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RESEARCH ARTICLE

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The effectiveness of smartphone compassion training on stress among Swedish university students: A pilot randomized trial

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Abstract

Objective: To investigate the effects of a 6-week smartphone compassion training intervention on mental health.

Method: Fifty-seven Swedish university students (mean age = 25, *SD* = 5) reporting high levels of stress were randomized to compassion training ($n = 23$), mindfulness ($n = 19$), or waitlist ($n = 15$).

Result: Multilevel models indicated that both compassion and mindfulness training increased self-compassion compared to the waitlist, while only compassion significantly reduced stress. Between-group effect sizes for compassion compared to waitlist were large for both self-compassion ($d = 1.61$) and stress ($d = 0.94$). Compassion and mindfulness did not differ significantly, but effect sizes were in favor of compassion. Secondary outcomes indicated positive effects on emotional awareness, while no effect was found for global psychological distress.

Conclusions: Our results suggest that compassion training via a smartphone application can improve self-compassion and reduce stress among university students. Future studies in larger clinical samples are warranted.

KEYWORDS

eHealth, mental health, self-compassion, smartphone application, stress

1 | INTRODUCTION

Mental health problems are prevalent among adolescents and younger adults globally (Gustavson et al., 2018; Patel et al., 2007, 2018) and seem to be increasing (Brann et al., 2017), also among students attending higher education (Bayram & Bilgel, 2008; T. M. Evans et al., 2018; Huang et al., 2018). A recent report by the Public Health Agency of Sweden (2018), indicated that 17% of the Swedish population between the ages 16 and 84 experienced reduced psychological well-being, 39% were bothered by anxiety, and 16% by stress. Especially young adults between 16 and 29 reported problems with stress, 35% of women and 18% of men. There was an increase for each year and consistently higher numbers for women than men.

According to the National Union of Students in the UK, the number of students seeking mental health support while studying has increased more than 50% in 5 years. Some of the students report that "seeking help is not easy" and that there is a lot of shame attached (BBC Shared Data Unit, 2018; Galante et al., 2018).

In Sweden, similar levels of distress, anxiety, and depression are seen among students (Public Health Agency of Sweden, 2018), and an inverse correlation between mental illness and student achievement and future plans after school has been shown (Beiter et al., 2015). Attending university conveys a lot of potential stress and many students report that they experience a lot of academic pressure, that they feel lonely moving away from home, and that trying to find new friends and new tribes are all challenges that can increase self-criticism and impair well-being (Binder et al., 2019).

1.1 | Treatment gap

A recent meta-analysis based on mostly studies from the USA show high rates of self-assessed stress-related problems such as anxiety and depression among university students, and that only a small proportion receive treatment from the university health services (Regehr et al., 2013). The study also concludes that universities are challenged to institute preventive programs that are addressing stress, anxiety, and depression. When it comes to offering solutions in terms of psychological aid there are many helpful methods (Huang et al., 2018), but the increasing numbers seeking help makes it important to use new scalable technology to make the support more accessible for those in need (Price et al., 2014). In the last decades, there has been a growing interest in developing digital healthcare applications, and also to evaluate them scientifically (Andersson, Carlbring, et al., 2009; Andersson & Cuijpers, 2009; Andersson & Titov, 2014; Linardon et al., 2019; Barak, et al., 2008). In Sweden, several online healthcare services have been launched recently (Saarela et al., 2016; www.1177.se). However, while different smartphone applications are offering psychological techniques for the general public as a way to increase health, few have been tested in randomized controlled trials (Weisel et al., 2019).

1.2 | Digital training to target mental health problems in university students

Recent systematic reviews of prevention programs suggest that digital training has a moderate effect in reducing mental health problems, both group-based, online, and self-administered, in university students (McEwan et al., 2018; Rith-Najarian et al., 2019), and a meta-analysis showed that web-based psychological interventions improved well-being among university students, by reducing stress-related problems, depression, and anxiety (Davies et al., 2014).

1.3 | From web-based to app-based interventions

As technology develops, the next step after web-based interventions is mental health apps. Due to that so many of the world's population today have a smartphone, the market for applying care over the phone is huge (Hintz et al., 2015). A study by Van Ameringen et al. (2017) investigated the current state of mobile applications for disorders based on diagnostic and statistical manual of mental disorders, 5th edition categories such as anxiety, mood disorders, obsessive-compulsive disorder, and posttraumatic stress disorder. Positive aspects of using a mobile-based intervention were the potential to reach people in, for example, remote areas, easy access at times that suited participants, and also the overcoming of financial barriers that often exist in traditional healthcare. The negative aspect was the limited research on the efficacy of using the apps.

