) OR (compassion[Title/Abstract])). Similar search strategies were used for the rest of the databases (Additional File 1).

Eligibility Criteria

The inclusion criteria for the studies were: (a) original publications in English and Spanish available in full text, (b) whose study population were university students enrolled in health sciences, (c) that had interventions based on cultivation of compassion/ self-compassion and contained at least one module on this subject, (d) with a quasi-experimental design with or without a control group, with or without randomisation and clinical or experimental studies and (e) that measured compassion and/or self-compassion as outcome variables. More specifically, interventions whose explicit or implicit objective was to promote compassion or self-compassion were included, regardless of whether these terms appeared in the program name. Programs specifically designed to cultivate compassion or self-compassion were included, as were broader interventions that incorporated at least one clearly defined compassion or self-compassion module. This decision was grounded in established theoretical frameworks that conceptualize compassion as

Table 1 PIO strategy for the formulation of the research question

Question PIO	Search
P (Population)	Health science students (nurse, medical, physiotherapist and psychological student)
I (Intervention)	Interventions that include cultivating compassion or self-compassion
O (Outcome)	Improve self-compassion or compassion

a multidimensional and trainable capacity that can be cultivated progressively [25, 27]. Furthermore, in university health education, compassion-related content is often delivered in short or modular formats, largely due to curricular and organisational constraints. Excluding these interventions would have substantially limited the validity and practical relevance of the review. To address the heterogeneity arising from the inclusion of both comprehensive and partial interventions, subgroup analyses were performed based on duration, type of control group used, and sample size. To reduce the risk of bias, the search period was unlimited.

Study selection process (screening)

The screening and selection process were conducted in accordance with the PRISMA guidelines to ensure methodological transparency and reproducibility. The process was carried out in three sequential phases, with the aim of discerning the suitability of the articles. In the first phase, all records identified through database searches were exported to a reference manager and duplicates were manually removed. After this, the titles of the articles were reviewed, removing those that were unrelated. In the second phase, two reviewers independently screened the titles and abstract to assess their potential eligibility based on predefined inclusion and exclusion criteria. The third phase involved a full-text review of the remaining studies to confirm their eligibility for the inclusion. This was performed by two reviewers independently and any disagreements on the articles selected were resolved by a third reviewer. A data collection sheet was designed including country, authors, study design, population, compassion-based intervention, control group, measurement tools, outcomes (compassion and self-compassion), follow-up and duration of the intervention.

Methodological Quality Assessment

The quality of the articles was analysed using the Joanna Briggs Institute Meta-Analysis of Statistics Assessment and Review Instrument (JBI-MASARI) for randomised clinical trials (RCTs) [43] and quasi-experimental studies [44]. The JBI-MASARI assessment instrument consists of a 13-item checklist for RCTs and a 9-item checklist for quasi-experimental studies with four possible responses: yes (1 point), no (-1 point), unclear (0 points) and not applicable. The quality assessment process was carried out by two authors independently twice, allowing for increased methodological rigour, as well as an accurate assessment of biases in the literature. Version 5.4 of the Cochrane Review Manager (Rev Man) software was used to describe the quality of the studies (The Cochrane Collaboration, 2020) [45].

Data Analysis

For the meta-analysis, the statistical program Stata Statistical Software: Release 18 [46] was used. Articles were included if they provided sample size, mean and standard deviation of the variables under study in the post-intervention phase, both in the control and experimental groups. Inverse variance was calculated with a random effects model [47] to account for variation in effect sizes between studies [48]. A forest plot was used to represent the results showing the effect size of each study and the weighted mean effect of all studies with their respective 95% confidence intervals. The effect size was assessed using Cohen's *d*, which is measured as small ($d \leq 0.20$), moderate ($0.20 < d < 0.80$) or large ($d \geq 0.80$) [49]. The Z-contrast associated with the probability level ($p \leq 0.05$) made it possible to test the null hypothesis of a mean effect of the intervention programs in the studied population equal to 0. For the degree of heterogeneity of the studies, the H statistic was calculated using Cochran's (Q) statistic [50], which indicates the presence of heterogeneity with a score of $H > 1$. In addition, the T2 test was used, which indicates that the higher the score, the greater the heterogeneity. To determine the degree of heterogeneity, the I2 statistic was used, with 25% considered as low, 50% as medium and 75% as high [51]. In addition, subgroup analyses were performed stratified by intervention characteristics (duration), discipline, and type of control, evaluating differences using the Q test between groups under a mixed-effects model. Likewise, for the compassion variable, in those studies where means and standard deviations were not reported, effect sizes were estimated from the available inferential statistics following standardised conversion procedures to allow their inclusion in the quantitative synthesis.

To calculate the probability of publication bias, we used Egger's [52] regression test and Rosenthal's [53] method for calculating the Fail-Safe N. A sensitivity analysis using the leave-one-out method was also conducted to detect influential studies in the overall effect size. Finally, power analysis with a 0.05 significance level was calculated for each study in the meta-analyses using Jamovi 2.6.19 statistical software [54]. This analysis allowed us to determine the ability of the meta-analysis to detect an effect size given the average sample size.

Results

Study selection

Figure 1 shows the article selection process [42]. A total of 667 articles were found, of which 612 remained after removing duplicates. After being filtered by title and abstract, 405 of these were reviewed in full text. Only 24 articles were selected for the final review. The remaining studies were excluded for various reasons, as presented

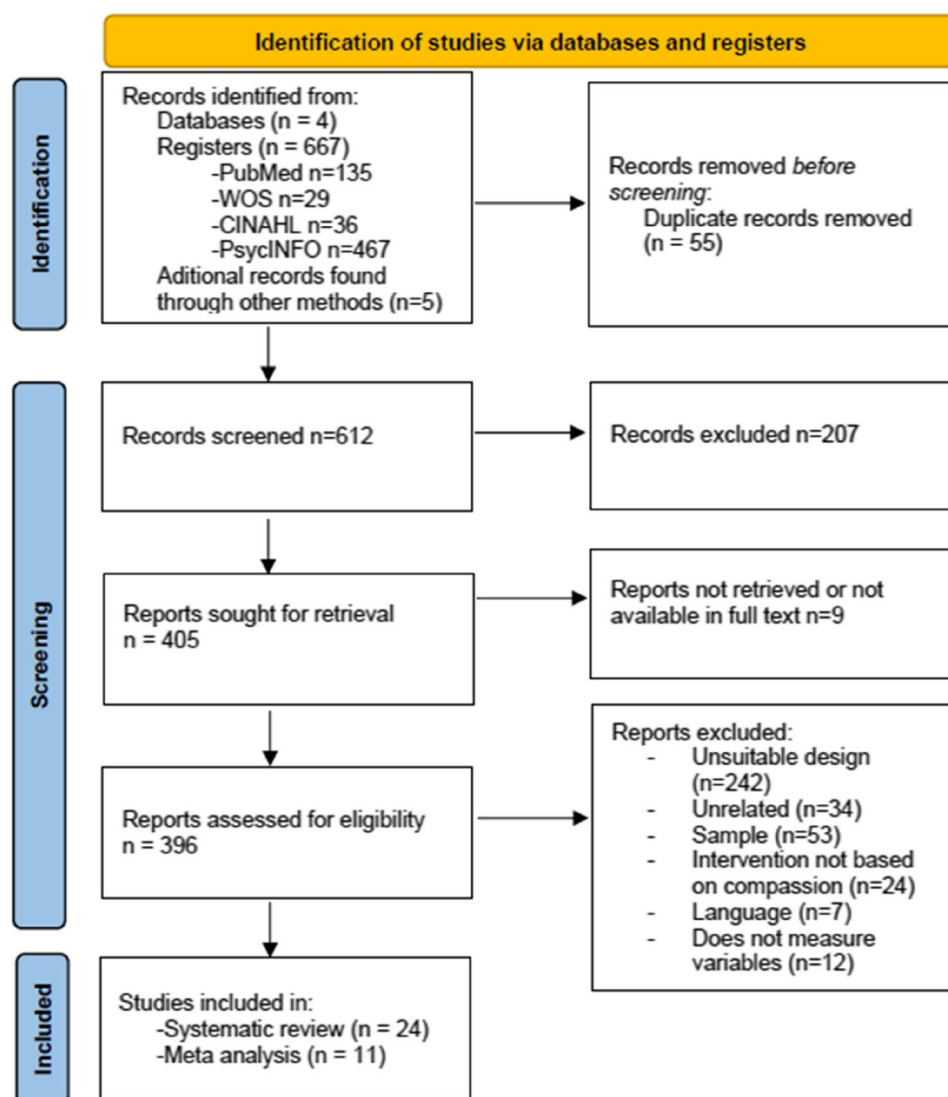


Fig. 1 Article selection process

in Fig. 1. Only 11 studies met the inclusion criteria for the meta-analysis.

