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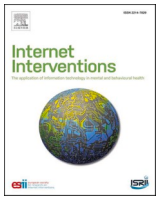

Efficacy of the internet-based intervention "Cultivating our resilience" (CORE) for improving resilience and coping strategies in university students: A randomized controlled trial

Rocio Herrero [a,b], Marvin Franke [c,d], Dennis Görlich [e], Azucena Garcia-Palacios [b,f], Rosa Baños [b,g,*], Corinna Jacobi [h], Thomas Berger [i], Michael P. Schaub [j], Tobias Krieger [i], David D. Ebert [d], Cristina Botella [b,f]

[a] University of Zaragoza, Teruel, Spain
[b] CIBER Pathophysiology of Obesity and Nutrition (CB06/03), Carlos III Institute of Health, Madrid, Spain
[c] Friedrich-Alexander-University Erlangen-, Nuremberg, Germany
[d] Technical University of Munich, Munich, Germany
[e] Universität Münster, Münster, Germany
[f] University Jaume I, Castellon, Spain
[g] University of Valencia, Valencia, Spain
[h] TU Dresden, Dresden, Germany
[i] University of Bern, Bern, Switzerland
[j] University of Zurich, Zurich, Switzerland

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ABSTRACT

The college stage is marked by high prevalence of mental disorders, particularly anxiety, low mood, and substance abuse. Despite this, many affected students do not receive treatment, underscoring the need for preventive strategies. In respose, the CORE program, an internet-based intervention, was developed to enhance resilience and coping skills among college students. The present study, part of the ICare project (EU-634757), aims to assess the effectiveness of the CORE intervention in improving resilience and reducing symptoms of anxiety and depression in comparison to a Waiting List (WL) condition. The study was registered at ISRCTN (ISRCTN13856522).

In the study the unguided internet-based intervention (CORE) was compared to a WL control group in a multicenter two-arm, single-blind, randomized controlled trial (RCT) conducted in Spain, Germany, and Switzerland. Questionnaire based evaluations occurred at baseline (BL), 8 weeks (post-intervention), 6 and 12 months after randomization. A total of 493 students with low levels of resilience participated in the study.

Participants in the intervention group gained access to an internet-based program aiming to enhance resilience by learning to cope with stressors in daily life, promote self-empowerment, and improve well-being. Participants were instructed to engage in six interactive modules delivered weekly in a sequential order. The program's therapeutic content was developed following the Ryff model of well-being.

The primary outcome measure used was the Connor-Davidson Resilience Scale (CD-RISC-25). Additionally, anxiety and depressive symptomatology, coping strategies, and well-being were measured. Participants in the CORE condition reported a significant increase in resilience compared to WL condition (Differences post-BL: d = 0.34, p = .0005; 6 M-BL: d = 0.24, p = .0171; 12 M-BL: d = 0.33, p = .0031). Although, a general time trend towards improvement in the resilience was observed in both groups. Participants in the CORE condition, compared to those in the WL condition, showed a significant reduction in anxiety symptoms in the short and long term (differences post-BL: d = 0.30, p = .0015; 6 M-BL: d = 0.18, p = .0857; 12 M-BL: d = 0.23, p = .0312) and depression in the short term. Furthermore, participants in CORE condition showed a significant improvement in positive functioning measurements, such as well-being and self-compassion compared to WL condition. (Differences post-BL: d = 0.25, p = .0123; 6 M-BL: d = 0.16, p = .1505; 12 M-BL: d = 0.13, p = .1835).

Adherence to fully complete the intervention was approximately 59 %.

* Corresponding author at: CIBER Pathophysiology of Obesity and Nutrition (CB06/03), Carlos III Institute of Health, Madrid, Spain.
E-mail address: banos@uv.es (R. Baños).

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In conclusion, our study revealed promising outcomes for the CORE program, indicating its efficacy. These results position the CORE program as a valuable and validated tool in fostering resilience, offering promising ways for addressing mental health challenges in academic settings.

1. Introduction

University students face several stressors, including academic pressure, financial burdens, and social adjustment, which make them particularly vulnerable to mental health problems. The prevalence of mental disorders is particularly pervasive among these population, with a prevalence rates ranging from 20 % to 45 % (Auerbach et al., 2016; Bruffaerts et al., 2018). Anxiety, low mood, and substance use disorders are the most prevalent mental disorders (Auerbach et al., 2016; Ebert et al., 2019). Compounding the issue, research indicates that the majority mental disorders have their initial onset in this stage of early adulthood (Dagani et al., 2019).

These disorders are strongly associated with a diminished quality of life and an increased vulnerability to other mental problems (Mihalopoulos et al., 2011). The negative effects of suffering from a mental disorder are enduring and related to poor academic performance, college dropout, and future functional impairment (Harrer et al., 2018; Williams et al., 2015).

Despite the high prevalence of mental disorders in college students, only 6.7–23.1 % of college students receive treatment (Auerbach et al., 2016). Barriers, such as fear of stigmatization, or the downplaying of stress as part of college lifestyle, can explain, in part, this to low levels of help-seeking behaviours (Ebert et al., 2019).

Considering the elevated risk of mental disorders in the university population and the low level of help-seeking, there is growing demand for effective and early interventions that prevent the onset of different disorders (Dagani et al., 2019; Duffy et al., 2019). In this regard, an approach centered on promoting wellbeing and resilience could be attractive for college students and can help to tackle these challenges by providing individuals with coping strategies and adaptive skills (Bolier and Abello, 2014).

Resilience interventions are designed to provide individuals with coping strategies and adaptive skills to better manage stressors. These interventions are, grounded in principles retrieved from cognitive-behavioral therapy, acceptance and commitment therapy, mindfulness-based therapy, and problem-solving therapy. Previous systematic reviews and meta-analyses demonstrated the positive impact of these interventions on various mental health outcomes, as well as modest improvements in resilience across both clinical and non-clinical populations (Díaz-García et al., 2021; Joyce et al., 2018; Leppin et al., 2014; Macedo et al., 2014; Robertson et al., 2015; Vanhove et al., 2016), employing a variety of formats (i.e. self-guided, computer-based, individual sessions, group sessions) and settings (i.e. industrial, universities, schools, hospitals).

Focusing specifically on interventions targeting college students, the meta-analysis conducted by Abulfaraj et al. (2024) showed that resilience interventions effectively reduce anxiety and stress. However, there is limited evidence regarding their impact on depression and resilience itself. They concluded that more rigorous studies are needed in the field. In addition, Díaz-García et al. (2021) highlighted several theoretical and methodological deficiencies in the field (e.g. targeting resilience and not having a proper resilience measure in the study) which emphasize the need of further research to address these gaps.

To effectively promote mental health, interventions should be easily available and affordable. The internet can be a tool to achieve this goal. This technology allows people to access to interventions at a low cost, from any location, and with minimal or without support from a healthcare professional (Ashford et al., 2016; Kazdin, 2017; WHO, 2019). In addition, as the global internet use is rising, especially among young people, the internet is positioned as a tool that can help to implement scalable mental health solutions (Baños et al., 2017). Several reviews and meta-analyses suggested that Internet-based programs can be as effective as traditional face-to-face interventions for a variety of mental health disorders, such as depression, anxiety, adjustment disorders, grief, and also for the prevention of mental health disorders (Andersson et al., 2019; Andrews et al., 2018; Dworschak et al., 2022). Furthermore, studies showed that these interventions are feasible, acceptable and effective across different populations (Ebert et al., 2015; Heber et al., 2017; Gentili et al., 2022).

Interventions focusing on enhancing resilience can benefit from the online format to reach a larger proportion of the target population effectively. Previous research provided initial support for the efficacy of internet-delivered resilience interventions (Aikens et al., 2014; Bekki et al., 2013; Enrique Roig et al., 2020; Rose et al., 2013). However, notwithstanding potential benefits, further studies are needed to explore the effects of online resilience training in more depth (Abbott et al., 2008; Díaz-García et al., 2021; Joyce et al., 2018; Rose et al., 2013). Thus, the objective of the current study is to evaluate the efficacy of a program: CORE, based on the Ryff's model (2014) compared to a waiting list (WL) control group, in the improvement of resilience and the reduction of anxiety and depressive symptomatology among university students.

The Ryff model is a well-established framework that identifies six dimensions of psychological well-being (Ryff, 1989, 2014). Research has demonstrated that these dimensions offer a comprehensive approach to understand how people can thrive, even under adverse circumstances, and are associated with better mental health outcomes, increased life satisfaction, and resilience (Ryff, 2014; van Dierendonck and Lam, 2022). By targeting these elements, the CORE program aims to enhance students' ability to cope with stress, fostering greater resilience and promoting well-being.

2. Methods

2.1. Objective

The ICare CORE trial was designed and conducted to assess the efficacy of the CORE online intervention to increase resilience and coping skills among university students.

2.2. Study design

A multicenter two-armed randomized controlled trial (RCT) was conducted in Spain (Spanish group), as well as Germany, Switzerland, and Austria (German group). Repeated measurements were assessed at baseline, 4 weeks, 8 weeks (post-intervention), 6 months, and 12 months after randomization. An unguided internet-based intervention for enhancing resilience (CORE) was compared to a waiting list condition (WL) as described below.

The study was registered at the ISRCTN registry (ISRCTN13856522) and the DRKS German Clinical Trials Register (DRKS00011265). The reporting followed the CONSORT Statement (Moher et al., 2010), the CONSORT-EHEALTH guidelines (Eysenbach and CONSORT-EHEALTH Group, 2011), and the SPIRIT statement (Chan et al., 2013).

The study protocol was published in Herrero et al. (2019). In divergence to the proposed methods after trial commencement, eligibility criteria were adapted during the trial. In addition to first-year students, advanced year students were recruited to reach the recruitment aims. Last, the original design allocated participants to CORE or Care-as-Usual condition. However, as the participating universities did

not have student support programs, the comparison condition was reclassified as a waiting-list control group (WL).

