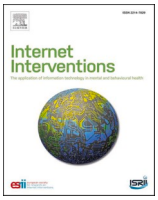
Internet Interventions 35 (2024) 100697

Contents lists available at ScienceDirect

Internet Interventions

journal homepage: www.elsevier.com/locate/invent



Bridging the adherence gap in internet interventions: A randomized controlled trial study protocol investigating context-specific self-efficacy

Ewelina Smoktunowicz [a,*], Jan Maciejewski [a], Magdalena Lesnierowska [a], Per Carlbring [b]

[a] StresLab Research Centre, Institute of Psychology, SWPS University, Warsaw, Poland
[b] Department of Psychology, Stockholm University, Stockholm, Sweden

ARTICLE INFO

Keywords:
Adherence
Self-guided internet intervention
Self-efficacy
Stress
Work engagement

ABSTRACT

Low adherence in self-guided internet interventions is linked to poorer outcomes. Although some predictors of adherence have been identified, few are modifiable for widespread application. One personal variable with the potential to increase adherence in internet interventions is context-specific self-efficacy. This protocol outlines a randomized controlled trial design, divided into two phases. In Phase 1 (students, $N = 216$), participants will complete a self-efficacy-enhancing exercise, which will be compared to a waitlist control group to test its effectiveness in increasing internet intervention adherence self-efficacy. Phase 2 will be the main two-arm trial, where all participants (medical students, $N = 952$) will undergo an internet intervention called Med-Stress Student. In the experimental group, the program will be preceded by the self-efficacy-enhancing exercise developed in Phase 1. We anticipate that participants in the experimental group will show higher adherence (primary outcome) to the intervention and greater improvement in intervention outcomes (secondary outcomes i.e., lower stress and higher work engagement) at posttest, as well as at six-month and one-year follow-ups. If effective, enhancing context-specific self-efficacy could be recommended before any internet intervention as a relatively simple way to boost participants' adherence.

1. Introduction

Adherence, defined as the extent to which people engage with or complete a therapeutic intervention (Beatty and Binnion, 2016), is a primary challenge that internet interventions face in both research and practice (Ryan et al., 2018). This issue is particularly evident in self-guided interventions, which, unlike guided interventions, cannot depend on professionals' input to monitor and enhance adherence when needed (Karyotaki et al., 2015; Carlbring et al., in press). Self-guided interventions play a crucial role though in making healthcare more accessible to diverse demographics. Once created, these interventions no longer require professional input and have the potential to be widely accessible, thus removing more barriers than other internet intervention formats (Edge et al., 2023).

Lower adherence can negatively impact intervention efficacy (Donkin et al., 2011; Eysenbach, 2005; Ryan et al., 2018; Vandelanotte et al., 2016). Since self-guided programs may yield weaker effects (Karyotaki et al., 2021), it is vital to identify factors that promote adherence. Several attempts have been made, such as Beatty and Binnion's (2016) systematic review, which found that factors associated with higher adherence included female sex, greater treatment expectancy, sufficient time, and personalized intervention content. A similar pattern of results was found in a study focusing on adherence to self-guided intervention (Kazlauskas et al., 2020). Some findings also suggest that age may be a factor, with older participants exhibiting higher adherence (e.g., Castro et al., 2018; Karyotaki et al., 2015). Factors related to the formal aspects of interventions, such as persuasive design (e.g., technology-delivered updates, interactions, feedback), also significantly predicted adherence (Kelders et al., 2012).