Characteristics of the studies

Twenty-four studies were included in this systematic review. The main data extracted from each of the studies are presented in Table 2. The articles included were all published between 2014 and 2024, meaning that almost all of them were published in the last ten years ($n=23$), and more than half in the last 5 years ($n=19$). The included studies were conducted in Spain ($n=6$), Australia ($n=3$), USA ($n=3$), Canada ($n=2$) and in the UK ($n=2$), as well as in Holland ($n=1$), China ($n=1$), Chile ($n=1$), Japan ($n=1$), Turkey ($n=1$), Romania ($n=1$) and Africa ($n=1$). One of the included studies did not specify the location, stating that the data were collected at a European university. In terms of the study design, seven

quasi-experimental articles and eleven randomised clinical trials were selected. The overall sample size was 1,584 participants, of which 898 were in the intervention group and 686 in the control group. The included studies varied widely in terms of the number of students, ranging from 11 to 314 participants. Regarding the type of participants, data were collected from medical ($n=8$), psychology ($n=6$), nursing ($n=5$) and postgraduate ($n=4$) students. Another study had a mixed sample, collecting data from undergraduate medical, nursing, psychology and nutrition students.

With regard to the type of intervention, the included studies varied widely. Sixteen studies based their intervention on self-compassion and/or compassion, while five studies based their intervention on mindfulness, with specific training in compassion and/or self-compassion (LKM, compassion, self-compassion and/or

Table 2 Characteristics of the studies included in the systematic review and meta-analysis

Authors	Design	Country	Participants	Compassion-based intervention	Measurement tools	Results
Beaumont et al., 2017 [66]	Quasi-experimental study (mixed method)	UK	Postgraduate psychotherapy students (enrolled in Cognitive Behavioural Psychotherapy) N = 24 IG: n = 21 → Loss of participants n = 3 on the Compassion for Others Scale CG: n = 3 → Not used	CMT Duration: 3 days Hours/session: 2.5 Sessions: 6	Pre and Post Intervention: -SCS -CS	IG: → Significant increase in self-compassion post intervention. → No significant differences in compassion towards others post intervention.
Beaumont et al., 2021 [67]	Quasi-experimental study (mixed method)	UK	Postgraduate students of healthcare professions (enrolled in Compassion-focused therapy) N = 11	CMT (based on CFT) Duration: 12 weeks	Pre and Post Intervention: -SCS-SF	IG: → Significant increase in self-compassion post-intervention.
Bellosta-Batalla et al., 2021 [56]	Quasi-experimental study	Spain	Psychology students N = 90 GI1: n = 37 GI2 (Basic Psychotherapy Skills): n = 27 CG (waiting list group): n = 26	MCBI (based on MBSR + MSC) Duration: 2 months Hours/session: 2 Sessions: 8	Pre and Post Intervention: -SCS-SF Follow-up (3 months later): -SCS-SF	IG1: → Significant increase in self-compassion post intervention → Follow-up: maintained increase in relation to CG, but not significant in relation to IG2.
Bidik & Sisman, 2024 [58]	RCT	Turkey	Nursing students N = 80 IG: n = 40 CG (meditation + audio recordings): n = 40	Mindful Self Compassion Program One session online Duration: 90 min	Pre, Post Intervention and Follow-up (6 weeks): -SCS	IG: → Significant increase in self-compassion post-intervention and follow-up. CG: → Significant increase in self-compassion post-intervention and follow-up.
Boyd & Alexander, 2022 [72]	RCT (mixed method)	South Africa	Medical students N = 38 IG: n = 28 CG (Supportive counselling content): n = 14 → Loss of participants for unknown cause n = 4	MBI combined with Three Step Breathing Space + LKM Duration: 6 weeks	Pre and Post Intervention: -SCS-SF Follow-up (at 8 weeks): -SCS-SF	IG: → Significant decrease in self-compassion post-intervention and follow-up. → Mindfulness subscale (SCS-SF) had a significant effect post-intervention. CG: → Significant decrease in self-compassion post-intervention and follow-up.
Danilewitz et al., 2016 [59]	RCT	Canada	Medical students N = 22 IG: n = 13 CG (Waitlist control group): n = 9	MMP (MBSR adapted version) Duration: 8 weeks Hours/session: 1-1.5 Sessions: 8 Daily meditation practice → Module 7: "Loving Kindness" and "Being Compassionate to Ourselves and Our Patients", as well as LKM.	Pre and Post Intervention -SCS	IG: → Significant improvement in self-compassion in the IG post-intervention.
Finlay-Jones et al., 2017 [68]	Quasi-experimental study	Australia	Post-graduate psychology students (enrolled in Australian Psychology Accreditation Council) N = 37	SCO Duration: 6 weeks Hours/session: 1-2 Sessions: 6	Pre and Post Intervention: -SCS Follow-up (12 weeks): -SCS	IG: → Significant increase in self-compassion post intervention and follow-up.

Table 2 (continued)

Authors	Design	Country	Participants	Compassion-based intervention	Measurement tools	Results
González-García et al., 2021 [69]	Quasi-experimental study	Spain	Psychology students N=66	E-Mindfulness intervention ad hoc (based on MBSR, MBCT, MSC y CBCT) Duration: 16 days Total hours: 7 Sessions: 4 → 2 modules based on compassion: “Promote emotional regulation through self-compassion” and “promote resiliency through ethical responsibility and compassion”	Pre and Post Intervention: -SCS-SF	IG: → Significant post-intervention increase in self-compassion
Hidding et al., 2024 [55]	RCT	Holland	Psychology students N=64 IG: n=31 CG (two roleplays performed without perspective change): n=33	VR (compassionate role-play) + 3 examples derived from CFT □ Two roleplays In the perspective change condition, after each roleplay perspective change was used.	Pre and post Intervention: -SCCS	IG: → Significant improvement in self-compassion CG: → Significant improvement in self-compassion.
Joseph & Raque, 2023 [73]	RCT	USA	Nursing students N=189 IG: n=80 CG (body scan meditation): n=109	LKM Duration: 1 day Hours: 1 (10 min LKM) Sessions: 1	Post Intervention: -SCS-SF -CCS	- No statistically significant differences in self-compassion and compassionate care were found between groups.
Kurebayashi, 2021 [74]	RCT	Japan	Nursing students N=35 IG: n=18 CG (Conference): n=17	Brief lecture on the awareness of self-compassion, based on Self-kindness, Common humanity and Mindfulness Duration: 1 day Hours: 1 Sessions: 1	Pre and post intervention: -SCS Japanese version	IG: → Significant improvement in the mindfulness subscale of the SCS → Non-significant increase post-intervention in the rest of the SCS subscales
Martínez-Rubio et al., 2021 [60]	RCT	Spain	Psychology students N=24 IG: n=14 → Lost to follow-up n=1 CG (Wait-list control group): n=10 → Lost to follow-up n=4	MCBP (adaptation of MBCT) Duration: 6 weeks Hours/session: 1.5 Sessions: 6	Pre and Post Intervention: -SCS-SF	IG: → Significant improvement in self-compassion
Mascaró et al., 2018 [83]	RCT	USA	Medical students N=32 IG: n=21 CG (wait-list): n=11	CBCT+ daily meditation for 20 min Duration: 10 weeks Hours/session: 1.5 h Sessions: 10	Pre and Post Intervention -CLHS	IG: → Significant improvement in compassion post- intervention
Mehta et al., 2024 [61]	RCT	USA	Medical students N=17 IG: n=11 CG (different courses) n=6	Compassion Intervention + self-study activities Duration: 4 weeks Hours/session : 2 Sessions: 8	Pre and Post Intervention -SCS-SF -CS	IG: → Significant improvement in self-compassion and compassion post-intervention
Moore et al., 2024 [62]	RCT	Australia	Medical students N=101 IG: n=61 CG (usual curriculum): n=40	Mindfulness Training Program 2 modules based of compassion (week 6 and 7: compassion, loving-kindness and self-compassion) Duration: 8 weeks Minutes/session: 15 min Sessions: 8	Pre, Post and Follow Up (6 months) -SCS	IG: → Significant improvement in self-compassion post-intervention → Non-significant increase in follow-up in IG