2.3. Eligibility criteria

To participate in the study, interested students must: 1) have been enrolled university students with a score one standard deviation below the mean on the Connor-Davidson Resilience Scale (CD-RISC-25 score < 63; Allan et al., 2014); 2) with an adequate knowledge to understand and read Spanish or German (depending on study site); and 3) have had access to the Internet, and the ability to use a computer.

Interested students were excluded when they 1) had a history of common mental health disorders (NICE, 2011; Auerbach et al., 2018) in the past 12 months; 2) were currently or had been in psychotherapeutic treatment in the past 12 months or were on a waiting list for psychotherapy; 3) had a current or history of psychotic or bipolar disorder; 4) were at risk for suicide (indicated by the suicidal item on the Patient Health Questionnaire - PHQ-9 ≥1).

2.4. Ethics

The study was approved by the Ethics Committee of the University of Valencia (H1474291677268) and the University Jaume I, received the declaration of no objection from the Ethics Committee of the Canton of Zurich (Req2016–00443) and was approved by the Ethics Committee of the University of Erlangen (215_16 B).

2.5. Recruitment and procedure

This study was part of ICare (EU-634757), a European project whose goal was to develop an integrated health promotion model for the most prevalent disorders in Europe.

During the recruitment phase, the universities' websites (Universitat Jaume I and Universitat of Valencia, Spain; Universität Bern and Universität Zürich, Switzerland; Technische Universität Dresden, Germany) were used as distribution channels. Additionally, in Germany, the study was promoted via the StudiCare network (https://www.studicare.com/studicare-universitaeten), which reached out to students of 20 universities in German-speaking countries. In Spain, the study was also promoted via flyers and an e-mail newsletter to the whole community of the University of Valencia, and the University Jaume I. Moreover, the study's information was disseminated in regional newspapers in the Valencia area.

Interested students received a welcome e-mail where they were asked to sign the informed consent form and answer the screening questionnaire subsequently. After, participants were randomized to one of the study arms. Participants who reported a current or past diagnosis of anxiety or depressive disorders were excluded from the study and referred to specialized mental health services.

2.6. Randomization

Participants were randomly assigned using an online randomization tool in a 1:1 ratio. The used tool was adapted from a locally developed software for the trials conducted in the ICare project. Internal validation of correct assignment of precomputed randomization lists was performed before usage. For the CORE trial a stratified block randomization was applied with a fixed block length. Randomization lists were precomputed and uploaded to the randomization platform. A stratification by study site was introduced using two separate randomization lists, which ensured the balancing of groups within country groups. Block length was confidential, and the online platform provided allocation concealment, i.e., study personnel had access to the randomization function at all times with only access to randomization results of already randomized participants. The randomization results (study arm) was used by study personnel to assign the correct content in the intervention platform.

2.7. Interventions

2.7.1. CORE condition

Participants in the intervention group received access to an internet-based prevention program aiming to teach skills and strategies to enhance resilience by learning to cope with stressors in daily life, promoting self-empowerment, and increasing well-being. The intervention was initially written in English, and reviewed by the German and Spanish teams. Each site translated the intervention into their respective languages, with a back-translation process conducted to verify accuracy and consistency.

Participants were instructed to work on the six interactive modules delivered weekly in a sequential order (more detail about the content in Herrero et al., 2019). The therapeutic concept of the programs was derived from evidence-based techniques following the Ryff model of well-being (Ryff, 2014), with each module focusing on a specific topic: 1) Autonomy, 2) Self-Acceptance, 3) Environmental Mastery, 4) Purpose in Life, 5) Positive Relations and 6) Personal Growth.

Each module was composed of psychoeducative content and exercises to practice the proposed skills. Moreover, multimedia elements such as videos, audios, vignettes, and images were used to enrich the experience. Participants could fill out a guided diary between modules, focusing on the modules' topics. The aim of the diary is to recap the learnings during the session. A more thorough description of the intervention is presented in the study protocol (Herrero et al., 2019). The intervention was delivered through the Minddistrict platform (https://www.minddistrict.com/; Minddistrict B.V., Amsterdam, The Netherlands), an Internet-based eHealth platform.

2.7.2. Waiting list condition

Participants allocated to the “waiting list” (WL) condition were asked to complete the assessments, but did not receive any intervention during the assessment period. After the last follow-up assessment, all participants were offered access to the CORE intervention.

2.8. Measurements

2.8.1. Primary outcome: CD-RISC-25

The primary outcome used was the Connor-Davidson Resilience Scale (CD-RISC-25; Connor and Davidson, 2003), assessing the ability to cope with stress in a 25-item self-report format. Respondents were asked to indicate their level of agreement using a 5-point Likert scale from “strongly disagree” to “strongly agree”. The sum score ranges from 0 to 100 with higher scores reflecting greater resilience. Data shows that CD-RISC-25 has a good reliability at screening ($\alpha = 0.708$) and baseline ($\alpha = 0.776$). The assessment of CD-RISC-25 values at screening and baseline assessment allowed us to estimate repeatability of CD-RISC-25. Overall, screening and baseline CD-RISC-25 scores correlated well (Pearson correlation: $r = 0.825$, $p < .0001$). We estimated the test-retest coefficient of repeatability (CoR) based on the mean with-in standard deviation (s_w) as 2.77 x s_w. This resulted in a CoR of $2.77 \times 2.69 = 7.45$.

2.8.2. Secondary outcomes

The secondary outcomes are described in greater detail in the study protocol (Herrero et al., 2019). A concise list of secondary outcomes is given in Table 1.

We analyzed standardized Cronbach's alpha values for key secondary outcome measures. Data shows that all instruments have good reliability (RS14: $\alpha = 0.815$; GAD7: $\alpha = 0.808$; PHQ9: $\alpha = 0.759$).

Other measurements include socio-demographic variables such as gender, year of birth, marital status, nationality, level of education, and living situation. Other relevant health-related measures were assessed, specifically: a previous diagnosis of a psychological disorders and if treatment is currently undertaken.

Table 1
List of secondary outcomes.

Construct	Scale	Outcome
Well-being	Ryff Scales of Psychological Well-Being - PWBS-29 (Ryff, 1989).	Facets of psychological well-being
Depression	Patient Health Questionnaire - PHQ-9 (Kroenke et al., 2001).	Symptoms of depression
Positive and negative emotionality	Positive and Negative Affect Schedule – PANAS (Watson et al., 1988).	Positive and negative affect
Anxiety	Generalized Anxiety Disorder Questionnaire - GAD-7 (Spitzer et al., 2006).	Symptoms of anxiety
Stress	Perceived Stress Scale - PSS-4 (Cohen et al., 1983).	Degree to which current life situations are appraised as stressful
Self-esteem	Rosenberg Self-Esteem Scale self - RSES (Robins et al., 2001).	Positive and negative feelings about the self
Self-compassion	Self-Compassion Scale - Short Form - SCS-SF (Raes et al., 2011).	Overall self-compassion (total score) and three facets: common humanity (SCSCH), mindfulness (SCS-M), and self-kindness (SCS-SK).
Enjoyment	Enjoyment Orientation Scale – EOS (Hervás and Vázquez, 2006).	To be receptive and try to do pleasant things
Substance abuse	Alcohol Use Disorders Identification Test - AUDIT-C (Bush et al., 1998)	Active alcohol use
Expectancy about treatment	The Credibility and Expectancy Questionnaire – CEQ (Devilly and Borkovec, 2000).	Patients' expectations about treatment
Satisfaction with the treatment	Client Satisfaction Questionnaire – CSQ (Attkisson and Greenfield, 1996).	Global patient satisfaction with the treatment.
Working alliance	Working Alliance Inventory for Technology-Based Interventions- WAI-TECH (Herrero et al., 2020).	Therapeutic alliance between the technological tool and the patient

Adherence was assessed by considering the session completion rates (Beintner et al., 2019).

2.9. Sample size

The planned total sample size of $N = 464$ was based on the smallest effect size detected in previous studies (Cohen's d = 0.32), a significance level of 0.05, a power of 0.80, and a dropout rate of 30 % on the primary outcome measure (CD-RISC-25). In-depth considerations on sample size computations are presented in the study protocol (Herrero et al., 2019). Based on these considerations, 493 participants have been randomized and analyzed in this trial. While in terms of the planned total sample size the study over-recruited by $N = 29$, this allowed for a slightly higher power in all analyses.

2.10. Statistical analysis

The primary null hypothesis (equality of gain in resilience) was tested by means of the individual pre-post CDRISC score differences between baseline and 8 weeks follow-up between the two study arms (CORE vs WL) in participants with complete data in both time points. The individual pre-post CDRISC scores showed a close to normal distribution. We, therefore, according to the protocol and statistical analysis plan, tested the primary endpoint using a two-sided two-sample *t*-test between the mean pre-post differences. The non-parametric test results of the primary analysis are presented in the supplement. We further reported results on the primary endpoint analyzed in a mixed linear model (sensitivity analysis) and after multiple imputation (MI, k = 10, fully conditional specification with predictive mean matching). Latter was reported as intention-to-treat analysis. Cohen's d was provided using the between-group effect (CORE vs. WL) divided by the pooled standard deviation. Aggregation of MI results was conducted with Rubin's rule within proc. mianalyze (SAS Software, Version 9.4). Cohen's d effect sizes were reported for completer and ITT analyses. Secondary analyses comprised the 6-month, and 12-month follow-up of the primary outcome as well as analyses on the secondary outcomes (Table 1). Adherence measures were computed from session completion data as well as available log-files analyzed for platform usage.

3. Results

3.1. Participants description

Flow of participants is shown in the CONSORT diagram (Fig. 1). After screening for eligibility $N = 3499$, $N = 3000$ were excluded. Finally, a total of 499 university students were randomized either to CORE ($N = 249$) or the WL group ($N = 250$). Six participants asked for the deletion of their data, therefore a total of 493 students were included in the final data analysis, 248 in CORE group, 245 in WL group.

Of the total sample, 76.4 % were female with a mean age of 25.01 (SD = 6.45). The majority were single (40.8 %) or with partner but living apart (36.4 %). In total, 12.1 % lived alone, 39.6 % lived with their family and a 30.9 % lived with colleagues (See Table 2).