In a review by Coulon et al. (2016), 60 smartphone applications were evaluated (32 of them included evidence-based content for stress reduction) and the authors emphasize the potential in mobile health and highlight the need to distinguish evidence-based programs from others. Another review and meta-analysis by Weisel et al. (2019) conclude that standalone smartphone apps for mental health problems such as self-injury and suicidal ideation can not be recommended according to the current level of evidence. However, Firth, Torous, Nicholas, Carney, Pratap et al. (2017) found in a meta-analysis smartphone interventions to be promising tools for depression and in another meta-analysis by Firth, Torous, Nicholas, Carney, Rosenbaum et al. (2017) psychological interventions via smartphones were effective in reducing anxiety.

The need for professional help is often greater than can be met, and digital training may reach people who would not otherwise seek or receive treatment. A meta-analysis by Lindhiem et al. (2015) found that the use of mobile-based techniques as an added component in treatment or as a substitute for a clinician was overall higher on treatment outcome than without a digital solution. Similar evidence was found in a systematic review by Lee et al. (2018) regarding smartphone applications and positive health outcomes.

1.4 | Compassion

The concept of compassion has played an essential role in diverse traditions such as Greek philosophy, Buddhist psychology, and ethics, as well as contemporary moral philosophy (Fröding & Osika, 2015; White, 2017). Furthermore, the roots of compassion have been investigated and debated from evolutionary and biological perspectives (De Waal, 2010; Gilbert, 2005; Keltner, 2009; Klimecki, 2019). The Oxford English Dictionary defines Compassion as an emotional response to suffering ("Compassion," 2019) Professor Paul Gilbert; the founder of compassion focused therapy (CFT) is using the following definition "*A sensitivity to suffering in self and others with a commitment to try to alleviate and prevent it*" (Gilbert, 2010) and according to CFT compassion is a motivation that can be cultivated, as compared to Goetz et al. (2010) who define compassion as the feeling that arises in witnessing another's suffering and that motivates a subsequent desire to help.

Gilbert (2019) has suggested that compassion can be strengthened in three directions; giving compassion to others, receiving compassion from others, and self-compassion. Research indicates that it can both be described as an emotional response to negative stimuli and as an active mindset modulated by specific attributes and skills training (Goetz et al., 2010; Strauss et al., 2016). A substantial body of research demonstrate that compassion can be developed by training and that the training is associated with greater psychological well-being in both clinical and nonclinical populations (Jazaieri et al., 2013, 2014, 2018; Kirby et al., 2017; MacBeth & Gumley, 2012). Compassion training has been described to increase stress resilience, mental health, and feelings of social safety, which reduces social anxiety (Cuppage et al., 2018; Hofmann et al., 2011; MacBeth & Gumley, 2012; Trompetter et al., 2017) and to be stress-buffering (Cosley et al., 2010), also associated with positive emotions (Klimecki et al., 2013). This has been consistent in self-report measures (Kirby, 2017; MacBeth & Gumley, 2012) and is additionally supported through stress-related psychobiological responses on biomarkers such as lower sympathetic nervous

system activation, reduced inflammatory responses after induced stress, and increased parasympathetic activation, shown as, for example, increased heart rate variability (Homan & Sirois, 2017; Kim, Cunnington, et al., 2020; Kim, Parker, et al., 2020; Kirschner et al., 2019). Compassion training has also been described to be a method for stress reduction, which can be theoretically based on, for example, the generalized unsafety theory of stress, which postulates that our feeling of unsafety is actually our default mode, and constantly activates our stress response (Brosschot, 2010; Brosschot et al., 2005, 2018). To manage stress, there is, hence, a need to balance the almost continuously activated stress response by activating the "safeness system" in the body and transform self-critical and self-attacking thoughts (Gilbert, 2019).

1.5 | Self-compassion training

Directing compassion towards oneself, that is, self-compassion, is a concept that has been connected to several positive effects (Ferrari et al., 2019; Neff et al., 2018) and can by itself be understood as a stress-coping strategy. Self-compassionate individuals are less anxious, have fewer negative thoughts, focus less on negative emotions, and are less likely to generalize these events to self-critical conceptions about themselves (Allen & Leary, 2010). Self-compassion facilitates coping with negative life-events, for example, stress and disappointment related to academic failure (Neely et al., 2009; Smeets et al., 2014). Self-compassion protects against stress in these situations and is associated with well-being (Fong & Loi, 2016; Gedik, 2019). Another aspect that is relevant to psychological well-being is the difference between self-compassion and self-esteem. In a study by Neff and Vonk (2009), these two ways of psychological functioning were examined, and it was shown that self-compassion predicted more stable feelings of self-worth and less association with social comparison. Both concepts predicted the level of happiness, optimism, and positive affect. Recent research has also shown that cultivating self-compassion by recalling memories of experiences of care-seeking and care-giving decreases perceived stress (Hermanto et al., 2017). Self-compassion is applied as an emotion regulation strategy (Dundas et al., 2017; Neff & Germer, 2013) and in CFT creating a compassionate self is a way of developing self-compassion, which is also a strategy to deal with adversities, by focusing on being a certain kind of person (Gilbert & Basran, 2018).