Table 2 (continued)

Authors	Design	Country	Participants	Compassion-based intervention	Measurement tools	Results
Orosa-Duarte et al. (2021) [63]	RCT	Spain	Medical, nursing, psychology and nutrition students <i>N</i> = 84 IG1: <i>n</i> = 31 IG2 (MBSR): <i>n</i> = 23 CG: <i>n</i> = 30	App 'REM Volver a casa' (Mindfulness-Based Emotional Regulation: 'Going home') Duration: 8 weeks Hours: 200 min Sessions: 8	Pre and Post Intervention -SCS	IG: → Similar increases in post-intervention scores in both IG and IG2. → Intervention groups accounted for more than 30% of changes in self-compassion.
Pickard, Deane & Gonsalvez, 2024 [70]	Quasi-experimental study	Australia	Postgraduate psychology students <i>N</i> = 98	Brief Mindfulness Intervention Program + daily mindfulness practice Duration: 6 weeks Hours: 1 Sessions: 6 → One module based on Compassion for oneself and others	Pre and Post Intervention -SCS-SF	IG: → Significant increase in self-compassion.
Póka & Barta, 2024 [81]	RCT	Romania	Psychology students <i>N</i> = 66 IG: <i>n</i> = 45 CG (passive control): <i>n</i> = 21	CMT: Duration: 12 weeks Hours: 2 h	Pre, Post intervention and Follow up (3 months): -SCS-SF	IG: → Significant increase in self-compassion → Maintained changes at follow-up.
Rodríguez-Moreno, Rojas & Roca, 2024 [77]	RCT	Spain	Medical students <i>N</i> = 40 IG: <i>n</i> = 22 CG(waiting list group) <i>n</i> = 18	CCT Duration: 8 weeks Hours: 2 h group online session + 30 min of daily home practice Sessions: 8	Pre, Post intervention and Follow up (2 months): -SCS-SF -CSP	IG: → Increased score post-intervention and follow-up in the self-kindness, common humanity, and mindfulness subscales of the SCS-SF → In relation to compassion towards others, the score decreases post-intervention and follow up. GC: → Decrease in self-kindness post-intervention and follow-up. → Increased score post-intervention and follow-up in the common humanity subscale of the SCS-SF → Scores of the mindfulness self-compassion subscale of the SCS-SF are maintained in CG in post-intervention and decrease in follow-up. → In relation to compassion towards others, the score decreases post-intervention and follow up.
Rojas et al., 2023 [76]	RCT	Spain	Medical students <i>N</i> = 44 IG: <i>n</i> = 18 CG(waiting list group): <i>n</i> = 22	CCT: Duration: 8 weeks Hours: 2 h + 30 min of practice at home on formal and informal compassion Sessions: 8	Pre and Post Intervention -CS -SCS-SF Follow-up (2 months): -CSP -SCS-SF	IG: → Significant increase in the dimensions (self-kindness, common humanity, and mindful self-compassion) of the SCS-SF → No significant changes in compassion towards others and empathic concern. → At follow-up, only a significant increase in self-kindness was maintained.

Table 2 (continued)

Authors	Design	Country	Participants	Compassion-based intervention	Measurement tools	Results
Smeets et al., 2014 [64]	Quasi-experimental study	Europe	Female undergraduate psychology students <i>N</i> = 49 IG: <i>n</i> = 27 CG (Group intervention for teaching time management skills): <i>n</i> = 22	SC Intervention Duration: 3 weeks Hours/ session: session 1 and 2 (1.5 h) and session 3 (45 min). Sessions: 3	Pre and Post Intervention: -SCS-SF	IG: → Significant increase in self-compassion in IG with large effect size.
Villalón et al., 2023 [75]	RCT	Chile	Medical students <i>N</i> = 314 GI1: <i>n</i> = 42 GI2(PSE): <i>n</i> = 32 CG (general intervention): <i>n</i> = 240	IBAP+ practice at home Duration: 4 weeks Hours/session: 1 h Sessions: 4	Pre and Post Intervention: SCS-SF Follow-up (3 months) SCS-SF	IG: → Significant post-intervention increase in the shared humanity subscale of the SCS-SF → Significant increase in follow-up scores on the Shared Humanity subscale of the SCS-SF.
Wang et al., 2022 [71]	Quasi-experimental study (mixed method)	Canada	<i>N</i> = 31 Nursing students (mentees): <i>n</i> = 23 Nurses graduated in the last 5 years (mentors): <i>n</i> = 8	Workshop on conscious self-compassion and career guidance+ MSC training and resource manual Duration: 1 day	Pre and Post Intervention: -SCS	IG: → Increased post-intervention self-compassion score for mentees.
Yang et al., 2024 [65]	RCT	China	Nursing students <i>N</i> = 28 IG: <i>n</i> = 13 CG (passive group): <i>n</i> = 15	Online compassion training program based in MSC and CCT Duration: 8 week	Pre and post Intervention: -SCS-SF	IG: → Increase post-intervention in self-compassion scores although not significantly → Scores were slightly higher in IG than in CG. CG: → Increase post-intervention in self-compassion scores although not significantly

CBCT Cognitively-based Compassion Training, CCS Compassion Competence Scale, CCT Compassion Cultivation Training, CFT Compassion-Focused Therapy, CG Control Group, CLHS Compassionate Love for Humanity Scale, CMT Compassionate Mind Training, CS Compassion Scale, CSP Compassion Scale Pommier, IBAP Brief Online Mindfulness and Compassion-Based Inter-care Program for Students, IG Intervention Group, LKM Loving Kindness Meditation, MBCT Mindfulness Based Cognitive Therapy, MBI Mindfulness-based intervention, MBSR Mindfulness based stress reduction, MCBi Mindfulness and compassion-based intervention, MCBP Mindfulness- and Compassion-based Program, MMP Mindfulness Meditation Program, MSC Mindful Self-Compassion, MTP Mindfulness Training Programme, PSE Psychoeducational intervention, RCT Randomized Clinical Trial, SC Self-Compassion, SCCS Self-Compassion and Self-Criticism Scale, SCO Self-Compassion Online, SCS Self-Compassion Scale, SCS-SF Self-Compassion Scale - Short Form

loving kindness learning modules). Lastly, three studies have compassion-based interventions developed by the authors that include virtual reality, applications or readings. In relation to the duration of the intervention, the studies can be categorised as follows: less than 15 days (*n* = 6), between 15 days and one month (*n* = 2), between 1 and 2 months (*n* = 9), 2 months or more (*n* = 7). With regard to variables, five studies measured variables related to compassion. To be precise, compassionate competence (*n* = 1) was analysed through the Compassion Competence Scale (CCS), while compassion towards others (*n* = 5) used the Compassionate Love for Humanity Scale (CLHS), the Compassion Scale (CS) and the Compassion Scale Pommier (CSP). The majority of the identified studies measure self-compassion (*n* = 23), using 22 studies the Self-Compassion Scale (SCS) in its long and short version, as well as a Japanese adaptation. On the other hand, Hidding et al. [55] measures self-compassion

through the Self-Compassion and Self-Criticism Scale (SCCS). Only 9 studies took follow-up measurements, at three months (*n* = 4) and two months (*n* = 3), six months (*n* = 1) and six weeks (*n* = 1) post-intervention. Self-compassion showed significant improvements in most studies (*n* = 16). In addition, one study found a non-significant increase in self-compassion and four studies reported improvements in some dimensions of self-compassion. However, one study found a significant decrease in self-compassion after the intervention. Meanwhile in another study, no statistically significant differences were found. In relation to compassion, two studies showed significant improvements in this variable post-intervention, two other studies found no statistically significant differences post-intervention and one study found that the scores decreased slightly post-intervention and follow-up.