All participants, with exception of one, were included with a CD-RISC-25 score ≤ 63 at screening. One participant in the control condition presented a CD-RISC-25 score higher than 63 and was erroneously included. This participant nevertheless was analyzed, in line with the planned intention-to-treat (ITT) principle. 31 participants (CORE: 15; WL: 16) had initially a sufficiently low CD-RISC-25 score at screening, but changed to higher scores at baseline assessment (See supplement material). Consistent with the ITT principle, these participants were also retained in the analyses.

3.2. Adherence

On average 59 % (146/249) participants in the interventional arm, finalized all six sessions of the CORE program. 16 (6.4 %) students started the first session, but did not finalize it, and additional 22 (8.8 %) participants finalized only the first session. On average participants who finalized at least one session in CORE completed 4.8 out of 6 sessions. 62.5 %.

3.3. Primary analysis within the assessment completer sample

Participants who received the CORE program showed an increase in resilience measured with CD-RISC-25 of 8.43 points (SD = 10.6) after 8 weeks. In contrast, the WL group showed an increase in resilience of 3.86 (SD = 9.03) points (See Fig. 2). Both study arms differed significantly in their increase by 4.57 points (95%CI 2.58–6.55; t-statistic = 4.53, df = 377, $p < .0001$). Cohen's d is 0.47 (95%CI 0.26–0.67) indicating a medium to large between-group effect of the CORE program.

It is also noteworthy that within-group increases in resilience were significant for both CORE and WL groups (p-value $< .05$), indicating a general upward trend in student's resilience over time.

3.4. ITT results after multiple imputation

3.4.1. Primary outcome

With respect to resilience measured by the CD-RISC-25 we observed low levels of resilience at baseline (CORE: 51.81 (8.59); WL: 51.20 (9.59)). Within both study's arms the resilience level increased over time with a stronger increase in the CORE group (post: 59.63 (11.33); 6 M-FU: 60.63 (13.00); 12 M-FU: 63.38 (13.12)) compared to the WL group (post: 55.66 (11.79); 6 M-FU: 57.29 (12.74); 12 M-FU: 58.85(13.10))

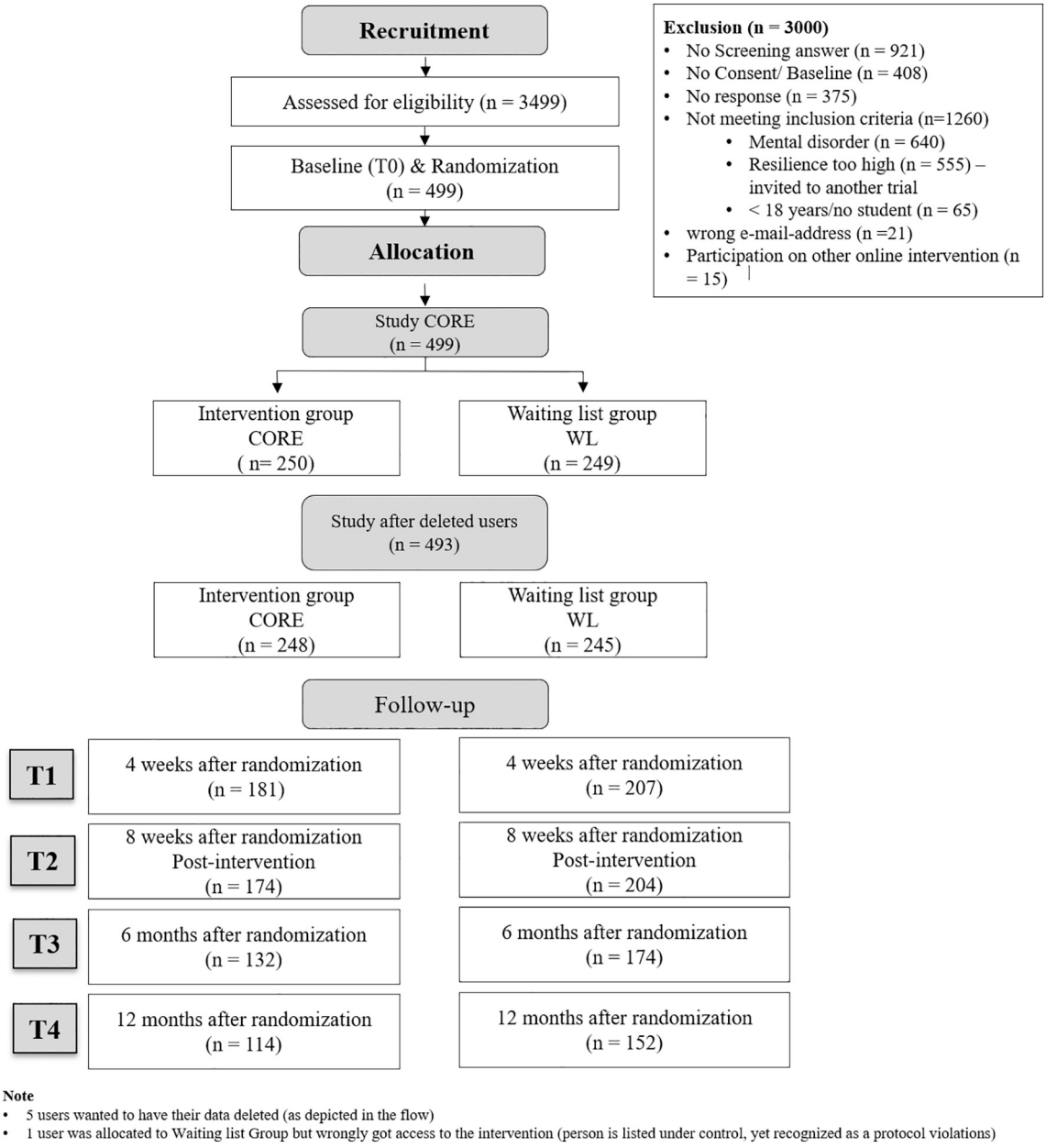

Fig. 1. Consort participant flow chart for the study.

(See Fig. 3). We observed effect sizes between 0.24 and 0.34 for the comparisons of resilience increase compared to baseline (BL) for all time points (Differences post-BL: d = 0.34[95%CI:0.26,0.42], $p = .0005$; 6 M-BL: d = 0.24[0.13–0.36], $p = .0171$; 12 M-BL: d = 0.33[0.19,0.47], $p = .0031$).

3.4.2. Secondary outcomes

We found that our second resilience measure (RS14) shows a similar behavior over time as CD-RISC-25. There is an increase in resilience scores over time in both groups, with a stronger increase in CORE (Table 3). Statistically, we can prove a benefit of CORE over WL for RS14 only at the post-intervention time point. Effect sizes are comparably smaller, i.e. d = 0.24[0.13,0.35], d = 0.09[−0.02,0.21], d = 0.15 [0.02,0.28], for post-BL, 6 M-BL, 12 M-BL differences, respectively.

Anxiety symptoms (GAD7) were reduced significantly in CORE condition in comparison to WL in the short and long term. GAD7 score decreased in CORE from 9.26 (SD = 4.21) at baseline to 6.10 (SD = 3.47) after 4 weeks, 6.66 (SD = 3.75) at the post-intervention assessment, 6.97 (SD = 4.31) after 6 months and 6.93 (SD = 4.17) after 12 months. In the WL there was an initially also more prominent decrease from 8.90 (SD = 4.29) to 6.68 (SD = 4.30) after 4 weeks, but a stabilization of score around 7.6 for the rest of the follow-up (Table 3). CORE reached a small to medium effect size compared to WL at all assessment time points (4 weeks = d = 0.24[0.15–0.33], $p = .0139$; Post = d = 0.30[0.22–0.38], $p = .0015$; 6 M = d = 0.18[0.07–0.29], $p = .0857$; 12 M = d = 0.23 [0.12–0.35], $p = .0312$).

Depression symptoms (PHQ9) were reduced significantly in CORE condition in comparison to WL in the short term, but no longer improvement in this variable was observed (Table 3). Similar results were found for PANAS (positive aspects) and EOS.

The PBWS scales showed that participants profited from the CORE program with respect to psychological well-being in the short term (post = d = 0.54[0.33–0.75]; $p < .0001$) and after 12 months (d = 0.42 [0.17–0.67]). With respect to PBWS subscales we could not see a differential behavior for the self-acceptance scale and personal growth. Positive relation, purpose and domain subscales contribute to the short-

Table 2
Descriptive statistics of socio-demographic variables.

Factor	Whole cohort $N = 493$	CORE $N = 248$	WL $N = 245$	p-value
Sex, n(%)				0.0057[#]
Male	116 (23.4)	45 (18.1)	71 (28.9)	
Female	378 (76.4)	203 (81.5)	175 (71.1)	
Other	1 (0.2)	1 (0.4)	0	
Age				0.7589
mean (SD)	25.01 (6.45)	24.83 (6.12)	25.19 (6.79)	
median (Q1;Q3)	23 (21;27)	23(21;26)	23 (21;27)	
missing	6	3	3	
Marital status, n(%)				0.5113[#]
Single	202 (40.8)	94 (37.7)	108 (43.9)	
w/ partner, living apart	180 (36.4)	97 (39.0)	83 (33.7)	
married/living w/ partner	109 (22.0)	56 (22.5)	53 (21.5)	
divorced w/o new partner	3 (0.61)	1 (0.4)	2 (0.81)	
divorced w/ new partner	1 (0.2)	1 (0.4)	0 (0)	
widowed w/o new partner	0 (0)	0 (0)	0 (0)	
widowed w/ new partner	0 (0)	0 (0)	0 (0)	
Trial site, n(%)				0.9995
Spain	183 (37.0)	92 (37.0)	91 (37.0)	
Germany + Switzerland	312 (63.0)	157 (63.0)	155 (63.0)	
Study year, n(%)				0.8641
First-year student	50 (10.1)	25 (10.0)	25 (10.2)	
Second-year student	78 (15.8)	36 (14.5)	42 (17.1)	
Third year student	107 (21.6)	56 (22.5)	51 (20.7)	
4+ years	260 (52.5)	132 (53.0)	128 (52.0)	
I am no student	0 (0)	0(0)	0(0)	
Education, n(%)				0.7172[#]
EQF Level 2	3 (0.61)	3 (1.2)	0 (0)	
EQF Level 3	3 (0.61)	2 (0.8)	1(0.4)	
EQF Level 4 (A-levels)	161 (32.5)	80 (32.13)	81 (32.9)	
EQF Level 5	23(4.65)	11 (4.42)	12 (4.88)	
EQF Level 6 (BA, BSc)	229 (46.26)	117 (47.0)	112 (45.53)	
EQF Level 7 (MA, MSc)	67 (13.5)	33 (13.25)	34 (13.8)	
EQF Level 8 (Doctorate)	8 (1.62)	3 (1.2)	5 (2.03)	
unknown	1 (0.2)	0	1 (0.4)	
Mental health diagnosis (ever), n(%)	132 (26.8)	65 (26.2)	67 (27.3)	0.7755
Children at home, n(%)	88 (17.8)	42 (16.9)	45 (18.3)	0.6767
Living situation, n(%)				
Alone	60 (12.1)	21 (8.4)	39 (15.9)	0.1187[#]
	196 (39.6)	100 (40.2)	96 (39.0)	
	153 (30.9)	79 (31.7)	74 (30.1)	
Family	13 (2.6)	7 (2.8)	6 (2.4)	
Colleagues or friends	73 (14.8)	42 (16.9)	31 (12.6)	
Student dormitory with partner				