Online compassion interventions have shown positive effects on psychological well-being in other populations than students (Donovan et al., 2016; Finlay-Jones et al., 2017; Krieger et al., 2016; Mak et al., 2019; Rodgers et al., 2018). Conclusively, prior studies indicate it is relevant to study the feasibility and effectiveness of such interventions also in a mobile application.

1.6 | Mindfulness

Mindfulness involves being present and intentionally bringing one's attention to the internal and external experience with a nonjudging attitude (Williams & Kabat-Zinn, 2013), and the most common definition of mindfulness is "the awareness that emerges through paying attention, on purpose, in the present moment, and nonjudgmentally to the unfolding of experience moment by moment."

Mindfulness-based stress reduction (MBSR) developed by John Kabat-Zinn is a method to work with stressful thoughts, emotions, and tensions in the body, with an intention to free the mind and obtain mental health and well-being, and targets negative thoughts and rumination maintaining the experience of stress via cognitive processes centering on the future and the past even though the stressors were not present (Holzel et al., 2011).

1.7 | Aims and hypotheses

The purpose of this study is to evaluate if a smartphone application consisting of a psychological program focusing on compassion training has a positive effect on self-compassion, stress, emotional awareness, and global distress among university students suffering from stress. The compassion program was compared with two control groups; an active control consisting of a mindfulness program and inactive waitlist control.

Our main research hypothesis was that both the compassion and mindfulness interventions would be more effective on the outcome measures than the waitlist.

2 | METHODS

2.1 | Design

2.1.1 | Sample

The participants were recruited in Uppsala and Stockholm via advertisements at university campuses, departments, student clubs and organizations, and student-related Facebook pages. University students studying at least 75% of full-time were included. Criteria for taking part in the study were self-reported stress-related problems and self-criticism measured by questionnaires (see measures below). The sample consisted of 39 women, 17 men, and 1 person not defined as either man or woman. It was decided before the randomization to allot more participants to the active interventions and less to the waitlist group (Dumville et al. [2006], thus, the sample was randomized ($n = 25$) to each intervention group and (n = 15) to the control group. After dropouts the distribution was; compassion training ($n = 23$), mindfulness ($n = 19$), or waitlist ($n = 15$). The randomization was conducted using an online randomization tool (www.random.org). The gender randomization became uneven by chance, with one man in the mindfulness group and three men in waitlist control, and an equal number of men and women in the compassion group. The range of age was without significant difference between groups ($p = .17$) in compassion ($M = 23.7$; $SD = 3.0$), mindfulness ($M = 25.9$; $SD = 6.0$), and waitlist ($M = 26.6$; $SD = 6.0$). Also, the number of semesters that participants had taken were without significant difference between groups ($p = .91$) in compassion ($M = 5.43$; $SD = 3.06$), mindfulness ($M = 5.05$; $SD = 3.03$), and waitlist ($M = 5.33$; $SD = 2.41$). Also, the educational level was without significant difference between groups ($p = .17$). The distribution of gender ($p = .004$) was significant between the groups.

2.1.2 | Procedure

The first data collection (pre-intervention) was carried out at Uppsala University for approximately 2 h. After randomization, the three groups (compassion, mindfulness, and waitlist) were then given the same instructions before filling in the questionnaires and were kept unaware of which intervention group they had been assigned to until after completion of questionnaires. The questionnaire sheet included an informed consent form, a demographic questionnaire, primary and secondary outcome measures (see further below), and took 20–40 min to complete.

After the assessment, the waitlist participants were informed of their role for the upcoming 6 weeks and that they would be given access to both smartphone applications 6 weeks later when they returned for the second data collection. The participants that had been assigned to either compassion or mindfulness got a brief introduction to the application and information about intended usage and were then guided through the downloading process.

The primary outcome measures stress and self-compassion were also assessed at 2 and 4 weeks into the program using a digital survey, created with survey monkey, which was sent out to all participants via email. The participant registered with the help of their unique participant code and the survey took approximately 10 min to complete. The last postintervention evaluation took place at the campus for all participants and included the same five questionnaires that they had filled out 6 weeks prior.

2.1.3 | Interventions

The Compassion Mindset intervention (developed by first author Christina Andersson) is based on neuroscience, cognitive behavioral therapy, psychodynamic therapy, affect theory, attachment theory, and contemplative traditions as mindfulness and loving-kindness meditation (Gilbert, 2010, Kirby et al., 2017; Neff & Germer, 2013, Seppelä et al., 2017). It is a secular, structured, and comprehensive program for training in compassion, emotion awareness, emotion regulation, and stress resilience and consists of six modules—one for each week of the program. The themes for the six modules were (1) what is compassion, (2) Gilberts three-circle model of affect regulation (Gilbert, 2010), (3) self-compassion, (4) compassion mindset (developing qualities of compassion) (5) giving compassion to others, and (6) gratitude and wisdom. Each module includes five main components: a theoretical background, guided meditations, reflective exercises, breathing exercises, and practical exercises to encourage implementing a compassionate attitude in daily life. Participants were encouraged to use the program for 10–15 min per day, for 6 weeks. Adherence analysis showed that there was a considerable variation between participants, from using the application every other day (25%) and two times a week (30%).