CBCT: Cognitively-based Compassion Training; CCS: Compassion Competence Scale; CCT: Compassion

Cultivation Training; CFT: Compassion-Focused Therapy; CG: Control Group; CLHS: Compassionate Love for Humanity Scale; CMT: Compassionate Mind Training; CS: Compassion Scale; CSP: Compassion Scale Pommier; IBAP: Brief Online Mindfulness and Compassion-Based Inter-care Program for Students; IG: Intervention Group; LKM: Loving Kindness Meditation; MBCT: Mindfulness Based Cognitive Therapy; MBI: Mindfulness-based intervention, MBSR: Mindfulness based stress reduction;

MCBI: Mindfulness and compassion-based intervention; MCBP: Mindfulness- and Compassion-based Program; MMP: Mindfulness Meditation Program; MSC: Mindful Self-Compassion; MTP: Mindfulness Training Programme; PSE: Psychoeducational intervention; RCT: Randomized Clinical Trial; SC: Self-Compassion; SCCS: Self-Compassion and Self-Criticism Scale, SCO: Self-Compassion Online; SCS: Self-Compassion Scale; SCS-SF: Self-Compassion Scale - Short Form.

Methodological quality of the studies

Methodological quality was assessed using the JBI-MAStARI for RCTs ($n = 15$), as shown in Fig. 2, and for quasi-experimental studies ($n = 9$), as illustrated in Fig. 3. For RCTs, high scores were obtained for selection bias (random sequence generation and allocation concealment) and performance bias (blinding of participants and staff). Regarding the quasi-experimental studies, most of them scored negatively because they did not have a control group, did not make comparisons of similar groups, did not receive similar treatment or care apart from the intervention of interest, or did not measure control and intervention group outcomes in the same way. This process allowed for increased methodological rigour, as well as the assessment of biases in the scientific evidence found. For more information, see Additional File 2.

Meta-analysis results: Self-compassion variable

Of the 23 studies that measured the self-compassion variable, only 11 studies were included in the meta-analysis [55–65]. The rest were not included because they did not have a control group [66–71], because they did not specify when data collection took place [72–76] and because it does not measure all dimensions of the SCS scale [77]. The total number of participants was 625, including the two intervention groups of the studies by Bellosta-Batalla et al. [56] and Orosa-Duarte et al. [63]. Ten authors used the SCS scale to measure the self-compassion variable, both in its short version [56, 57, 60, 61, 64, 65] and in the full 22-item version [58, 59, 62, 63]. In the study of Hidding et al. [55] the SCCS was used, which has two dimensions self-compassion and self-criticism, including in this study only the dimension of self-compassion.

All interventions based on compassion showed a positive effect, with higher post-intervention scores identified in the experimental group. The meta-analysis was conducted using Cohen's d as the effect size metric, which was calculated as the standardized mean difference between the post intervention scores of the intervention scores of the intervention and control groups. When studies reported multiple outcome measures assessing self-compassion, a single effect size was derived by averaging the standardized effects, ensuring that each study contributed only one independent effect size to

	1. Was true randomization used for assignment of participants to treatment groups?	2. Was allocation to groups concealed?	3. Were treatment groups similar at the baseline?	4. Were participants blind to treatment assignment?	5. Were those delivering treatment blind to treatment assignment?	6. Were outcomes assessors blind to treatment assignment?	7. Were treatment groups treated identically other than the intervention of interest?	8. Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?	9. Were participants analyzed in the groups to which they were randomized?	10. Were outcomes measured in the same way for treatment groups?	11. Were outcomes measured in a reliable way?	12. Was appropriate statistical analysis used?	13. Was the trial design appropriate for the topic, and any deviations from the standard RCT design accounted for in the conduct and analysis?
Bidik et al. (2024)	+	+	+	+	+	+	+	+	+	+	+	+	+
Boyd & Alexander (2022)	+	+	+	+	+	+	+	+	+	+	+	+	+
Danilewitz et al. (2016)	+	+	+	+	+	+	+	+	+	+	+	+	+
Hidding et al. (2024)	+	+	+	+	+	+	+	+	+	+	+	+	+
Joseph & Raque (2023)	+	+	+	+	+	+	+	+	+	+	+	+	+
Kurebayashi (2020)	+	+	+	+	+	+	+	+	+	+	+	+	+
Martínez-Rubio et al. (2021)	+	+	+	+	+	+	+	+	+	+	+	+	+
Mascaro et al. (2016)	+	+	+	+	+	+	+	+	+	+	+	+	+
Moore et al. (2024)	+	+	+	+	+	+	+	+	+	+	+	+	+
Orosa-Duarte et al. (2021)	+	+	+	+	+	+	+	+	+	+	+	+	+
Rodríguez-Moreno et al. (2024)	+	+	+	+	+	+	+	+	+	+	+	+	+
Rojas et al. (2023)	+	+	+	+	+	+	+	+	+	+	+	+	+
Smeets et al. (2014)	+	+	+	+	+	+	+	+	+	+	+	+	+
Villalón et al. (2023)	+	+	+	+	+	+	+	+	+	+	+	+	+
Yang et al. (2024)	+	+	+	+	+	+	+	+	+	+	+	+	+

Fig. 2 Evaluation of the methodological quality of RCTs

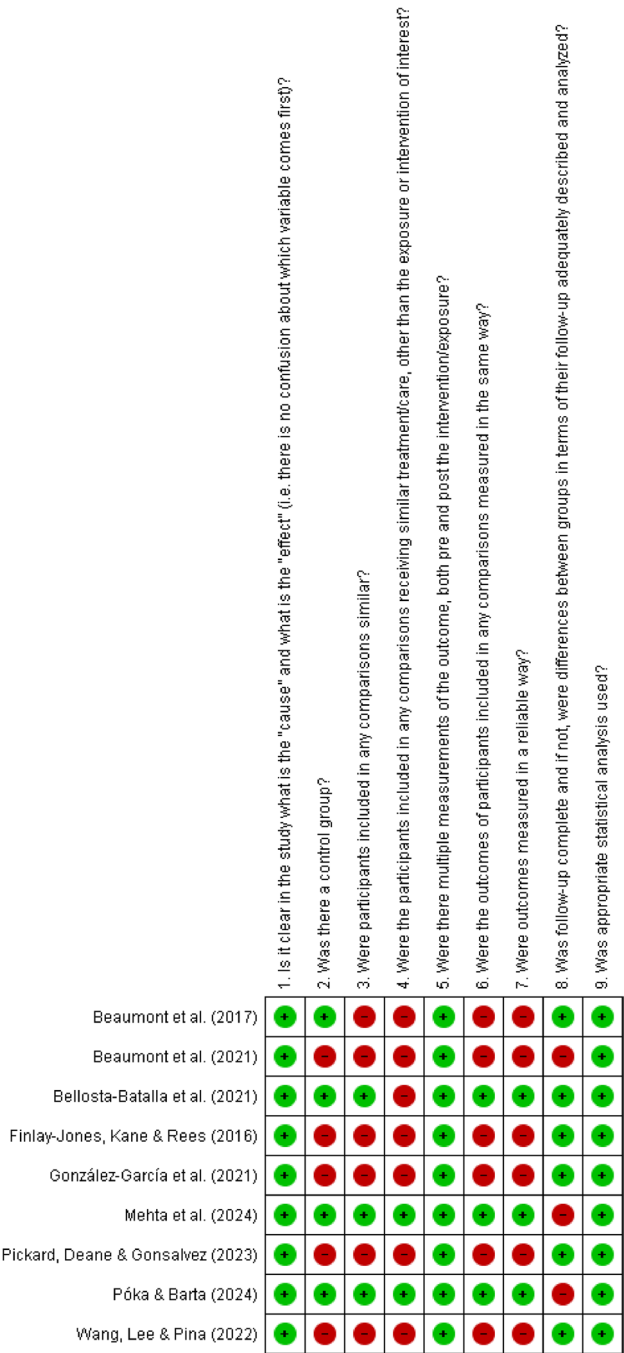


Fig. 3 Evaluation of the methodological quality of quasi-experimental studies

the overall analysis. The meta-analysis showed a significantly moderate effect size in the mean scores of all studies included in the meta-analysis ($d=0.52$, 95% CI [0.27, 0.78]; $Z=4.01$; $p<0.001$). Moreover, a high degree of heterogeneity ($I^2=60.29\%$) was found, which can be attributed to the variability of the studies ($T^2=0.13$; $H=2.52$) (Fig. 4).

Figure 5 shows the results of the “leave-one-out” sensitivity analysis, in which each study was sequentially removed to examine the stability of the pooled effect size. Leave-one-out showed the robustness of these findings, indicating that the overall effect size remained significant in all cases ($p<0.001$), ranging from 0.44 to 0.58 when omitting each study individually. These findings suggest that no single study unduly influenced the overall results, supporting the robustness and reliability of meta-analysis conclusions.