Most of these predictors are either stable characteristics or related to the intervention format. There is a need for a universal psychological variable with a strong theoretical foundation that can be enhanced in an evidence-based manner before internet intervention and that would increase users' adherence and, consequently, intervention outcomes. In the current study, we explore self-efficacy (Bandura, 1997), a variable previously found to improve adherence in contexts other than internet interventions. Defined as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (Bandura, 1997, p. 3), self-efficacy is recognized as a key personal resource (Hobfoll et al., 2018). It has been shown to predict willingness

* Corresponding author at: SWPS University, Chodakowska 19/31, 03-815 Warsaw, Poland.
E-mail address: esmoktunowicz@swps.edu.pl (E. Smoktunowicz).

https://doi.org/10.1016/j.invent.2023.100697
Received 4 June 2023; Received in revised form 22 November 2023; Accepted 1 December 2023
Available online 4 December 2023

to engage in challenging tasks and perseverance despite obstacles (Schwarzer, 1992)—factors that seem important for adherence. Indeed, several studies have found associations between self-efficacy and adherence in various contexts, such as adherence to face-to-face cognitive-behavioral therapy for insomnia (Bouchard et al., 2003) and adherence to treatment among individuals with heart failure (Maeda et al., 2013), HIV (Nokes et al., 2012), and those undergoing hemodialysis (Zrinyi, 2003). In the realm of internet interventions, findings on whether self-efficacy significantly predicts adherence are mixed (Beatty and Binnion, 2016). One reason for these discrepancies could be that most studies measured general self-efficacy, while a more predictive power is associated with self-efficacy tailored to a specific context (Bandura, 1977). In this study, we will focus on a particular type of self-efficacy: adherence to internet interventions.

Self-efficacy is considered a resource that can be enhanced for interventions. The four main sources of self-efficacy include performance accomplishments (mastery experiences), vicarious experiences, social persuasion, and physiological states (Bandura, 1977). Performance accomplishments cultivate self-efficacy through a pattern of repeated successes, typically making an individual resilient to occasional failures. In interventions, this often involves helping participants recognize that past successes can be repeated under different circumstances due to possessing specific skills or coping strategies. People utilize vicarious experiences to boost their self-efficacy by observing others successfully navigating difficult situations and applying those strategies to their lives. The objective of persuasion is to directly convince someone (or oneself) that a task can be achieved. Lastly, managing physiological and emotional reactions that might influence self-efficacy beliefs is beneficial. At the operational level, self-efficacy enhancement exercises take various forms: recalling past successes, using a model, identifying potential barriers and devising solutions, setting graded tasks, providing instructions, and offering guided reflections, among others. Multiple reviews have demonstrated that the effectiveness of these tasks depends on the health contexts in which they are applied and even on sample demographics (e.g., French et al., 2014; Marks et al., 2005). For instance, if an exercise requires participants to recall past successes in managing difficult situations, we need reasonable assurance that individuals in that particular intervention have relevant mastery experiences. Intervention designers should thus ensure that chosen exercises are not only theoretically supported but also compatible with the intervention's goals.

In the realm of internet interventions, self-efficacy has thus far been successfully bolstered mainly through exercises based on mastery and vicarious experiences (e.g., Cieslak et al., 2016; Smoktunowicz et al., 2021). We are unaware though of any internet intervention explicitly aiming to improve adherence by enhancing self-efficacy. Such experimental studies are also rare in traditional interventions. One example is a study demonstrating that promoting self-efficacy successfully increased adherence to treatment in patients with myocardial infarction (Polsook et al., 2016). In this case, self-efficacy was enhanced by building motivation, teaching essential skills for medication adherence, and implementing daily monitoring. However, this intervention was individually delivered, which is not a feasible approach when attempting to increase adherence to self-guided internet interventions. What is needed is a method to enhance internet intervention adherence self-efficacy that can be delivered in the same manner as self-guided interventions: on a large scale and without human support.