The Mindfulness App (developed by Mindapps Ltd.). The program included a 7-day introductory course to mindfulness, followed by self-administered practice of 5 weeks using six guided meditations, breathing exercises, and body scans. The participants were also recommended an additional 15 exercises in case they felt they needed more variation. The mindfulness training was self-administered, and the participants were recommended to use the program for 10–15 min each day, for 6 weeks. To make The Mindfulness App more comparable to the compassion mindset with regard to content and structure, the participants in the mindfulness group were also given an information folder as a complement to the application. The folder was developed by co-authors Kajsa Norback and Karin Rask and included the concept of mindfulness, how one can practice mindfulness, and how much training might be helpful for dealing with stressors of everyday life. It also included some advice on how to counter possible challenges of training in mindfulness, outlined the program, and had a page for written personal reflections. Adherence analysis from using the application every other day was 26% and two times a week 10%.

2.1.4 | Primary outcome measures

Self-Compassion Scale-Short Form (SCS-SF; Neff, 2003). This scale comprises 12 items, all rated on a 5-point Likert scale (1 = *Almost never*, 5 = *Almost always*), resulting in a minimum score of 12 and a maximum score of 60. This short-form scale has demonstrated good internal consistency (Cronbach's $\alpha = .86$) and a near-perfect correlation with the long-form (Raes et al., 2011). The Swedish version of the short form used in this study was translated by B. Strömberg (2012) and has in a study by Wallin and Wennlund (2014) demonstrated good internal consistency (Cronbach's $\alpha = .90$). Reliability in the current sample varied between 0.61 and 0.83 across assessment points.

Perceived Stress Scale (PSS-10; Cohen & Williamson, 1988). PSS-10 is a 10 items version of the original PSS-14, a widely used instrument to assess perceived stress. The scale consists of questions regarding thoughts and feelings over the last month, rated on a 5-point Likert scale (0 = *Never*, 4 = *Very often*). The maximum total score is 40, the minimum total score is 0. The Swedish translation used here has been developed by Eskin and Parr (1996)

and has in a study by Nordin and Nordin (2013) demonstrated good internal consistency (Cronbach's $\alpha = .84$). Reliability across assessment points in the current sample varied between 0.86 and 0.91.

2.1.5 | Secondary outcome measures

Toronto Alexithymia Scale (TAS-20; Parker et al., 2003). TAS-20 assesses alexithymia or emotion awareness and is comprised of three subscales (1) difficulties identifying feelings, (2) difficulties describing feelings to others, and (3) externally oriented thinking, that is, a preoccupation of external events rather than internal. It includes 20 items, some reversed and rated on a 5-point Likert scale resulting in a maximal total score of 100 and a minimum total score of 20. The Swedish translation used in this study has shown good internal consistency (Cronbach's $\alpha = .83$) and the three-factor model of alexithymia has demonstrated successful replicability in a Swedish sample of undergraduate students (Simonsson-Sarnecki et al., 2000). Reliability across assessment points in the current sample varied between 0.84 and 0.87.

Clinical outcomes in routine evaluation-outcome measure (CORE-OM; Evans et al., 2000). This scale aims to measure psychological problems using 34-items that cover four domains: (1) well-being, (2) symptoms, (3) functioning, and (4) risk. It takes 5–10 min to complete. The questions are about how they have been feeling over the last week and are rated on a 5-point Likert scale (0 = *not at all*, 4 = *most or all of the time*). Some items are reversed. Scores below 10 are considered in the clinical range and higher scores are associated with severe mental health. Internal consistency measured using the total scale on a nonclinical population was Cronbach's $\alpha = .94$ (Evans et al., 2002) and test–retest is good ($r = .90$). The Swedish version of the scale used in this study has a high internal consistency (Cronbach's $\alpha = .93$) and test–retest reliability ($r = .85$) (Elfström et al., 2012). Reliability across assessment points in the current sample varied between 0.93 and 0.93.

2.1.6 | Ethical considerations

The study has been approved by the Swedish Ethical Review Board in Stockholm (Dnr: 2013/1532-31/3). Data were handled with confidentiality, was anonymously coded, and all results presented on a group level. All participants provided informed consent and were informed that their participation was voluntary and that they could choose to terminate participation at any time, without stating a cause.