Egger’s test suggested the possible presence of publication bias (*Egger’s test* = 2.21; $p=0.0273$). However, this result should be interpreted cautiously, as Egger’s test can be sensitive to the number of studies and between study heterogeneity. Therefore, while some indication of publication bias cannot be ruled out, the Fail-safe N index was 31 ($p<0.001$) suggests that the overall findings retain a reasonable degree of robustness.

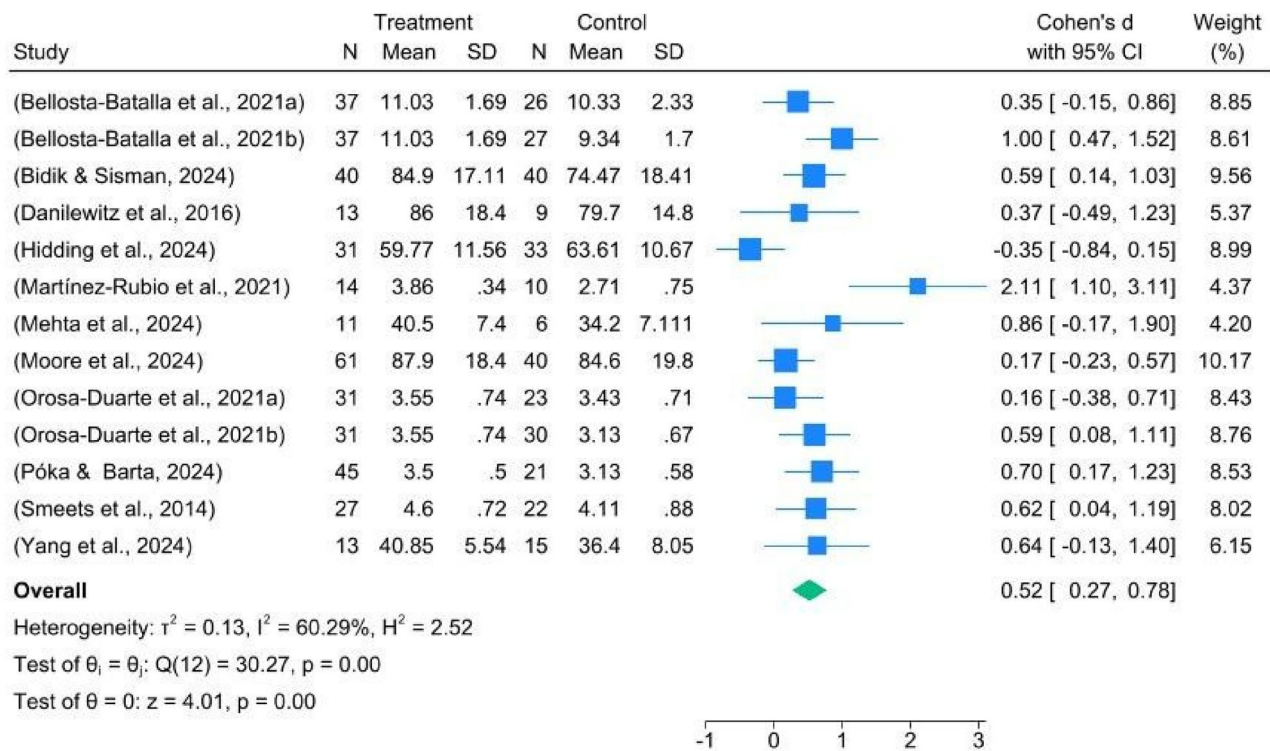
Subgroup analyses

The results of the meta-analysis show that interventions are effective in improving self-compassion in university students, although the heterogeneity figures indicate that these results should be interpreted with caution. Therefore, subgroup analyses were performed to determine whether study characteristics influenced effect size and to resolve heterogeneity between studies.

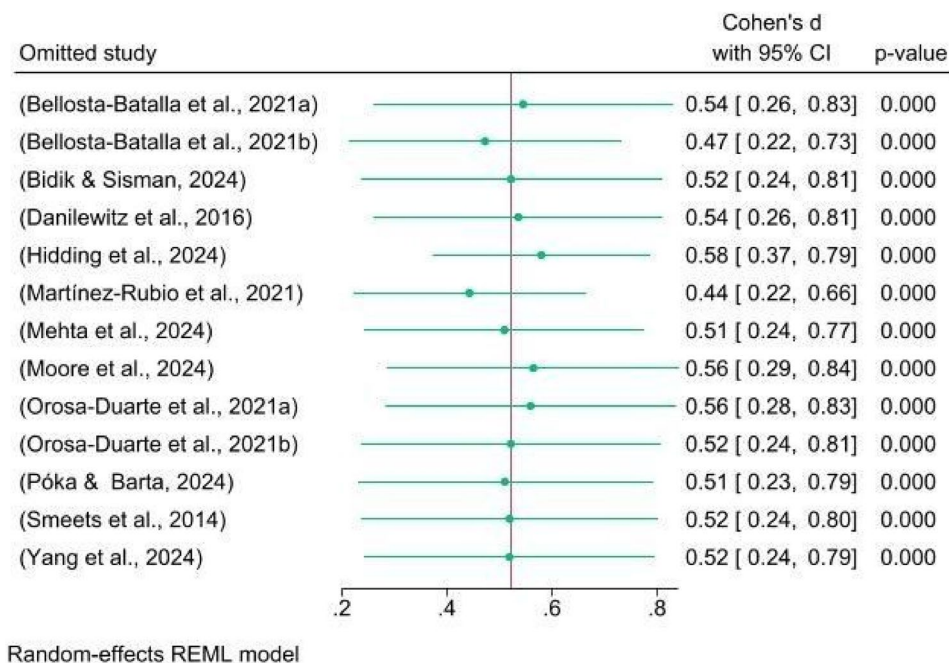
Subgroup analyses were performed based on the duration of the intervention, the type of sample, and the type of control group used. In this regard, duration appears to be a determining factor. Long programs (>4 weeks) work robustly and significantly ($g=0.58$, $p<0.001$, $k=9$), while short programs (<4 weeks) do not show clear results ($g=0.28$, $p=0.38$, $k=3$), as described in Fig. 6. Regarding the type of control group, subgroup analysis revealed that passive control groups had a greater effect ($g=0.58$) than active controls ($g=0.44$) (Fig. 7). Finally, research conducted on nursing and psychology students shows a larger effect size ($g \approx 0.60 - 0.70$) compared to a more modest one in medical students ($g \approx 0.27$), as shown in Fig. 8

Meta-analysis results: Compassion variable

Of the 6 studies that measured the compassion variable, only 5 studies were included in the meta-analysis [64, 73, 79, 80, 83]. Beaumont’s study was not included because they did not have a control group [66]. The total number of participants was 318, with 148 belonging to the experimental group and 170 to the control group. Four scales were used to measure the compassion variable: CCS [73], CLHS [78], CS [64, 79], CSP [80]. Similarly to self-compassion, the meta-analysis was performed using Cohen’s d as a measure of effect size. The meta-analysis showed a medium effect with marginal significance ($d = 0.43$, 95%