[#] Fisher's exact test; w – with; w/o – without; BA - Bachelor of Arts; BSc - Bachelor of Science; MA - Master of Arts; MSc - Master of Science; EQF – European Qualification Framework; WL – Waiting List; SD – standard deviation; Q1 – first quartile; Q3 – third quartile.

term effects. See Table 3 for details.

3.4.3. Sensitivity analyses

A linear mixed repeated measures model on absolute CDRISC scores including all follow-up time points (baseline, post-intervention, 6 month FU and 12 month FU) confirmed the significant effect of CORE over WL (group: F[1491],23.31; $p < .0001$; time: F[3944], 80.77, $p < .0001$; interaction, F[3944], 7.96, $p < .0001$). E.g. marginal mean CDRISC values increased from 51.2 at baseline to 55.2 under WL and from 51.8 to 60.1 in the CORE group at the post-intervention assessment.

A mixed model analysis including country (ES vs DE) as fixed factor using the pre-post differences of participants with complete pre-post data showed a consistent between-group effect for the intervention program (between group difference: 3.97; 95%CI:1.73–6.22), F:12.15, df:373, $p = .0005$) and no country-specific differences (F:0.05 df:373, $p = .8166$) or interaction between study arm and country (F:0.59, df:373, $p = .4412$).

4. Discussion

In this paper, we presented the results of an RCT conducted to test the efficacy of a self-guided online intervention (CORE) based on Ryff's model to promote resilience among university students compared to a WL control condition. The study investigated the impact on resilience, well-being, anxiety, depression, and other relevant parameters.

All participants recruited showed a low level of resilience at baseline, and results showed that both groups increased their levels on the measure, indicating a general time trend for the variable. However, participants in the CORE condition reported a significant improvement in resilience compared to WL condition, suggesting that even when there is a tendency to a general improvement in resilience, a specific intervention targeting resilience can boost this improvement. Moreover, the result is consistent for the two measures used to assess resilience in the post assessment. Nevertheless, in the RS-14, the follow-ups showed a similar trend but not significant. These results show the potential benefits of using an online intervention and contributes to this body of knowledge. The findings on resilience are in line with previous studies targeting resilience using online interventions. It is important to note, that not all studies demonstrated benefits on resilience, showing limited or no impact on the variable (Díaz-García et al., 2021). Compared to studies that reported the greatest benefits, such as Aikens et al. (2014), Enrique Roig et al. (2020), and Rose et al. (2013), the CORE intervention demonstrates comparable improvements, with similar effect size.

The study's impact extends beyond resilience enhancement, addressing key mental health outcomes like anxiety and depression. Results indicate that CORE was successful in reducing anxiety symptomatology in the short and long term and depression in the short term in comparison with WL. The observed reduction in anxiety symptoms, sustained over the long term, corroborates the effectiveness of digital interventions in managing anxiety, as reported in studies by Heber et al. (2017). Furthermore, the CORE intervention demonstrates similar improvements in the sustained reduction of anxiety symptoms than other studies targeting resilience in university students (Abulfaraj et al., 2024).

As it was highlighted in the metanalysis by Díaz-García et al. (2021), online interventions for resilience have shown non-consistency in their theoretical foundation. Many studies do not state a clear theoretical rationale behind the intervention, or focus on assessing proximal variables rather than resilience itself. In this regard, the results of this study are in line with Díaz-García et al. (2021) results, as the sensitivity analysis suggests that interventions with a well-defined theoretical foundation and targeted measurement show better effects. This study, contribute to the growth of this field by testing an intervention grounded in a well-established theoretical framework, with a well-known theory as background, the Ryff's model of psychological well-being (Ryff, 2014).

The self-guided nature of the CORE intervention may offer significant advantages from a cost-benefit perspective. Similar to other self-applied interventions, CORE reduces the associated costs with significant results un resilience and other relevant variables. These results are in line with similar studies, such as Enrique Roig et al. (2020). These characteristics makes the intervention highly scalable, particularly for university settings.

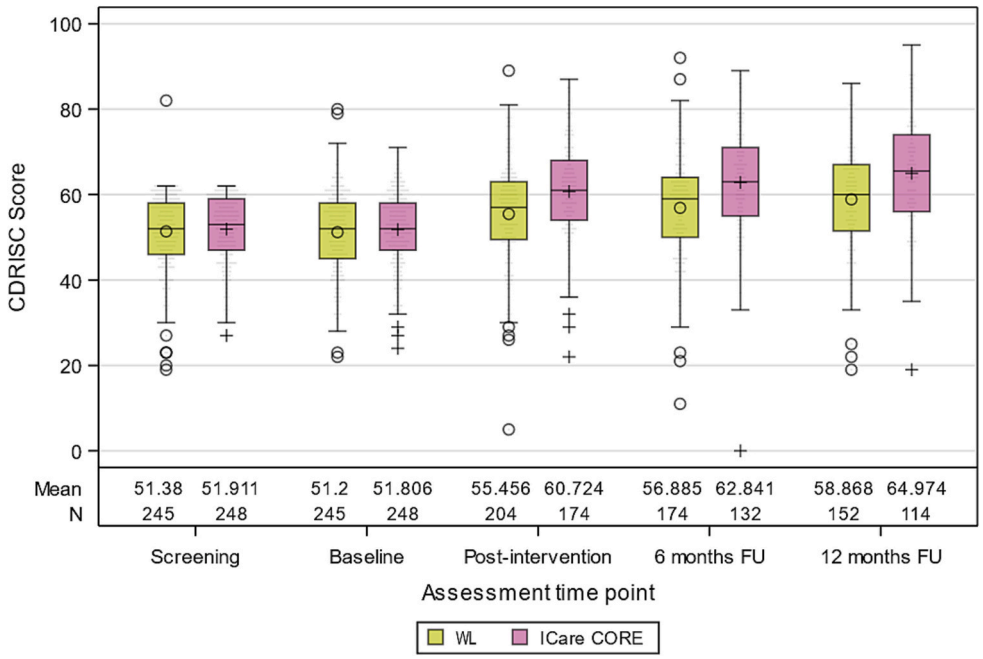

Fig. 2. Distribution of absolute CD-RISC-25 sum scores over the assessment time points by randomized group. Completer data shown. WL – Waiting LCAREist; 6 M - 6-month follow-up (FU); 12 M – Twelve-month FU.

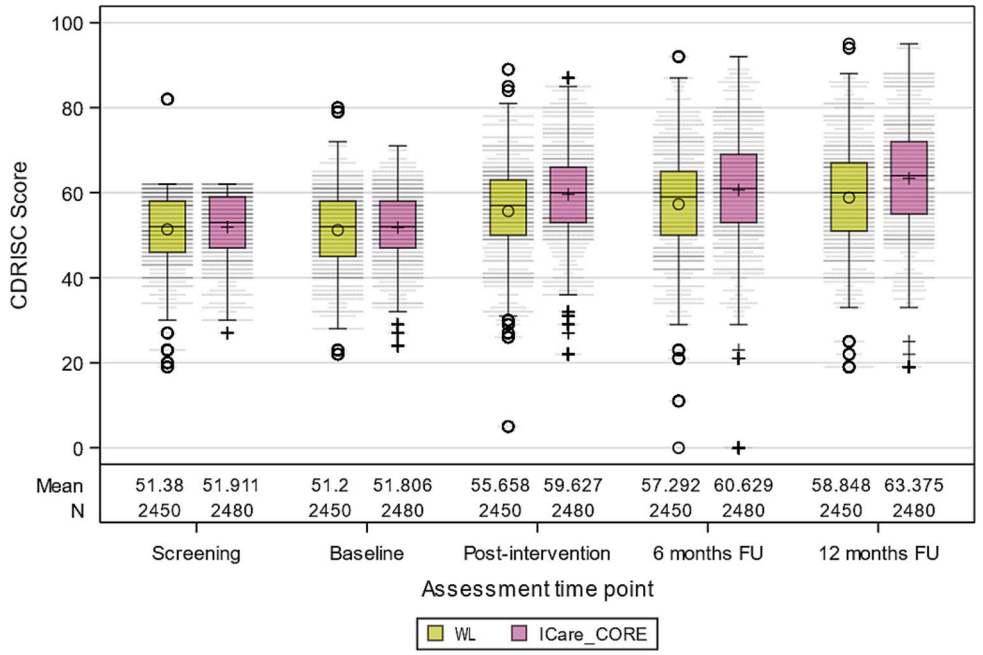

Fig. 3. Intention-to-treat analysis of the predictive-mean-matching multiple imputed CD-RISC-25 total scores (sum) over all assessments and imputation variants. Inset table shows uncorrected group means at the respective assessment time point. Sample size (N) gives the number of participants multiplied by the number of imputations (k = 10). Inferential statistics (Table 3) were pooled and analyzed according to Rubin's rule.