2.2 | Statistical analyses

Because the primary outcomes (i.e., SCS-SF and PSS-10) were assessed at four time points, we applied multilevel growth models (MLM; Singer & Willett, 2003) to test if change rates over time differed as a function of group allocation. Compared to traditional data analytic approaches, MLM provides advantages when analyzing repeated-measures data from randomized between-group designs (Hesser, 2015), including appropriate and flexible handling of dependence among observations, the possibility to model individual heterogeneity and nonlinear trajectories over time, as well as making use of all information available to provide accurate estimates under fairly unrestrictive missing data assumptions, and, thus, optimizing statistical power.

Model building started with estimating basic time models which included random effects for intercept and slope, as well as a fixed effect of time. Time was coded 0 for the baseline assessment, 2 for the assessment at Week 2, 4 for the assessment at Week 4, and 6 for the termination score. Next, we added a quadratic term (i.e., time × time) to test for possible nonlinearity in trajectories over time. This term proved significant as the main

effect and improved model fit for both measures (i.e., >2 reductions in Akaike's information criterion); thus, we decided to keep it. However, we discarded the quadratic term as a random effect since models did not converge.

To test if change rates in the active treatment groups differed from the Waitlist control, we entered two dichotomous (i.e., "dummy-coded") variables to the basic time-models. In the first variable, the waitlist and mindfulness groups were set to 0 and the compassion interventions were coded 1. In the second variable, waitlist and compassion were set to 0, and mindfulness was coded 1. These variables were entered simultaneously as both fixed effects and in interaction with time. This provides a model that treats the waitlist condition as a reference group and tests if change rates in the compassion and mindfulness groups differ from the waitlist control. To test for differences between the compassion and mindfulness groups, a second model was estimated using compassion as the reference group. An unstructured covariance structure was assumed in all models.

The MLM analyses were conducted according to the intention-to-treat principle, that is, all randomized participants were included, and models were estimated on all available data, using maximum likelihood estimation. This type of estimation provides unbiased estimates under the less restrictive assumption that missing data are missing at random (MAR; Enders, 2011; Little & Rubin, 2002). MAR allows the probability of missing data to be dependent on any observed or unobserved variable (e.g., initial symptom level), but not on the would-be score at the point of missingness. In total, 14.5% of the data was missing for SCS-SF (0%, 8.7%, 26.3%, and 21.1% across assessment points) and 14.0% for PSS-10 (0%, 24.6%, 7%, and 21.1%). While it is impossible to directly test if MAR holds, missing data were fairly low and unrelated to sex, age, initial symptom levels, and group allocation (all $p > .09$). Hence, we assumed MAR for our MLM calculations.

Secondary outcome variables (i.e., TAS-20 and CORE-OM) were assessed prepost and we, therefore, applied analysis of covariance (ANCOVA) to test for group differences at termination. Thus, scores at Week 6 were used as dependent variables, group allocation as the independent variable and baseline scores as a covariate. Baseline scores did not differ between groups on any measure (all $p > .636$) and the homogeneity of regression slopes assumption was met (all $p > .202$). Pairwise post hoc comparisons were based on estimated marginal means using Bonferroni correction. Since analyses of secondary outcomes were conducted on the completer sample (i.e., using listwise deletion) we also conducted sensitivity analyses using last observation carried forward (LOCF) imputation of missing data.

Between-group effect sizes (Cohen's *d*) for the primary outcome measures were calculated using model estimated means at termination and observed baseline *SD* for the whole sample as recommended by Feingold (2009). For the secondary outcome measures, we used the observed means at termination (i.e., completer data). We followed established conventions in the field and considered between-groups effect sizes of ≥0.20 as small, ≥0.50 as a medium, and ≥0.80 as large (Cohen, 1992). The primary significance level was set to $p < .05$ and all statistical calculations were performed with the SPSS (v. 21) software package.

3 | RESULTS

3.1 | Primary outcomes

Descriptive statistics are displayed in Table 1 and the result of our MLM estimations for SCS-SF and PSS-10 in Table 2. The model Intercept represents the average baseline score in the waitlist control group. The baseline estimates for compassion and mindfulness represents group differences at baseline, which were nonsignificant for both SCS-SF and PSS-10.