2. Study aims

The primary research question for this project is whether context-specific self-efficacy, specifically related to internet intervention adherence, improves adherence. To answer this question, we will conduct a randomized controlled trial (RCT). Because RCTs are not only costly in terms of money but also demand significant time and effort from participants, we will divide this study into two phases. The objective of Phase 1 is to test the effectiveness of an exercise designed to increase self-efficacy for adhering to internet interventions. We hypothesize that participants assigned to a condition in which they complete a self-efficacy-enhancing exercise will demonstrate higher internet intervention adherence self-efficacy compared to those in the control group. Phase 2 will rely on the success of Phase 1, as we will utilize the effective self-efficacy-enhancing exercise. If we fail to detect a difference in self-efficacy between the two groups, we will modify the exercise's content and repeat Phase 1. Phase 2 will be the main trial. We plan to implement "Med-Stress Student", an internet intervention designed to improve occupational health of medical students who are already professionally active. This program is a modified version of the "Med-Stress" intervention, which has been previously found to demonstrate clinical effectiveness (Smoktunowicz et al., 2021). To assess occupational health, we will focus on two key indicators: perceived job stress and work engagement. Work engagement, as defined by Schaufeli et al. (2002, p. 74), is "... a positive, fulfilling, work-related state of mind that is characterized by vigor, dedication, and absorption". By measuring both a positive outcome (work engagement) and stress, we ensure capturing the multidimensional aspects of occupational health. In Phase 2 we expect that participants who complete the self-efficacy-enhancing exercise before the main intervention, that is Med-Stress Student, will demonstrate higher adherence (primary outcome) and improved intervention outcomes (secondary outcomes i.e., reduced stress and increased work engagement) compared to those in an active control group, where Med-Stress Student will not be preceded by the self-efficacy enhancement exercise. Based on our understanding of adherence predictors, we anticipate a small difference between the two groups. It's crucial to underscore that even such small effects can have an impact in the case of self-guided interventions that can be disseminated on a large scale. Our overarching goal is to develop an exercise that can be used to increase adherence self-efficacy across various internet interventions, irrespective of their content.

3. Methods

This study was approved by the departmental Ethical Review Board at SWPS University (02/P/05/2023). Protocol version 1.0. was registered at ClinicalTrials.gov on 16th June 2023 (study identifier NCT05881161). The protocol follows the Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT) guidelines (Butcher et al., 2022; Supplementary Material). Departures from the protocol will be transparently listed in the future reporting of the study's results. Data will be collected online and subsequently managed and stored securely in a password-protected folder accessible only to the dedicated research team. When reporting the results, we will make the anonymized dataset and statistical code available.

3.1. Phase 1

3.1.1. Study design and sample

We will conduct an experimental study with two parallel conditions to evaluate the effectiveness of an evidence-based exercise on internet intervention adherence self-efficacy compared to a waitlist control. As the main study (i.e., Phase 2) targets medical students, Phase 1 will also be conducted with a student population. The only inclusion criteria will be student status and age: participants must be at least 18 years old.

To detect an anticipated effect size of $d = 0.40$ with a significance level set at $\alpha = 0.05$ and a power of $(1\text{-}\beta) = 0.90$, we will collect data from a sample of 216 participants. Effect size is anticipated based on previous studies that employed self-efficacy-enhancing exercises in internet interventions. In a study by Cieslak et al. (2016), the Cohen's d between the experimental condition (self-efficacy-enhancing exercise) and active control (education) was found to be 0.45 for contextual self-efficacy. In another study (Rogala et al., 2016), the effect for a different contextual self-efficacy was found to be $d = 0.64$. In both cases, the

control condition was an active one. Since the control condition in the current study is a waitlist, we might expect a larger difference. We anticipate a smaller effect size though, of $d = 0.40$, given that the exercise is short (compared to the interventions spanning several weeks described above). We will stop recruiting once we reach the planned number of participants.

3.1.2. Procedure

The study flow is illustrated in Fig. 1. Student participants will be recruited through targeted Facebook ads and the internal university system in exchange for credits. Interested students will be directed to the website, a survey platform, where they will learn more about the study conditions and will need to sign an informed consent form to participate. Internet interventions are still relatively uncommon in Poland (Topooco et al., 2017), which potentially makes it challenging for participants to respond to questions about adherence to programs they are not familiar with. To address this problem, participants will read a description of an example internet intervention (called Stressbot) designed to help students cope with stress and will be presented with screenshots from the intervention. To further enhance the realism of the experience, they will be asked to perform two short exercises from the Stressbot intervention. Participants will then be randomized (in a 1:1 block) via survey platform to either the experimental or control condition. In the experimental condition, they will complete the exercise designed to increase their self-efficacy for adhering to internet interventions. Participants in the control condition will be waitlisted. Finally, both groups will complete online the Internet Interventions Adherence Self-Efficacy Scale. Once Phase 1 is completed, participants in the control group will also gain access to the self-efficacy-enhancing exercise.