Adherence to the CORE program presents a nuanced picture of engagement in self-guided online interventions. Our study revealed that about 59 % of participants in the intervention arm completed all sessions, with an average completion of 4.8 out of 6 sessions for those who at least finished one session.

The level of adherence found leads us to consider two aspects that require further study. On the one hand, while the level of adherence is in general notable compared to other studies, may suggest that there is room for improvement, highlighting the common challenge in digital mental health interventions, the engagement (Baños et al., 2017). In this regard, strategies such as tailoring content to individual user preferences and needs could significantly enhance engagement, as supported by studies emphasizing the importance of personalized approaches in psychological interventions (Collins et al., 2004; Kazdin, 2017). On the other hand, the good results obtained in general, even in those who did not finish the whole intervention, may point that not all the participants need the same "dose" of intervention to improve (Robinson et al., 2020). Further studies are needed to explore the dose-response relationship in relation to individual characteristics and optimize efficacy.

Table 3
Intention-to-treat results after multiple imputation for all instruments and measurement times.

	Baseline		4-weeks		Post-intervention (8 weeks)		6-month FU		12-month FU	
Outcome	CORE (N = 248)	WL (N = 245)	CORE	WL	CORE	WL	CORE	WL	CORE	WL
CD-RISC-25, mean(sd)	51.81 (8.59)	51.20 (9.59)			59.63 (11.33)	55.66 (11.79)	60.63 (13.00)	57.29 (12.74)	63.38 (13.12)	58.85 (13.10)
Pre-post mean(sd)					7.82 (10.43)	4.46 (9.35)	8.82 (11.71)	6.09 (10.75)	11.57 (12.57)	7.65 (11.33)
Tests against baseline					**t(578.57) = 3.53, p = .0005, d = 0.34, [0.26, 0.42]**		**t(218.14) = 2.40, p = .0171, d = 0.24, [0.13, 0.36]**		**t(97.796) = 3.03, p = .0031, d = 0.33, [0.19, 0.47]**	
RS14, mean(sd)	59.72 (11.36)	57.58 (11.23)			65.57 (12.49)	60.82 (13.20)	65.31 (13.93)	62.11 (13.82)	67.38 (15.15)	63.31 (14.53)
Pre-post mean(sd)					5.85 (10.88)	3.25 (11.00)	5.59 (11.20)	4.54 (12.00)	7.66 (12.79)	5.74 (12.51)
Test against baseline					**t(204.5) = 2.35, *p* = .0199, d = 0.24, [0.13, 0.35]**		t(154.1) = 0.87, *p* = .3844, d = 0.09, [−0.02, 0.21]		t(119.59) = 1.44, *p* = .1536, d = 0.15, [0.02, 0.28]	
GAD7, mean(sd)	9.26 (4.21)	8.90 (4.29)	6.10 (3.47)	6.68 (4.30)	6.66 (3.75)	7.69 (4.66)	6.97 (4.31)	7.43 (4.84)	6.93 (4.17)	7.66 (4.75)
Pre-post mean(sd)			−3.16 (3.90)	−2.23 (3.89)	−2.60 (4.53)	−1.21 (4.67)	−2.29 (4.70)	−1.47 (4.64)	−2.34 (4.83)	−1.24 (4.71)
Test against baseline			**t(452.18) = −2.47, p = .0139, d = −0.24, [−0.33, −0.15]**		**t(859.87) = −3.18, p = .0015, d = −0.30, [−0.38, −0.22]**		t(201.62) = −1.73, p = .0857, d = −0.18, [−0.29, −0.07]		**t(124.36) = −2.18, p = .0312, d = −0.23, [−0.35, −0.12]**	
PHQ9, mean(sd)	9.02 (4.34)	8.85 (4.43)	7.23 (3.53)	7.88 (4.18)	6.81 (4.19)	7.77 (4.85)	7.05 (4.34)	7.63 (4.70)	7.16 (4.44)	7.68 (4.70)
Pre-post mean(sd)			−1.79 (3.50)	−0.97 (3.98)	−2.21 (4.34)	−1.09 (4.73)	−1.97 (4.69)	−1.22 (4.79)	−1.86 (5.18)	−1.17 (5.03)
Test against baseline			**t(822.92) = −2.29, *p* = .0222, d = −0.22, [−0.29, 0.15]**		**t(372,42) = −2.51, p = .0123, d = −0.25, [−0.34, −0.16]**		t(91.957) = −1.45, p = .1505, d = −0.16, [−0.30, −0.02]		t(218.17) = −1.33, p = .1835, d = −0.13, [−0.24, −0.03]	
PANAS-Positive, mean(sd)	28.45 (6.70)	27.89 (6.46)	29.12 (7.22)	27.27 (7.19)	31.24 (7.65)	29.30 (7.37)	31.51 (7.11)	29.76 (7.34)	32.34 (7.85)	30.41 (7.87)
Pre-post mean(sd)			0.66 (5.75)	−0.62 (5.02)	2.78 (6.37)	1.41 (6.00)	3.05 (6.30)	1.87 (6.75)	3.88 (7.25)	2.52 (7.04)
Test against baseline			**t(274.49) = 2.37, *p* = .0183, d = 0.24, [0.14, 0.34]**		**t(129.92) = 2.10, *p* = .0377, d = 0.22, [0.10, 0.34]**		t(617.46) = 1.88, *p* = .0599, d = 0.18, [0.10, 0.26]		t(135.32) = 1.81, *p* = .0720, d = 0.19, [0.05, 0.07]	
PANAS-Negative, mean(sd)	25.23 (6.43)	25.02 (6.85)	21.47 (6.49)	23.00 (7.22)	22.04 (6.68)	23.61 (7.09)	22.11 (6.70)	23.21 (7.29)	22.33 (6.87)	23.41 (7.42)
Pre-post mean(sd)			−3.76 (5.20)	−2.02 (5.15)	−3.20 (6.02)	−1.41 (5.91)	−3.13 (6.17)	−1.81 (6.40)	−2.90 (6.75)	−1.61 (6.84)
Tests against baseline			**t(880.96) = −3.54, *p* = .0004, d = −0.34, [0.03, −0.41]**		**t(1302.9) = −3.19, p = .0015, d = −0.30, [−0.37, −0.23]**		**t(572.9) = −2.18, *p* = .0300, d = −0.21, [−0.29, −0.13]**		t(93.506) = −1.75, *p* = .0838, d = −0.19, [−0.32, −0.06]	
PBWS self-accept, mean(sd)	14.65 (4.00)	14.21 (3.86)			16.34 (4.13)	15.08 (4.45)	16.36 (4.20)	15.71 (4.41)	16.73 (4.19)	15.63 (4.58)
Pre-post mean(sd)					1.85 (4.55)	0.85 (4.49)	1.85 (4.55)	0.85 (4.49)	1.85 (4.55)	0.85 (4.49)
Tests against baseline					t(55.763) = 1.89, *p* = .0635, d = 0.22, [0.04, 0.40]		t(55.763) = 1.89, p = .06, d = 0.22, [0.04, 0.400]		t(55.763) = 1.89, p = .0635, d = 0.22, [0.08, 0.04)	
PBWS, mean(sd)	108.28 (16.42)	107.69 (16.99)			117.58 (18.80)	111.41 (18.51)	116.72 (19.12)	113.62 (18.73)	117.96 (20.94)	113.24 (20.41)
Pre-post mean(std)					9.30 (14.14)	3.71 (12.66)	8.44 (14.90)	5.93 (14.38)	9.68 (16.76)	5.54 (15.95)
Tests against baseline					**t(265.37) = 4.17, p < .0001, d = 0.42, [0.32, 0.52]**		t(58.402) = 1.48, *p* = .1440, d = 0.17, [0.01, 0.33]		t(48.329 = 2.12, *p* = .0394, d = 0.25, [0.07, 0.44]	
PBWS Autonomy, mean(sd)	20.69 (5.74)	20.85 (5.79)			22.75 (5.69)	21.47 (5.37)	22.91 (5.41)	22.11 (5.30)	22.73 (5.59)	21.72 (5.54)
Pre-post mean(sd)					2.06 (4.56)	0.62 (4.17)	2.22 (4.72)	1.26 (4.52)	2.04 (5.04)	0.87 (4.85)
Tests against baseline					**t(195.84) = 3.25, *p* = .0014, d = 0.33, [0.22, 0.44]**		**t(292.31) = 2.08, *p* = .0383, d = 0.21, [0.11, 0.30)**		**t(95.074) = 2.18, *p* = .0318, d = 0.24, [0.09, 0.38)**	
PBWS Domain, mean (sd)	18.17 (3.89)	17.87 (3.96)			20.74 (4.06)	19.09 (3.98)	19.74 (4.49)	19.28 (4.38)	20.51 (4.56)	19.39 (4.51)
Pre-post mean(sd)					2.57 (3.36)	1.22 (3.35)	1.57 (3.69)	1.41 (3.69)	2.34 (4.13)	1.52 (4.16)
Tests against baseline					**t(1800.9) = 4.29, p < .0001, d = 0.40, [0.34, 0.46]**		t(129.19) = 0.41, *p* = .6799, d = 0.04, [−0.08, 0.16]		t(120.75) = 1.88, *p* = .0629, d = 0.20, [0.07, 0.33]	
PBWS persgrowth, mean(sd)	16.59 (2.10)	16.60 (2.13)			17.15 (2.08)	16.78 (2.18)	16.89 (2.15)	16.75 (2.07)	16.84 (2.09)	16.78 (2.12)
Pre-post mean(sd)					0.56 (2.09)	0.18 (2.20)	0.30 (2.15)	0.14 (2.11)	0.25 (2.38)	0.17 (2.28)
Tests against baseline					t(184.87) = 1.74, *p* = .0843, d = 0.18, [0.07, 0.29]		t(181.57) = 0.74, *p* = .4596, d = 0.08, [−0.03, 0.19]		t(84.647) = 0.31, *p* = .7583, d = 0.03, [−0.10, 0.17]	