The slope estimate represents the average change per time unit in the waitlist group and the time × time estimate adjusts for the overall nonlinearity in trajectories over time. The slope estimates for compassion and mindfulness represent the added change rate for each group compared to the waitlist control. For SCS-SF, these were significant for both compassion (estimate = 1.28, 95% confidence interval [CI, 0.81, 1.96], $p < .001$) and

TABLE 1 Descriptive statistics for primary outcomes

	Groups					
	Waitlist		Compassion		Mindfulness	
	n	*M* (*SD*)	*n*	*M* (*SD*)	*n*	*M* (*SD*)
SCS-SF						
Baseline	15	28.4 (6.3)	23	29.3 (7.5)	19	27.9 (7.3)
Week 2	14	32.6 (4.3)	21	33.8 (5.2)	17	34.1 (4.9)
Week 4	13	29.0 (4.3)	14	38.5 (7.7)	15	35.8 (7.2)
Termination	15	29.3 (6.3)	16	37.7 (7.7)	14	34.8 (7.2)
PSS-10						
Baseline	15	22.4 (6.7)	23	21.7 (5.8)	19	22.8 (5.8)
Week 2	14	20.6 (7.8)	14	15.7 (5.5)	15	16.7 (4.9)
Week 4	14	21.5 (7.4)	21	17.3 (5.1)	18	19.3 (5.1)
Termination	15	20.3 (6.8)	16	15.0 (4.8)	14	17.0 (6.5)

Abbreviations: PSS-10, Perceived Stress Scale; SCS-SF, Self-Compassion Scale-Short Form.

mindfulness (estimate = 1.04, 95% CI [0.45, 1.63], $p = .001$), indicating that the increase of self-compassion was stronger in both groups compared to the waitlist control. For PSS-10, we observed a significant slope estimate for compassion (estimate = –0.61, 95% CI [–1.17, –0.07], $p = .027$), but not for mindfulness (estimate = –0.53, 95% CI [–1.09, 0.02], $p = .058$), thus, only the compassion group had significantly steeper stress reduction compared to the waitlist. Comparing mindfulness with the compassion group as reference, we found no significant differences in

TABLE 2 Multilevel growth models estimating changes over time in primary outcome measures

	Measures	
	SCS-SF	PSS-10
Baseline score		
Intercept	28.78***	22.73***
Compassion	0.24	–1.20
Mindfulness	–0.72	0.02
Rate of change		
Slope	2.33	–1.61***
Time × time	–0.39***	0.21***
Compassion	1.28***	–0.61*
Mindfulness	1.04**	–0.53
Variance components		
Residual variance	8.65***	8.98***
Intercept	30.81***	29.29***
Slope	0.22	0.13
Correlation	–.06	–.08

Abbreviations: PSS-10, Perceived Stress Scale; SCS-SF, Self-Compassion Scale-Short Form.

***$p < .001$.

**$p < .01$.

*$p < .05$.

change rates for either SCS-SF (estimate = −0.33, 95% CI [−0.91, 0.23], $p = .237$) or PSS-10 (estimate = 0.07, 95% CI [−0.46, 0.61], $p = .280$). The model estimated group trajectories for SCS-SF and PSS-10 are displayed in Figures 1 and 2.

Calculation of between-group effect sizes at termination indicated that compassion had a large effect on both SCS-FS ($d = 1.61$, 95% CI [0.91, 2.31]) and PSS-10 ($d = 0.94$, 95% CI [0.30, 1.58]) compared to the waitlist control. The effect for mindfulness compared to the waitlist was large for SCS-SF ($d = 1.04$, 95% CI [0.32, 1.76]) and medium for PSS-10 ($d = 0.62$, 95% CI [−0.03, 1.27]). The effect for compassion compared to mindfulness was medium on SCS-SF ($d = 0.56$, 95% CI [−0.05, 1.19]) and small on PSS-10 ($d = 0.32$, 95% CI [−0.29, 0.93]).

3.2 | Secondary outcomes

Descriptive statistics and results for the secondary outcomes are displayed in Table 3. The ANCOVA calculations indicated significant group differences in mean termination score on emotion awareness (TAS-20, $F = 8.222$, $p = .001$), but not on global psychological distress (CORE-OM, $F = 1.542$, $p = .227$). These results were repeated in the data set with LOCF imputation (TAS-20, $F = 4.434$, $p = .017$; CORE-OM, $F = 0.204$, $p = .816$).

Pairwise post hoc comparisons based on estimated marginal means indicated that both compassion (mean difference = 6.841, $p = .001$) and The Mindfulness group (mean difference = 4.752, $p = .030$) differed significantly from waitlist. However, differences between compassion and mindfulness were nonsignificant (mean diffdifference = −2.089, $p = .718$). Between-group effect sizes and confidence intervals are displayed in Table 3.

4 | DISCUSSION

In this pilot randomized trial, a compassion intervention delivered via a smartphone application was compared to a mindfulness intervention and a waitlist control group in a university student sample experiencing stress and self-criticism. Both active interventions increased self-compassion, but only students in the compassion intervention