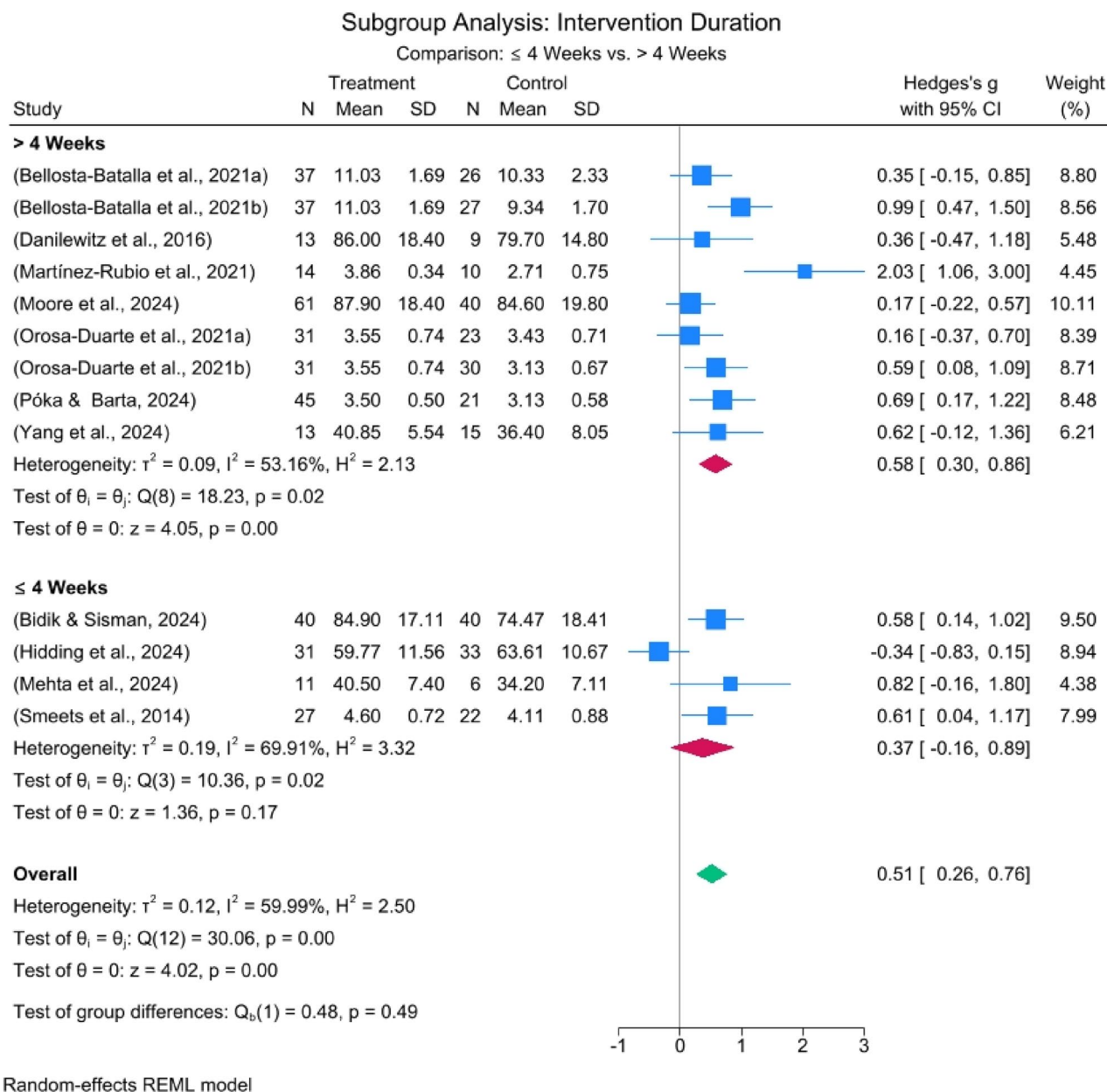
Random-effects REML model

Fig. 4 Difference of standardized means for the self-compassion variable**Fig. 5** Sensitivity analysis of pooled prevalence of self-compassion for each study being removed one at a time

CI [-0.09, 0.95]; $Z = 1.63$; $p = 0.10$). In addition, a high degree of heterogeneity was found ($I^2 = 79\%$), which can be attributed to the variability of the studies ($T^2 = 0.25$; $H = 4.78$) (Fig. 9).

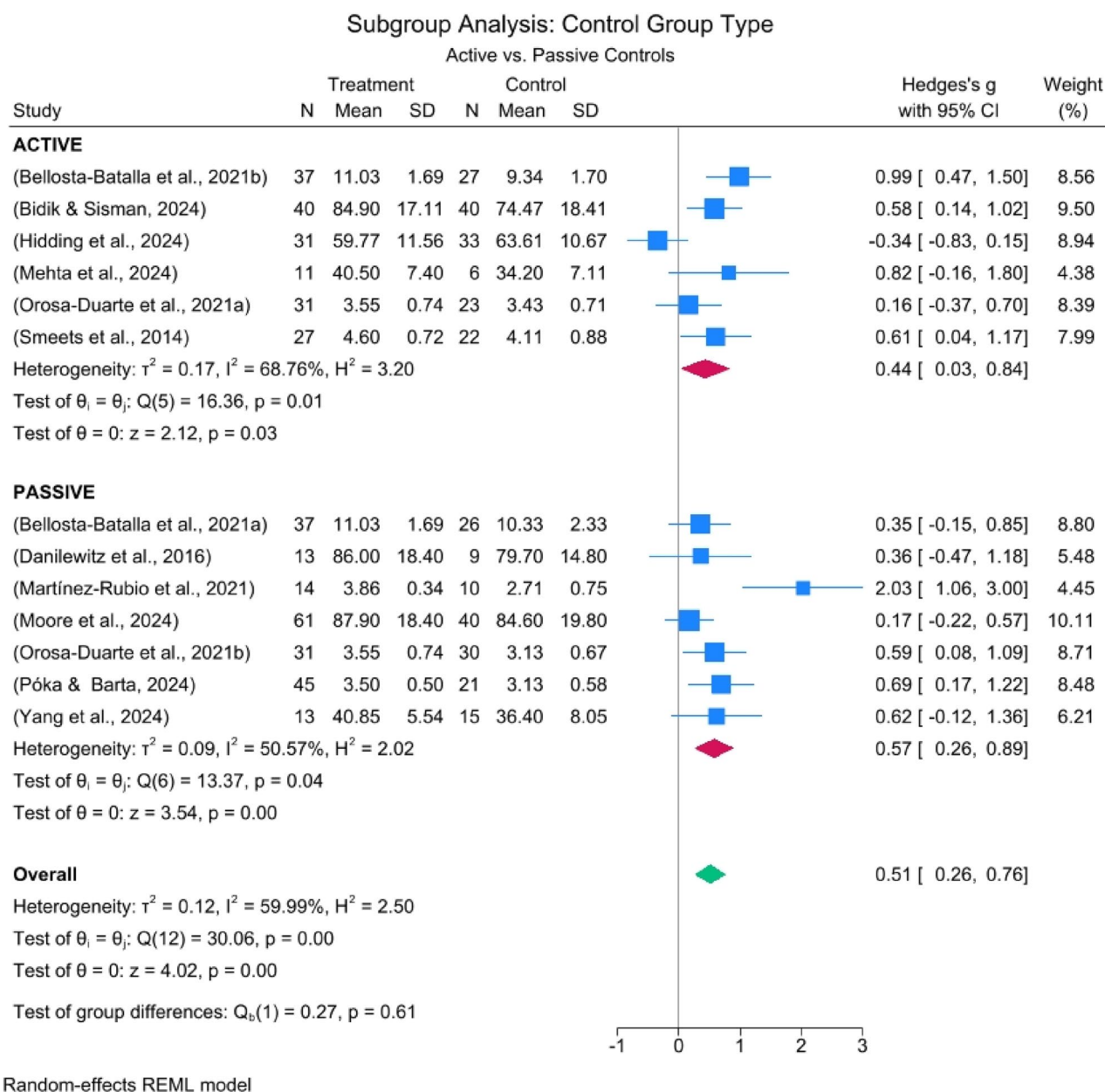
Discussion

The aim of our study was to analyse the effectiveness of programs aimed at cultivating compassion on the variables of self-compassion and compassion in university