3.1.3. Exercise to enhance self-efficacy for adherence to internet interventions

The exercise consists of a testimonial video and a set of text-based tasks. The video features a group of individuals sharing their experiences with an internet intervention, discussing initial expectations, unexpected barriers, and solutions that helped them adhere to the intervention. The video aims to enhance participants' adherence self-efficacy through vicarious experience (learning from models in the video) and social persuasion. Following the video, participants will complete two tasks. The first is guided reflection, where participants will reflect on the video, identify one potential obstacle they might face during a subsequent internet intervention, and will devise their own solution to prevent or overcome it. The aim of the task is to enhance self-efficacy through vicarious experience, planning, and self-persuasion. In the final task, participants will relate to one adherence strategy presented in the video - motivational self-talk. They will create a short, personalized catchphrase to use when participating in an intervention becomes difficult. Examples of such catchphrases are provided earlier in the video. This task relies on self-persuasion and planning. Although Bandura (1977, 1997) considered mastery experiences to be the most crucial source of self-efficacy, we opted against using them in the exercise, as we anticipate many students in the sample may have recent experiences of non-adherence to tasks (e.g., classes, physical activities, diets).

3.1.4. Outcome measure

The Internet Intervention Adherence Self-Efficacy Scale (IIASES) was developed over three pilot studies. Items were created based on the HIV Treatment Adherence Self-Efficacy Scale (HIV-ASES; Johnson et al., 2007) and subsequently adjusted to fit the context of internet interventions. Modifications were informed by: 1) reviewing papers on adherence to internet interventions and ensuring that identified issues were reflected in the proposed scale, 2) consulting field experts, such as internet intervention creators, and 3) obtaining feedback from users of an actual internet intervention, Med-Stress (Smoktunowicz et al., 2021), on factors that facilitated their continuation (completers) or impeded