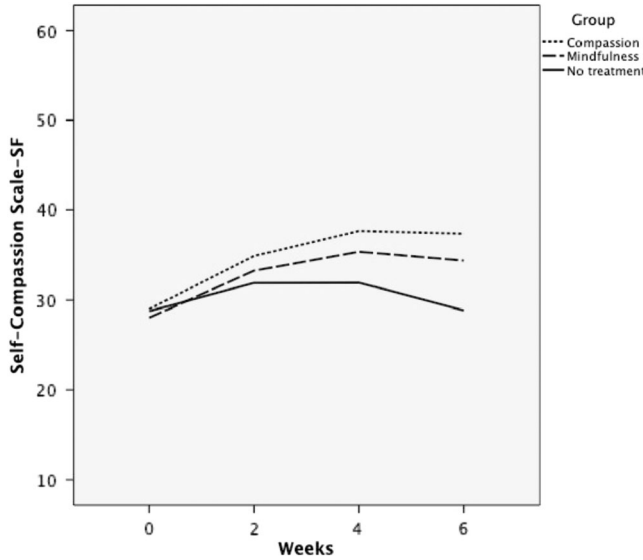

FIGURE 1 Model predicted group trajectories for the increase in self-compassion over time. SF, Short Form

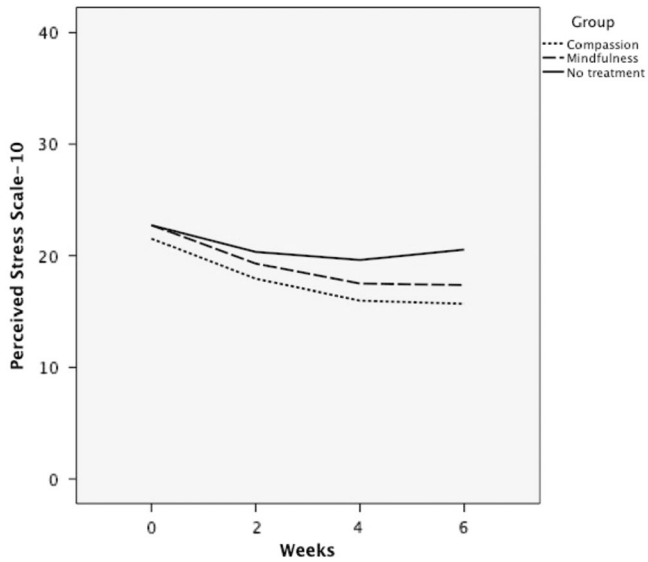

FIGURE 2 Model predicted group trajectories for the reduction in stress over time

had a significant stress reduction compared to the waitlist control. Our reflection regarding the larger effect size in the compassion sample is that mindful attention to inner states of suffering is a prerequisite for compassion, and along with the encouragement of a calm and non-judgemental attitude towards one's feelings.

On secondary outcome measures, similar results with a significant increase in emotional awareness for both active interventions compared to the control group were found, with effect sizes in favor of compassion. We choose mindfulness as an active control group to see if the aspect of warmth and kindness with an intention to be helpful would be of favor in the compassion group on emotional awareness. Although nonsignificant, a small effect size on global psychological distress suggests compassion may be more effective than mindfulness.

Our results for the mindfulness and compassion training are in line with previous research on both online mindfulness interventions and compassion interventions. Mindfulness interventions have shown a moderate effect size on stress reduction ($g = 0.51$; Spijkerman et al., 2016) and reductions in alexithymia (Norman et al., 2019).

Mental health problems among university students are well-known, and one aspect of finding suitable solutions to target the problems is to use a method that is geared towards (and easy to integrate into) everyday life. Most of the evidence-based online psychological programs that are available have not yet become accessible via mobile phone-based applications. This study tested if a mobile application can be effective as a tool for increasing psychological health and decreasing mental ill-health by combining various skills training. We created an app based on established compassion interventions (Kirby et al., 2017; Seppelä et al., 2017) and included theory and exercises for the students to do when convenient, instead of having to leave, for example, a lecture to join a group session. A systematic review of prevention programs targeting depression, anxiety, and stress in university students (Rith-Najarian et al., 2019) concluded that elements that had a strong positive effect were psychoeducation, relaxation, and cognitive restructuring, which is in line with the content of the compassion program in the current study.

One of the aims of this study was to evaluate if a digital psychological intervention containing different elements as breathing exercises, reflection practice, and guided imagery to cope with stress, difficult feelings, and self-criticism would be effective. The results of this study confirm that it has a significant effect on stress and self-compassion. In clinical psychology, many digital methods have been suggested to be effective but there is still limited evidence, especially based on randomized controlled trials (Nunes et al., 2020).