(*continued on next page*)

Table 3 (*continued*)

	Baseline		4-weeks		Post-intervention (8 weeks)		6-month FU		12-month FU	
Outcome	CORE (N = 248)	WL (N = 245)	CORE	WL	CORE	WL	CORE	WL	CORE	WL
PBWS posrelation, mean(sd)	16.84 (2.09)	16.78 (2.12)			21.24 (5.58)	20.92 (5.82)	21.17 (5.71)	21.40 (5.65)	21.47 (5.65)	21.60 (5.62)
Pre-post mean(sd)					1.57 (3.87)	0.70 (3.41)	1.50 (4.32)	1.19 (4.35)	1.79 (4.71)	1.39 (4.36)
Tests against baseline					**t(494.18) = 2.46, *p* = .0144, d = 0.24, [0.16, 0.32]**		t(370.49) = 0.73, *p* = .4649, d = 0.07, [−0.01, 0.16]		t(186.67) = 0.87, *p* = .3832, d = 0.09, [−0.02, 0.20]	
PBWS purpose, mean (sd)	18.51 (4.40)	17.95 (4.48)			20.13 (4.98)	18.55 (4.95)	19.97 (5.14)	18.72 (5.29)	20.36 (5.19)	18.80 (5.29)
Pre-post mean(sd)					1.61 (3.84)	0.60 (3.43)	1.46 (4.22)	0.77 (4.20)	1.85 (4.55)	0.85 (4.49)
Tests against baseline					**t(52.44) = 2.35, *p* = .0224, d = 0.28, [0.10, 0.45]**		t(133.82) = 1.56, *p* = .1211, d = 0.16, [0.05, 0.28]		t(55.763) = 1.89, p = .0635, d = 0.22, [0.04, 0.40]	
EOS, mean(sd)	24.33 (6.99)	23.80 (6.28)			26.97 (6.99)	25.28 (6.65)	26.72 (7.65)	25.86 (7.17)	27.07 (7.80)	25.76 (7.66)
Pre-post mean(sd)					2.64 (5.80)	1.48 (5.58)	2.39 (6.21)	2.05 (6.27)	2.74 (6.70)	1.96 (6.51)
Tests against baseline					**t(541.94) = 2.11, *p* = .0352, d = 0.20, [0.12, 0.29]**		t(130.59) = 0.51, *p* = .6096, d = 0.05, [−0.07, 0.18]		t(107.24) = 1.11, *p* = .2706, d = 0.12, [−0.02, 0.25]	
PSS, mean(sd)	7.99 (1.50)	8.06 (1.43)			8.00 (1.35)	7.87 (1.37)	8.25 (1.33)	8.20 (1.33)	8.15 (1.53)	8.00 (1.44)
Pre-post mean(sd)					0.01 (1.71)	−0.19 (1.72)	0.27 (1.71)	0.13 (1.87)	0.16 (1.97)	−0.06 (1.93)
Tests against baseline					t(418.77) = 1.17, *p* = .2442, d = 0.11, [0.03, 0.20]		t(88.703) = 0.68, *p* = .5013, d = 0.07, [−0.07, 0.21]		t(189.35) = 1.14, *p* = .2552, d = 0.12, [0.01, 0.22]	
SCSSF, mean(sd)	2.51 (0.52)	2.56 (0.57)			2.98 (0.60)	2.73 (0.60)	3.02 (0.67)	2.82 (0.65)	3.13 (0.69)	2.90 (0.66)
Pre-post mean(sd)					0.47 (0.60)	0.17 (0.52)	0.51 (0.66)	0.26 (0.57)	0.62 (0.70)	0.34 (0.63)
Tests against baseline					**t(436.3) = 5.48, p < .0001, d = 0.53, [0.45, 0.61]**		**t(126.41) = 3.89, *p* = .0002, d = 0.41, [0.26, 0.56]**		**t(322.29) = 4.21, p < .0001, d = 0.42, [0.33, 0.50]**	
SCSSF Comm hum, mean(sd)	2.48 (0.78)	2.48 (0.81)			2.96 (0.84)	2.73 (0.81)	3.04 (0.96)	2.84 (0.88)	3.14 (0.87)	2.96 (0.86)
Pre-post mean(sd)					0.48 (0.93)	0.26 (0.81)	0.56 (1.04)	0.36 (0.93)	0.66 (0.95)	0.48 (0.92)
Tests against baseline					**t(1153.7) = 2.69, *p* = .0073, d = 0.25, [0.19, 0.32]**		**t(177.39) = 1.99, *p* = .0477, d = 0.20, [0.09, 0.32]**		t(85.01) = 1.74, *p* = .0849, d = 0.19, [0.05, 0.33]	
SCSSF Isolation, mean (sd)	2.42 (0.95)	2.52 (0.95)			2.99 (0.98)	2.75 (1.00)	3.02 (1.06)	2.84 (1.03)	3.01 (0.03)	2.80 (0.03)
Pre-post mean(sd)					0.57 (1.00)	0.22 (0.98)	0.60 (1.06)	0.31 (0.99)	0.59 (1.12)	0.27 (1.01)
Tests against baseline					**t(130.28) = 3.31, *p* = .0012, d = 0.35, [0.23, 0.47]**		**t(256.3) = 2.77, *p* = .0061, d = 0.28, [0.17, 0.38]**		**t(904.11) = 3.11, *p* = .0019, d = 0.30, [0.22, 0.37]**	
SCSSF Mindful, mean (sd)	3.04 (0.85)	3.06 (0.85)			3.39 (0.80)	3.20 (0.83)	3.47 (0.81)	3.30 (0.82)	3.55 (0.81)	3.38 (0.82)
Pre-post mean(sd)					0.35 (0.88)	0.15 (0.84)	0.43 (0.85)	0.25 (0.85)	0.51 (0.94)	0.32 (0.92)
Tests against baseline					**t(236.41) = 2.28, *p* = .0237, d = 0.23, [0.13, 0.33]**		**t(205.97) = 2.12, *p* = .0351, d = 0.21, [0.11, 0.31]**		**t(182.64) = 2.02, *p* = .0450, d = 0.21, [0.09, 0.32]**	
SCSSF Overident, mean(sd)	1.99 (0.74)	2.11 (0.76)			2.52 (0.81)	2.29 (0.81)	2.47 (0.92)	2.38 (0.91)	2.63 (0.93)	2.43 (0.84)
Pre-post mean(sd)					1.00 (1.02)	0.63 (1.06)	1.03 (1.12)	0.72 (1.10)	1.02 (1.15)	0.68 (1.08)
Tests against baseline					**t(149.13) = 3.42, *p* = .0008, d = 0.35, [0.24, 0.47]**		**t(328.38) = 2.81, *p* = .0052, d = 0.28, [0.18, 0.37]**		**t(1078.7) = 3.20, p = .0014, d = 0.30, [0.24, 0.37]**	
SCSSF Self-judge, mean(sd)	2.50 (0.91)	2.59 (0.98)			3.08 (0.96)	2.75 (0.96)	3.00 (0.95)	2.76 (1.00)	3.12 (1.00)	2.88 (1.02)
Pre-post mean(sd)					0.58 (0.89)	0.16 (0.92)	0.50 (0.92)	0.17 (0.89)	0.61 (1.02)	0.28 (1.01)
Tests against baseline					**t(1481.8) = 5.00, p < .0001, d = 0.47, [0.41, 0.53]**		**t(109.89) = 3.43, *p* = .0009, d = 0.37, [0.22, 0.51]**		**t(93.962) = 3.01, *p* = .0033, d = 0.33, [0.18, 0.48]**	
SCSSF Self-kind, mean (sd)	3.12 (1.00)	2.88 (1.02)			3.12 (1.00)	2.88 (1.02)	3.12 (1.00)	2.88 (1.02)	3.12 (1.00)	2.88 (1.02)
Pre-post mean(sd)					0.61 (1.02)	0.28 (1.01)	0.61 (1.02)	0.28 (1.01)	0.61 (1.02)	0.28 (1.01)
Tests against baseline					**t(93.962) = 3.01, p = .0033, d = 0.33, [0.18, 0.48]**		**t(93.962) = 3.01, p = .0033, d = 0.33, [0.18, 0.48]**		**t(93.962) = 3.01, p = .0033, d = 0.33, [0.18, 0.48]**	
AUDITC, mean(sd)	2.68 (1.85)	2.97 (2.04)	2.48 (1.77)	2.90 (2.07)	2.43 (1.66)	2.81 (2.02)				
Pre-post mean(sd)			−0.20 (0.92)	−0.07 (1.04)	−0.24 (0.90)	−0.16 (1.16)				
Tests against baseline			t(1027.5) = −1.38, *p* = .1686, d = −0.13, [−0.20, −0.06]		t(284.29) = −0.80, *p* = .4253, d = −0.08, [−0.17, 0.02]					
RSE, mean(sd)	15.82 (6.42)	17.15 (6.40)	17.48 (6.64)	18.01 (6.70)	18.80 (6.60)	18.76 (6.43)				

(*continued on next page*)

Table 3 (*continued*)

	Baseline		4-weeks		Post-intervention (8 weeks)		6-month FU		12-month FU	
Outcome	CORE (N = 248)	WL (N = 245)	CORE	WL	CORE	WL	CORE	WL	CORE	WL
Pre-post mean(sd)			1.66 (4.23)	0.86 (3.86)	2.98 (4.77)	1.61 (4.23)				
Tests against baseline			t(71.152) = 1.76, p = .0835, d = 0.20, [0.05, 0.35]		**t(50.341) = 2.57, p = .0133, d = 0.30, [0.13, 0.48]**					

Abbrev: SD – standard deviation; d – Cohen's d; WL – waiting list; FU – follow-up.
Significant results are emphasized in bold.

5. Limitations, future directions, and implications

One notable limitation of our study is the selection of participants with low baseline resilience scores. This selection criterion, while critical for assessing the intervention's impact, may limit the generalizability of our findings to populations with higher initial resilience. The challenge of participant selection in mental health interventions is well-documented, with implications for the applicability and scalability of findings (Cuijpers et al., 2019; Kazdin, 2017). Future studies should aim to include a broader range of resilience levels to assess the intervention's efficacy more comprehensively. Methodological, a number of unknown confounders may exist, which could not be considered in our analyses.