**Fig. 6** Subgroup Analysis: Intervention Duration

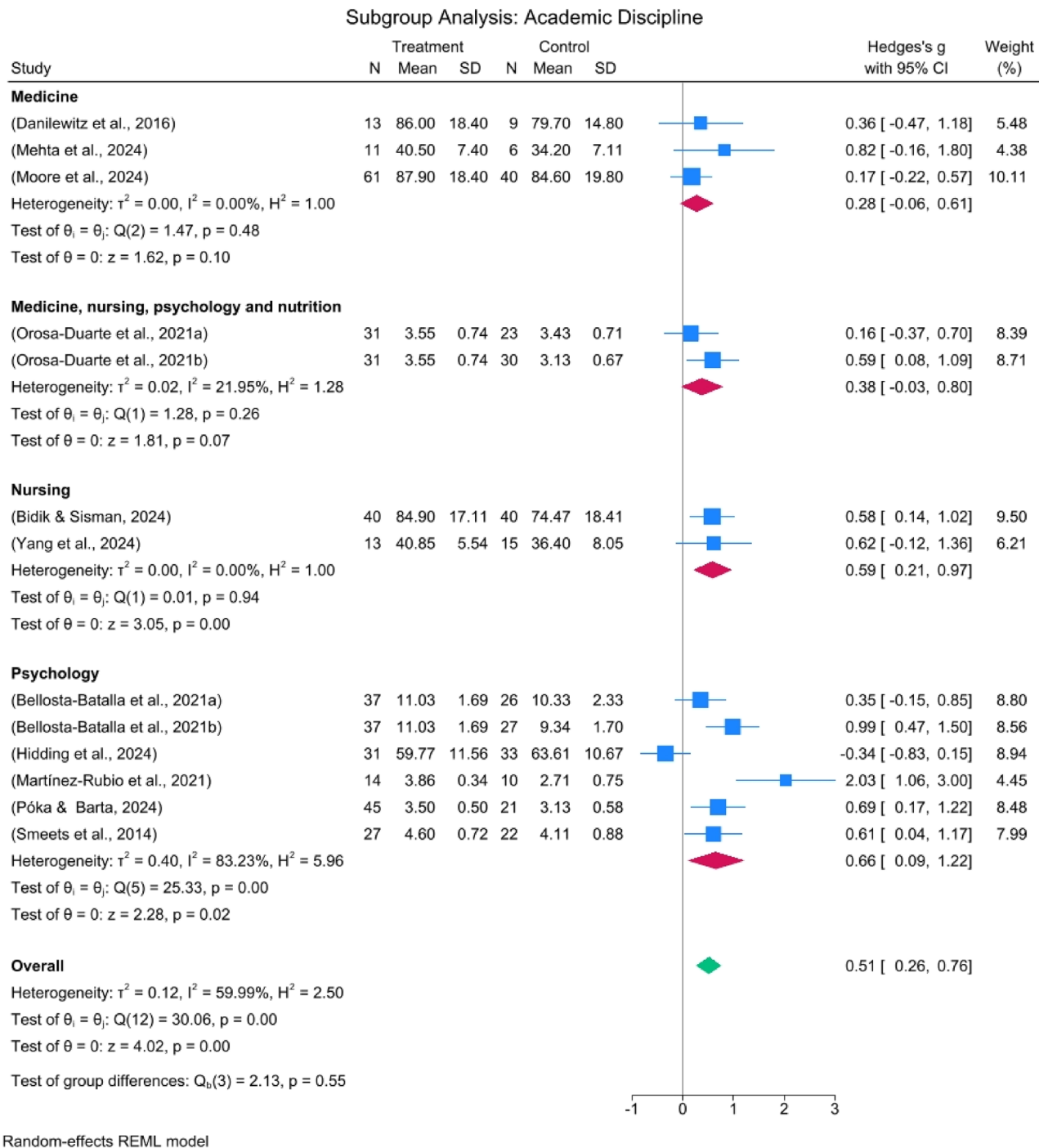
healthcare students. The literature on interventions aimed at cultivating compassion and/or self-compassion in university healthcare students is still limited and heterogeneous. The heterogeneity observed among the interventions included reflects the current state of compassion training for healthcare university students. In this regard, compassion and self-compassion are often integrated as specific activities in the curriculum. As described in the literature, compassion is conceptualised as a trainable skill that can be cultivated [29, 30], even when interventions are brief, limited or modular in format.

Despite the heterogeneity described, the interventions based on compassion and self-compassion were shown to produce a moderately significant effect on the self-compassion variable among university healthcare students. Similarly, several meta-analyses identified that these interventions are effective in improving self-compassion in healthcare professionals [41], in different types of patients [78–80], in the general population [79] and in university students [81]. In our systematic review, several studies included in the systematic review did not report post-intervention improvements in the self-compassion variable [72–74]. These findings warrant careful consideration and may be explained by several, non-mutually

**Fig. 7** Subgroup Analysis: Control Group Type

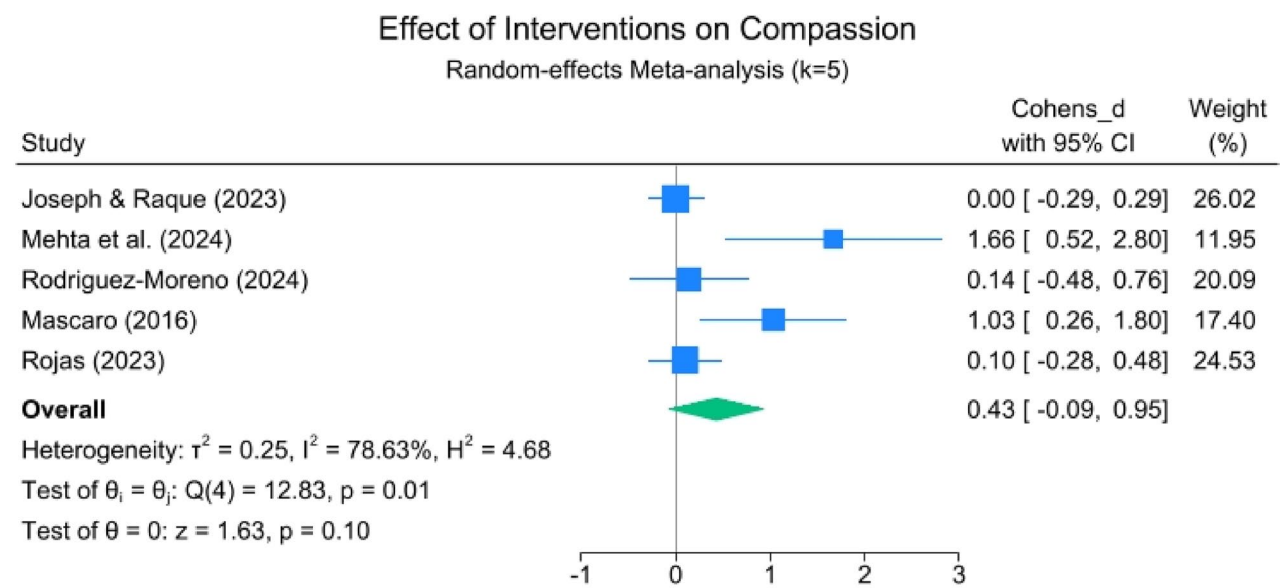
exclusive hypotheses. Boyd & Alexander [72] used LKM practice as part of their intervention, which was based on actively cultivating feelings of kindness, compassion and care towards oneself and others [82]. With regard to quantitative data, these authors identified a significant decrease in self-compassion on the SCS-SE, although there was a significant increase on the mindfulness subscale. However, in the qualitative data analysis, fourteen participants reported increased awareness, self-care and self-compassion, as well as decreased self-criticism, guilt, anger and disappointment after the intervention. These results may be due to the fact that LKM practice was introduced from the fifth week (out of a six-week

program), which may not have allowed sufficient time for changes in self-compassion to consolidate and be captured by post intervention quantitative measures. The qualitative results further suggest that change may have been occurring at an early or subjective level that was not fully reflected in standardized scales. Furthermore, the context of the COVID-19 pandemic, with its high level of academic and personal uncertainty, may have limited profound changes in self-compassion. The intervention in Kurebayashi's [74] study, which was developed by its authors, produced a non-significant increase in the SCS scale, although the mindfulness subscale significantly increased. This study describes how creating compassion

**Fig. 8** Subgroup Analysis: Academic Discipline

training programs raises many challenges because compassion is a dynamic, individualised and complex construct [17]. The intervention developed appears to activate mindfulness, but not the affective components of self-compassion (kindness toward oneself and shared humanity). This may be because process recording focuses on mistakes, weaknesses, and clinical performance, which may reinforce negative self-evaluation in

nursing students. Lastly, Joseph & Raque [73] found no statistically significant differences between groups on the variables of self-compassion and compassionate care, which is most likely linked to their main limitation of not having carried out pre-intervention measurements. Taken together, these findings suggest that brief or single-session interventions may be insufficient to produce measurable improvements in self-compassion [73, 74], in



Note: Includes converted effect size estimates for Mascaro et al. (2018) and Rojas et al. (2023).

Fig. 9 Difference of standardized means for the compassion variable

contrast to interventions lasting 6–8 weeks with regular practice, which tend to yield more consistent outcomes [56, 59, 63]. Furthermore, most participants had previous experience with meditation, reducing the likelihood of detecting significant changes after the intervention. It should also be considered that LKM emphasises directing compassion towards others, which may diminish the specific impact on self-compassion.