TABLE 3 Statistics and effect sizes for secondary outcome measures

	Groups								Between-group effect sizes[b]		
	Waitlist		Compassion		Mindfulness		ANCOVA[a]				
Measures	*n*	*M* (*SD*)	*n*	*M* (*SD*)	*n*	*M* (*SD*)	*F*	*p*	Comp versus wait (95% CI)	Mind versus wait (95% CI)	Comp versus mind (95% CI)
TAS-20											
Baseline	15	50.4 (11.8)	23	47.8 (12.1)	17	48.0 (12.4)			0.84[c]	0.43[c]	0.39
Termination	15	50.7 (11.8)	16	40.7 (7.6)	14	45.5 (10.3)	8.222	.001	(0.10, 1.57)	(−0.31, 1.17)	(−0.33, 1.12)
CORE-OM											
Baseline	14	1.4 (0.5)	22	1.3 (0.6)	18	1.4 (0.6)			0.89	0.54	0.40
Termination	14	1.3 (0.5)	15	0.8 (0.4)	14	1.0 (0.5)	1.542	.227	(0.19, 1.59)	(−0.21, 1.30)	(−0.34, 1.13)

Abbreviations: ANCOVA, analysis of covariance; CI, confidence interval; CORE-OM, clinical outcomes in routine evaluation-outcome measure; DERS-16, Difficulties in Emotion Regulation Scale; TAS-20, Toronto Alexithymia Scale.

[a]With one covariate (baseline score).

[b]Cohen's *d* calculated on observed values at termination.

[c]Pairwise post hoc test based on estimated marginal means significant ($p < .05$).

Still, while global psychological distress as measured by the CORE-OM scale was reduced in both interventions, the changes did not reach statistical significance. One reason could be the small sample size. Also, changes in global psychological distress may not be expected to be large in this nonclinical group of students (Elfström et al., 2013). Future studies should focus on evaluating the compassion application in clinical samples.

Few studies have been conducted with an active control group, and, therefore, it has been difficult to state the active components of compassion. The compassion intervention contains the three flows of compassion: self-compassion, receiving compassion, and giving compassion. The mindfulness intervention was influenced and contained techniques from a well-known researched mindfulness program (MBSR) and contains mindfulness techniques such as body scans, awareness, and breathing exercises. From an ethical point of view, it is important to give the control group a program that has in prior studies shown positive results on mental health (Cavanagh et al., 2014; Møller et al., 2019; Neff & Dahm, 2014) and a recent study by Brito-Pons et al. (2018) compared a compassion intervention with a mindfulness intervention and passive control and found a higher effect size (d = 1.12) on self-compassion in the compassion intervention.

4.1 | Limitations

Some limitations apply. The first and most important is the small sample, which limits the conclusions that can be drawn. While effects on stress and emotional regulation were significant for compassion in comparison with the waitlist, the confidence intervals are wide due to the low power. Thus, the magnitude of the effects should be interpreted with caution. Second, the recruitment strategy raises the possibility of self-selection bias (i.e., volunteering and motivation for time investment and for self-compassionate persons). This, and the fact that our participants tended to have high levels of education (presumably with good language skill and self-discipline) relative to the general public, raise questions on generalizability. It is also a common finding in internet-based psychological studies that highly educated women are especially prone to apply for guided web-based self-help interventions, and it could be considered an act of self-compassion to participate in a study like this. Third, although we standardized the interventions to make them equivalent, the format of the interventions differed somewhat between treatments. We are aware that the interventions mindfulness and compassion are similar in the aspect that mindfulness is part of the compassion cultivation but this overlap was expected. Fourth, the use of the app was quite low, on average two times a week although the recommendation was 10 min per day. Despite relatively low usage, the result shows a positive effect even with such a small dose, which supports the use of this kind of psychological intervention. Fifth, because of the uneven gender distribution, it is not possible to analyze the difference between gender on using the apps. Sixth, the SCS-SF, which has good internal consistency was used in this study (Raes et al., 2011). However, it is not recommended to use the SCS-SF for measurements on subscale levels, and the SCS-SF does not allow differentiation between the negative versus the positive spectrum of self-compassion changes (Muris & Petrocchi, 2016).

Lastly, there was no long-term follow-up, which would be recommended in future studies, which in turn can clarify the dose response of using the app if the amount of 2–3 times a week, in the beginning, is enough and make the user use it over a longer time period and the effects on the outcome measures.

5 | CONCLUSION

Taken together, results from the current study are encouraging and suggest that compassion training via a smartphone application may be beneficial for university students with stress-related problems and self-criticism. As the development turns towards technology-based treatments in healthcare, there is a need to find a sustainable way to use the methodology. It would be interesting to conduct future studies with more participants due to the

limited power in this study by applying a longer and more flexible recruiting period, recruit from more universities, and also test this program in clinical populations, for example, in primary care settings. It would also be of interest to add reminders and push notifications and guided features to nudge the participants to practice. This has then to be done with caution in order to not stress the user, which could confer the opposite effect.

In addition, it would be interesting to examine if the different directions of the flow of compassion would benefit different persons. For example, which of the flows of receiving, giving, or self-compassion is better to start with, and could any parameters be highlighted to show which directions have an impact on various outcome measures? Using the compassion mindset training app could also serve as a preventive program and a source to develop positive mental health. Conclusively, from a public health, and equality perspective, digital compassion training is a promising alternative, worthy of further scientific evaluation.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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