Another limitation of the study is the absence of an active control group. Although, the inclusion of and active control was intended in the design, the lack of available support programs limited its implementation. This limitation constrained the potential of the results obtained.

In addition, the computer-based delivery of the intervention also poses a limitation, considering the growing prevalence of mobile device usage, especially among young adults. Adapting the intervention to a mobile platform could potentially expand its reach and appeal, aligning with the preferences of the target demographic (Krebs and Duncan, 2015; Linardon and Fuller-Tyszkiewicz, 2020). Research has shown that mobile-based mental health interventions can increase accessibility and engagement, especially among younger users who are more accustomed to smartphone usage for various applications (Firth et al., 2017; Torous et al., 2018).

Further research is also needed to explore the long-term sustainability of the intervention's effects. Assessing whether initial improvements in resilience and mental health outcomes are maintained or enhanced over extended periods is crucial for understanding the lasting impact of such interventions. Longitudinal studies could provide valuable insights into the durability of the effects and inform the development of strategies to reinforce and sustain the benefits over time (Vigo et al., 2016).

6. Conclusion

This study contributes to the growing body of research on digital resilience interventions, demonstrating the efficacy of a self-guided online program in improving resilience and mental health outcomes among university students. The findings highlight the potential of self-guided online interventions, such as CORE, to address critical mental health challenges. Future work should aim to refine engagement strategies, improve the intervention, and explore long-term and cost-effective impacts of the intervention.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.invent.2025.100811.

References

Abbott, J.A.M., Klein, B., Ciechomski, L., 2008. Best practices in online therapy. J. Technol. Hum. Serv. 26 (2–4), 360–375. https://doi.org/10.1080/15228830802097257.

Abulfaraj, G.G., Upsher, R., Zavos, H.M.S., Dommett, E.J., 2024. The impact of resilience interventions on university students' mental health and well-being: a systematic review. Education Sciences 14 (5), 510. https://doi.org/10.3390/educsci14050510.

Aikens, K.A., Astin, J., Pelletier, K.R., Levanovich, K., Baase, C.M., Park, Y.Y., Bodnar, C. M., 2014. Mindfulness goes to work: impact of an online workplace intervention. J. Occup. Environ. Med. 56 (7), 721–731.

Allan, J.F., McKenna, J., Dominey, S., 2014. Degrees of resilience: profiling psychological resilience and prospective academic achievement in university inductees. British Journal of Guidance & Counselling 42 (1), 9–25. https://doi.org/10.1080/03069885.2013.793784.

Andersson, G., Carlbring, P., Titov, N., Lindefors, N., 2019. Internet interventions for adults with anxiety and mood disorders: a narrative umbrella review of recent meta-analyses. Can. J. Psychiatry 64 (7), 465–470. https://doi.org/10.1177/0706743719839381.

Andrews, G., Basu, A., Cuijpers, P., Craske, M.G., McEvoy, P., English, C.L., Newby, J.M., 2018. Computer therapy for the anxiety and depression disorders is effective, acceptable and practical health care: an updated meta-analysis. Journal Anxiety Disorders 55, 70–78. https://doi.org/10.1016/j.janxdis.2018.01.001. Epub 2018 Feb 1. PMID: 29422409.

Ashford, M.T., Olander, E.K., Ayers, S., 2016. Computer- or web-based interventions for perinatal mental health: a systematic review. J. Affect. Disord. 197, 134–146.

Attkisson, C.C., Greenfield, T.K., 1996. The client satisfaction questionnaire (CSQ) scales and the service satisfaction scale-30 (SSS-30). In: Outcomes Assessment in Clinical Practice, pp. 120–127.

Auerbach, R.P., Alonso, J., Axinn, W.G., Cuijpers, P., Ebert, D.D., Green, J.G., Hwang, I., Kessler, R.C., Liu, H., Mortier, P., Nock, M.K., Pinder-Amaker, S., Sampso, N.A., Aguilar-Gaxiola, S., Al-Hamzawi, A., Andrade, L.H., Benjet, C., Calndas-de-Almeida, J.M., Demyttenaere, K., Florescu, S., de Girolamo, G., Gureje, O.,… Bruffaerts, R., 2016. Mental disorders among college students in the World Health Organization world mental health surveys. Psychol. Med. 1–16.

Auerbach, R.P., Mortier, P., Bruffaerts, R., Alonso, J., Benjet, C., Cuijpers, P., Demyttenaere, K., Ebert, D.D., Green, J.G., Hasking, P., Murray, E., Nock, M.K., Pinder-Amaker, S., Sampson, N.A., Stein, D.J., Vilagut, G., Zaslavsky, A.M., Kessler, R.C., Collaborators, W.H.O.W.M.H.-I.C.S., 2018. WHO world mental health surveys international college student project: prevalence and distribution of mental disorders. J. Abnorm. Psychol. 127 (7), 623–638. https://doi.org/10.1037/abn0000362.

Baños, R.M., Etchemendy, E., Mira, A., Riva, G., Gaggioli, A., Botella, C., 2017. Online positive interventions to promote well-being and resilience in the adolescent population: a narrative review. Front. Psychol. 8, 10.

Beintner, I., Vollert, B., Zarski, A.C., Bolinski, F., Musiat, P., Görlich, D., Riper, H., 2019. Adherence reporting in randomized controlled trials examining manualized multisession online interventions: systematic review of practices and proposal for reporting standards. J. Med. Internet Res. 21 (8), e14181.

Bekki, J.M., Smith, M.L., Bernstein, B.L., Harrison, C., 2013. Effects of an online personal resilience training program for women in STEM doctoral programs. J. Women Minorities Sci. Eng. 19 (1), 17–35.

Bolier, L., Abello, K.M., 2014. Online positive psychological interventions: State of the art and future directions. In: Parks, A.C., Schueller, S.M. (Eds.), The Wiley Blackwell Handbook of Positive Psychological Interventions. Wiley, Chichester, pp. 286–309.

Bruffaerts, R., Mortier, P., Kiekens, G., Auerbach, R.P., Cuijpers, P., Demyttenaere, K., Green, J.G., Nock, M.K., Kessler, R.D., 2018. Mental health problems in college freshmen: prevalence and academic functioning. J. Affect. Disord. 225, 97–103. https://doi.org/10.1016/j.jad.2017.07.044.

Bush, K., Kivlahan, D.R., McDonell, M.B., Fihn, S.D., Bradley, K.A., 1998. The AUDIT alcohol consumption questions (AUDIT-C): an effective brief screening test for problem drinking. Arch. Intern. Med. 158 (16), 1789–1795.

Chan, A.W., Tetzlaff, J.M., Altman, D.G., Laupacis, A., Gøtzsche, P.C., Krleža-Jerić, K., Hróbjartsson, A., Mann, H., Dickersin, K., Berlin, J.S., Doré, C.J., Parulekar, W.R., Summerskill, W.S.M., Groves, T., Schulz, K.F., Sox, H.C., Rockhold, F.W., Rennie, D., Moher, D., 2013. Statement: defining standard protocol items for clinical trials. Ann. Intern. Med. 158 (3), 200–207. https://doi.org/10.7326/0003-4819-158-3-201302050-00583.

Cohen, S., Kamarck, T., Mermelstein, R., 1983. A global measure of perceived stress. J. Health Soc. Behav. 24 (4), 385–396. https://doi.org/10.2307/2136404.

Collins, L.M., Murphy, S.A., Bierman, K.L., 2004. A conceptual framework for adaptive preventive interventions. Prev. Sci. 5 (3), 185–196.

Connor, K.M., Davidson, J.R., 2003. Development of a new resilience scale: the Connor-Davidson resilience scale (CD-RISC). Depress. Anxiety 18 (2), 76–82. https://doi.org/10.1002/da.10113.

Cuijpers, P., Noma, H., Karyotaki, E., Cipriani, A., Furukawa, T.A., 2019. Effectiveness and acceptability of cognitive behavior therapy delivery formats in adults with depression: a network meta-analysis. JAMA Psychiatry 76 (7), 700–707. https://doi.org/10.1001/jamapsychiatry.2019.0268.

Dagani, J., Baldessarini, R.J., Signorini, G., Nielssen, O., de Girolamo, G., Large, M., 2019. The age of onset of bipolar disorders. In: de Girolamo, G., McGorry, P.D., Sartorius, N. (Eds.), Age of Onset of Mental Disorders: Etiopathogenetic and Treatment Implications. Springer Nature, Cham, pp. 75–110. https://doi.org/10.1007/978-3-319-72619-9_5.

Devilly, G.J., Borkovec, T.D., 2000. Psychometric properties of the credibility/expectancy questionnaire. J. Behav. Ther. Exp. Psychiatry 31 (2), 73–86.

Díaz-García, A., Franke, M., Herrero, R., Ebert, D.D., Botella, C., 2021. Theoretical adequacy, methodological quality and efficacy of online interventions targeting resilience: a systematic review and meta-analysis. Eur. J. Public Health 31 (Suppl. 1), i11–i18. https://doi.org/10.1093/eurpub/ckaa255.

van Dierendonck, D., Lam, H., 2022. Interventions to enhance eudaemonic psychological well-being: a meta-analytic review with Ryff's scales of psychological well-being. Applied Psychology. Health and Well-Being. Advance online publication. https://doi.org/10.1111/aphw.12398.

Duffy, A., Saunders, K.E., Malhi, G.S., Patten, S., Cipriani, A., McNevin, S.H., Geddes, J., 2019. Mental health care for university students: a way forward? Lancet Psychiatry 6 (11), 885–887.

Dworschak, C., Heim, E., Maercker, A., 2022. Efficacy of internet-based interventions for common mental disorder symptoms and psychosocial problems in older adults: a systematic review and meta-analysis. Internet Interv. 27, 100498. https://doi.org/10.1016/j.invent.2022.100498.