The meta-analysis reported that the effect size for self-compassion ($d = 0.52$) suggests that these interventions are generally effective in improving self-compassion among healthcare university students. However, when interpreting the results of the meta-analysis on self-compassion, the observed heterogeneity, which ranged from moderate to high ($I^2 = 60.29\%$), must be taken into account. First, there were substantial differences in intervention duration and intensity. Evidence suggests that longer and more intensive interventions are more likely to produce robust and stable improvements in self-compassion [56, 59, 63] which may partly explain the variability in effect sizes observed. Second, heterogeneity may be related to the type of control group employed. Danilewitz et al. [59], Martínez-Rubio et al. [60], Moore et al. [62], Póka & Barta [57] and Yang et al. [65] did not implement an intervention, whereas Bidik & Sisman [58], Hidding et al. [55], Mehta et al. [61] and Smeets et al. [64] used an active control group. Lastly, the studies by Bellosta-Batalla et al. [56] and Orosa-Duarte et al. [63] had one active control group and one which did not receive any intervention. Studies using passive control groups tended to yield larger effect sizes than those employing active control conditions, in which other factors may attenuate

between-group differences. Third, participant characteristics, particularly professional discipline (e.g., medicine, nursing, psychology, or mixed healthcare student samples), may have contributed to heterogeneity. To mitigate the heterogeneity found, subgroup analyses were performed based on sample type, duration of intervention, and type of control group. The results found regarding the duration of the intervention suggest that structured programs lasting more than one month are the ones that really drive change in self-compassion, while shorter interventions do not achieve the desired change or obtain inconsistent results. Regarding differences in the control group, programs based on cultivating compassion and/or self-compassion achieve better results in self-compassion compared to control groups that do not apply intervention and other active interventions, demonstrating that the effect is specific and not a placebo effect attributable to the intervention itself. Finally, better results were obtained in psychology and nursing students. This can be attributed to the fact that these professions tend to have a greater predisposition toward emotional concepts than the more technical and rational culture of medical students. Another contributing factor may be that nursing and psychology students undertake clinical placements early on in their training, giving them more contact with patients.

With respect to the compassion variable, the literature review only yielded six studies that measured this variable [61, 66, 73, 76, 77, 83]. Most of the studies included in our systematic review focus on measuring self-compassion rather than compassion towards others. In this regard, the study by Quaglia et al. [84] already identified

the tendency of researchers to conduct interventions based on compassion towards others, even though they are evaluated using measures focused on self-compassion. First of all, the interventions developed by Beaumont et al. [66], Rodríguez-Moreno et al. [77] and Rojas et al. [76] found significant improvements in self-compassion but not in the compassion variable. Several hypotheses may explain why these results occur. First, the primary focus of the interventions was intrapersonal rather than interpersonal. Across the three studies, most intervention components explicitly targeted self-related processes, such as reducing self-criticism, enhancing emotional regulation, cultivating a compassionate self, or coping with academic and clinical stress. For example, Beaumont et al. [66] emphasised Compassionate Mind Training techniques aimed at soothing the threat system and addressing self-criticism, while Rojas et al. [76] and Rodríguez-Moreno et al. [77] prioritised emotional awareness and self-care. Consequently, improvements may have occurred more readily in self-compassion than in compassion directed toward others, which may require more explicit relational or behavioural training. Second, high baseline levels of compassion toward others may have limited detectable change. This was explicitly noted by Beaumont et al. [66], where compassion for others scores were already high at pre-intervention, suggesting a ceiling effect. Under such conditions, quantitative instruments may lack sensitivity to capture incremental changes in compassion. Conversely, the interventions developed by Mascaro et al. [78] and Mehta et al. [61] were shown to be effective in improving compassion towards others. Despite limited evidence, a pilot meta-analysis of the compassion variable was performed, finding a marginal mean effect. As with the self-compassion variable, high heterogeneity and high variability were identified among the studies. Although the trend is positive and clinically relevant ($d = 0.43$), the extremely high variability among studies (some very effective versus others ineffective) prevents us from declaring conclusive statistical efficacy.

Therefore, results should be interpreted with caution and highlight the need for more methodologically rigorous and standardized interventions.

Limitations

The main limitation of this study is the scarcity of scientific evidence on self-compassion and compassion interventions in university healthcare students, which restricts the strength of the conclusions. Another important limitation is the high heterogeneity across studies, including differences in design, intervention formats, types, duration, outcome measures, and control conditions. In addition to heterogeneity, methodological quality and risk of bias in the included studies must be

considered when interpreting the results. Although the use of JBI critical appraisal tools allowed for a structured assessment of study quality, several important limitations were identified, such as limited randomization and lack of blinding. Also, a considerable proportion of the studies used quasi-experimental designs and small sample sizes. The frequent use of ad hoc or single-session interventions further reduces the likelihood of detecting robust and sustained effects.

In addition, the lack of post-intervention follow-up measurements means that little is known about the long-term effect of these interventions. Although some studies include follow-up assessments, the majority were short-term, typically ranging from several weeks to a few months post intervention. Consequently, the maintenance of improvements in self-compassion and compassion over long term remain uncertain. Language limits may also have restricted the inclusion of relevant studies published in non-English or non-Spanish languages. This may have led to the exclusion of relevant evidence published in other languages, introducing a potential risk of linguistic bias and limiting the overall representativeness of the findings.

In both meta-analyses, the wide variation in intervention formats and control conditions is considered a major limitation. More specifically, the number of studies included in the compassion meta-analysis was relatively small, which reduced statistical power and limited the precision of the combined effect estimates. Furthermore, compassion was conceptualised and measured heterogeneously across studies, with instruments capturing different dimensions of the construct, which may have contributed to the variability in results. Finally, although a power analysis was conducted, the lack of statistical significance observed in some pooled effects should be interpreted with caution. This finding likely reflects a Type II error associated with small sample sizes and high heterogeneity across studies, rather than a true absence of intervention efficacy. Therefore, the robustness of the pooled estimates may be limited, and these analytical considerations should be taken into account when interpreting the results.

In terms of recommendations for future research, the limited literature available highlights the need to develop new studies on the short- and long-term effects of interventions based on compassion and/or self-compassion on university healthcare students. Current findings provide only preliminary support, underscoring the importance of conducting methodologically robust trials with adequate sample sizes. Additionally, upcoming studies should use standardized measurement tools, incorporate longer follow-up periods, and report outcomes for both self-compassion and compassion to improve comparability and strengthen the evidence base.

Finally, compassion-based and/or self-compassion programs may be cautiously considered during university training, as the available literature suggest promising but still limited evidence indicating that such practice is currently lacking [35, 85]. Rather than firm recommendations, the evidence suggests that universities consider piloting or gradually integrating these training programs from undergraduate education, within the regulated curriculum of health professions [44]. In this regard, the literature tentatively suggests that implemented programs often range between 8 and 12 weeks and include individual practical exercises and face-to-face group sessions [86, 87].

Conclusions

This is the first meta-analysis to investigate the effectiveness of interventions based on compassion/self-compassion in university healthcare students. The results provide moderate and consistent evidence supporting the effectiveness of these interventions in improving self-compassion, with a significant medium effect size despite moderate heterogeneity. In contrast, the evidence for increasing compassion towards others is limited and inconclusive. Although a positive trend was observed, the small number of studies, high heterogeneity, and lack of statistical significance in the pooled analysis prevent definitive conclusions regarding efficacy for this outcome. Further high-quality, large-scale randomised controlled trials with standardised protocols are needed to strengthen the evidence base and clarify which intervention formats are most effective. Nevertheless, given that compassion and self-compassion are essential skills for future professionals, and considering the potential benefits of interventions, it is suggested that these programs be tested in undergraduate and postgraduate health education.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12909-026-08956-8>.

Additional File 1.

Additional File 2.

Authors' contributions

All authors have participated in the development of this study. R-F, MD and A-C, A conceived the study and participated in the data collection, data analysis and in writing the manuscript. A-C, T and O-G, A managed the data, created the database and participated in the data analysis. I-M, O; V-M, MI and A-C, A participated in the interpretation of the data and in writing the manuscript.

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Data availability

Data from this study can be obtained by email to the corresponding authors upon reasonable request.

Declarations

Ethics approval and consent to participate

Not applicable. This study was registered in the International Prospective Register of Systematic Reviews (PROSPERO) under CRD42024529563.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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