Ebert, D.D., Zarski, A.C., Christensen, H., Stikkelbroek, Y., Cuijpers, P., Berking, M., Riper, H., 2015. Internet and computer-based cognitive behavioral therapy for anxiety and depression in youth: a meta-analysis of randomized controlled outcome trials. PloS One 10 (3), e0119895. https://doi.org/10.1371/journal.pone.0119895.

Ebert, D.D., Mortier, P., Kaehlke, F., Bruffaerts, R., Baumeister, H., Auerbach, R.P., Alonso, J., Cuijpers, P., Kuechler, A.M., Green, J., Hasking, P., Lapsley, C., Sampson, N.A., Kessper, R.C., 2019. Barriers of mental health treatment utilization among first-year college students: first cross-national results from the WHO World Mental Health International College Student Initiative. Int. J. Methods Psychiatr. Res. 28 (2), e1782. https://doi.org/10.1002/mpr.1782.

Enrique Roig, A., Mooney, O., Salamanca-Sanabria, A., Lee, C.T., Farrell, S., Richards, D., 2020. Assessing the efficacy and acceptability of a web-based intervention for resilience among college students: pilot randomized controlled trial. JMIR formative research 4 (11), e20167. https://doi.org/10.2196/20167.

Eysenbach, G., CONSORT-EHEALTH Group, 2011. CONSORT-EHEALTH: improving and standardizing evaluation reports of web-based and mobile health interventions. J. Med. Internet Res. 13 (4), e126. https://doi.org/10.2196/jmir.1923.

Firth, J., Torous, J., Nicholas, J., Carney, R., Pratap, A., Rosenbaum, S., Sarris, J., 2017. The efficacy of smartphone-based mental health interventions for depressive symptoms: a meta-analysis of randomized controlled trials. World Psychiatry 16 (3), 287–298. https://doi.org/10.1002/wps.20472.

Gentili, A., Failla, G., Melnyk, A., Puleo, V., Tanna, G.L.D., Ricciardi, W., Cascini, F., 2022. The cost-effectiveness of digital health interventions: a systematic review of the literature. Front. Public Health 10, 787135.

Harrer, M., Adam, S.H., Fleischmann, R.J., Baumeister, H., Auerbach, R., Bruffaerts, R., Cuijpers, P., Kessler, R.C., Berking, M., Lehr, D., Ebert, D.D., 2018. Effectiveness of an internet- and app-based intervention for college students with elevated stress: randomized controlled trial. J. Med. Internet Res. 20 (4), e136. https://doi.org/10.2196/jmir.9293.

Heber, E., Ebert, D.D., Lehr, D., Cuijpers, P., Berking, M., Nobis, S., Riper, H., 2017. The benefit of web-and computer-based interventions for stress: a systematic review and meta-analysis. J. Med. Internet Res. 19 (2), e32. https://doi.org/10.2196/jmir.5934.

Herrero, R., Mira, A., Cormo, G., Etchemendy, E., Baños, R., García-Palacios, A., Ebert, D. D., Franke, F., Berger, T., Schaub, M.P., Görlich, D., Jacobi, C., Botella, C., 2019. An internet-based intervention for improving resilience and coping strategies in university students: study protocol for a randomized controlled trial. Internet Interv. 16, 43–51. https://doi.org/10.1016/j.invent.2018.12.002.

Herrero, R., Vara, M.D., Miragall, M., Botella, C., García-Palacios, A., Riper, H., Kleiboer, A., Baños, R.M., 2020. Working Alliance Inventory for Online Interventions-Short Form (WAI-TECH-SF): the role of the therapeutic alliance between patient and online program in therapeutic outcomes. Int. J. Environ. Res. Public Health 17 (17), 6169. https://doi.org/10.3390/ijerph17176169.

Hervás, G., Vázquez, C., 2006. Enjoying every little thing: Orientation to daily gratification as a mediator of the relationship between extraversion and subjective well-being. In: 3rd European Conference of Positive Psychology. Braga, Portugal.

Joyce, S., Shand, F., Tighe, J., Laurent, S.J., Bryant, R.A., Harvey, S.B., 2018. Road to resilience: a systematic review and meta-analysis of resilience training programmes and interventions. BMJ Open 8, e017858.

Kazdin, A.E., 2017. Addressing the treatment gap: a key challenge for extending evidence-based psychosocial interventions. Behav. Res. Ther. 88, 7–18. https://doi.org/10.1016/j.brat.2016.06.004.

Krebs, P., Duncan, D.T., 2015. Health app use among US mobile phone owners: a national survey. JMIR Mhealth Uhealth 3 (4), e101. https://doi.org/10.2196/mhealth.4924.

Kroenke, K., Spitzer, R.L., Williams, J.B., 2001. The PHQ-9: validity of a brief depression severity measure. J. Gen. Intern. Med. 16 (9), 606–613. https://doi.org/10.1046/j.1525-1497.2001.016009606.x.

Leppin, A.L., Bora, P.R., Tilburt, J.C., Gionfriddo, M.R., Zeballos-Palacios, C., Dulohery, M.M., Sood, A., Erwin, P.J., Brito, J.P., Boehmer, K.R., Montori, V.M., 2014. The efficacy of resiliency training programs: a systematic review and meta-analysis of randomized trials. PloS One 9, e111420.

Linardon, J., Fuller-Tyszkiewicz, M., 2020. Attrition and adherence in smartphone-delivered interventions for mental health problems: a systematic and meta-analytic review. J. Consult. Clin. Psychol. 88 (1), 1–13. https://doi.org/10.1037/ccp0000459.

Macedo, T., Wilheim, L., Gonçalves, R., Freire Coutinho, E.S., Vielete, L., Figueira, I., Ventura, P., 2014. Building resilience for future adversity: a systematic review of interventions in non-clinical samples of adults. BMC Psychiatry 14, 227.

Mihalopoulos, C., Vos, T., Pirkis, J., Carter, R., 2011. The economic analysis of prevention in mental health programs. Annu. Rev. Clin. Psychol. 7, 169–201.

Moher, D., Hopewell, S., Schulz, K.F., Montori, V., Gøtzsche, P.C., Devereaux, P.J., Elbourne, D., Egger, D., Altman, D.G., 2010. CONSORT 2010 explanation and elaboration: updated guidelines for reporting parallel group randomised trials. J. Clin. Epidemiol. 63 (8), e1–e37. https://doi.org/10.1016/j.jclinepi.2010.03.004.

National Institute for Health and Care Excellence, 2011. Common mental health disorders: Guidance and guidelines. www.nice.org.uk/guidance/cg123.

Raes, F., Pommier, E., Neff, K.D., Van Gucht, D., 2011. Construction and factorial validation of a short form of the self-compassion scale. Clin. Psychol. Psychother. 18 (2), 250–255.

Robertson, I.T., Cooper, C.L., Sarkar, M., Curran, T., 2015. Resilience training in the workplace from 2003 to 2014: a systematic review. J. Occup. Organ. Psychol. 88, 533–562.

Robins, R.W., Hendin, H.M., Trzesniewski, K.H., 2001. Measuring global self-esteem: construct validation of a single-item measure and the Rosenberg self-esteem scale. Pers. Soc. Psychol. Bull. 27 (2), 151–161.

Robinson, L., Delgadillo, J., Kellett, S., 2020. The dose-response effect in routinely delivered psychological therapies: a systematic review. Psychother. Res. 30 (1), 79–96. https://doi.org/10.1080/10503307.2019.1566676.

Rose, R.D., Buckey, J.C., Zbozinek, T.D., Motivala, S.J., Glenn, D.E., Cartreine, J.A., Craske, M.G., 2013. A randomized controlled trial of a self-guided, multimedia, stress management and resilience training program. Behav. Res. Ther. 51 (2), 106–112. https://doi.org/10.1016/j.brat.2012.11.003.

Ryff, C.D., 1989. Happiness is everything, or is it? Explorations on the meaning of psychological well-being. J. Pers. Soc. Psychol. 57 (6), 1069–1081. https://doi.org/10.1037/0022-3514.57.6.1069.

Ryff, C.D., 2014. Psychological well-being revisited: advances in the science and practice of eudaimonia. Psychother. Psychosom. 83 (1), 10–28. https://doi.org/10.1159/000353263.

Spitzer, R.L., Kroenke, K., Williams, J.B., Löwe, B., 2006. A brief measure for assessing generalized anxiety disorder: the GAD-7. Arch. Intern. Med. 166 (10), 1092–1097. https://doi.org/10.1001/archinte.166.10.1092.

Torous, J., Nicholas, J., Larsen, M.E., Firth, J., Christensen, H., 2018. Clinical review of user engagement with mental health smartphone apps: evidence, theory and improvements. Evid. Based Ment. Health 21 (3), 116–119. https://doi.org/10.1136/eb-2018-102891.

Vanhove, A.J., Herian, M.N., Perez, A.L.U., Harms, P.D., Lester, P.B., 2016. Can resilience be developed at work? A meta-analytic review of resilience-building programme effectiveness. Journal of Occupational and Organizational Psychology 89, 278–307.

Vigo, D., Thornicroft, G., Atun, R., 2016. Estimating the true global burden of mental illness. Lancet Psychiatry 3 (2), 171–178. https://doi.org/10.1016/S2215-0366(15)00505-2 (PMID: 26851330).

Watson, D., Clark, L.A., Tellegen, A., 1988. Development and validation of brief measures of positive and negative affect: the PANAS scales. J. Pers. Soc. Psychol. 54 (6), 1063–1070. https://doi.org/10.1037/0022-3514.54.6.1063.

Williams, M., Coare, P., Marvell, R., Pollard, E., Houghton, A.-M., Anderson, J., 2015. Understanding Provision for Students with Mental Health Problems and Intensive Support Needs: Report to HEFCE by the Institute for Employment Studies (IES) and Researching Equity, Access and Partnership (REAP). Institute for Employment Studies, Brighton.

World Health Organization, 2019. WHO guideline: Recommendations on digital interventions for health system strengthening. In: Web Supplement 2: Summary of Findings and GRADE Tables (No. WHO/RHR/19.7). World Health Organization.