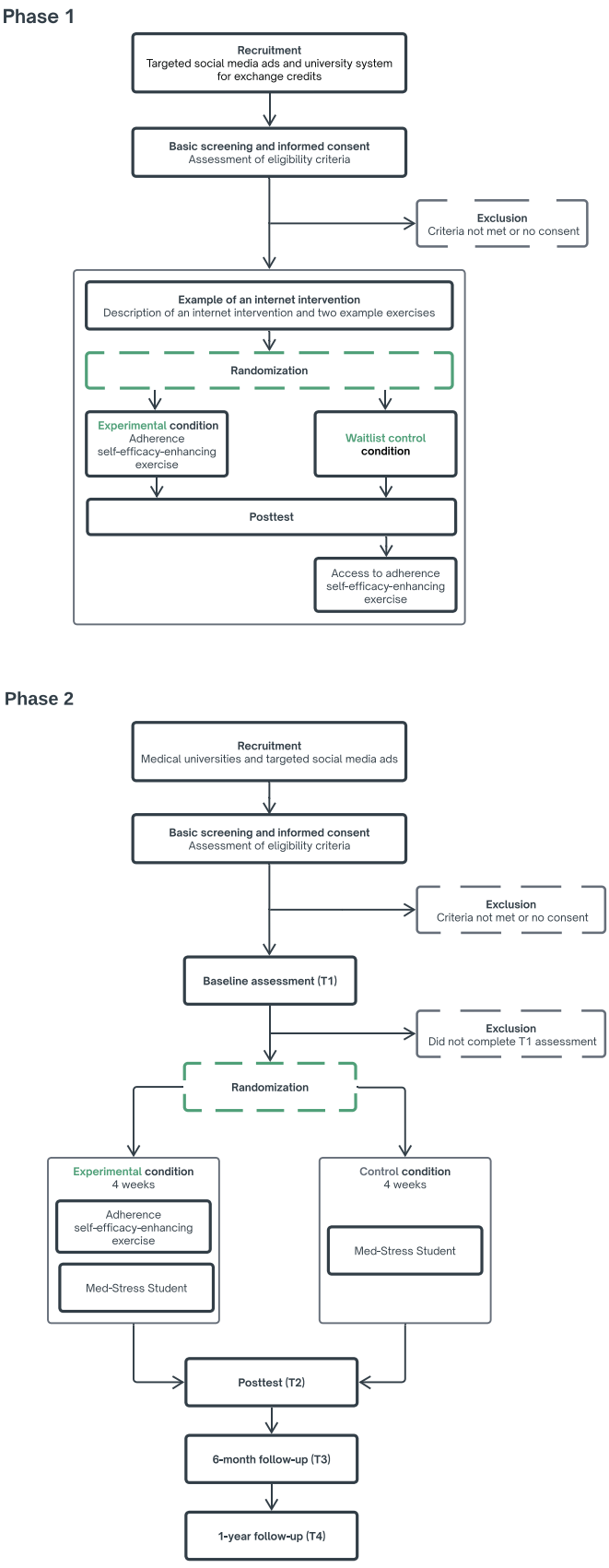


Fig. 1. Study flow: Phase 1 and Phase 2.

their completion (dropouts). The initial scale consisted of 14 items (Table 1). The scale's psychometric properties were tested in three pilot studies. In Study 1, participants engaged in a two-week happiness-enhancing intervention (called Hapibot) delivered via Meta's Messenger app. Over a one-week period: two consecutive days of tasks, followed by a break, and then another two consecutive days of tasks. The tasks needed to be completed online and offline. Happiness-boosting exercises included identifying appreciative aspects of life and photographing them, planning and participating in enjoyable activities, and rephrasing perceptions of successes and failures.

Study 1's sample was divided into two subsamples for exploratory (n = 95) and confirmatory factor analyses (n = 283). Eigenvalues (8.43 and 1.21) from the exploratory factor analysis and scree plot identified two factors, consistent with the HIV-ASES structure. The first factor, called Integration, referred to incorporating internet interventions into daily routines, while the Perseverance factor related to maintaining participation despite challenges. Confirmatory factor analysis (CFA) indicated poor model fit based on multiple goodness-of-fit indices (see Table 2). Additionally, the adherence self-efficacy mean in the sample was high (M = 7.63, SD = 1.60, scale 1–10), suggesting that participants might have overestimated their anticipated adherence. Participants had likely no prior experience with internet interventions, and the description provided before completing the scale was probably overly optimistic.

Factor loadings for the initial version of the scale were all >1, and the scale's reliability was very good (Cronbach's alpha for Integration factor was 0.91 and for Perseverance factor it was 0.94), providing no statistical grounds for removing any items. Following Stanton et al.'s (2002) guidelines, we then removed those items that could have been viewed as redundant by study participants, potentially causing negative reactions (items 2 and 7; see Table 1). In Study 2, we aimed to provide participants with a more realistic picture of what it means to remain adherent to an internet intervention, including information on time and effort required.

Table 2
Confirmatory factor analyses of the IIASES-14 in Study 1 (N = 283), IIASES-12 in Study 2 (N = 155), and of the IIASES-8 in Study 3 (N = 305).

Model	CFI	TLI	SRMR	RMSEA [90 % CI]	χ^2	df
IIASES-14						
One-factor model	0.83	0.80	0.06	0.17 [0.16–0.18]	674.20	77
Two-factor model	0.86	0.85	0.06	0.15 [0.13–0.16]	512.16	76
IIASES-12						
One-factor model	0.87	0.84	0.07	0.14 [0.12–0.16]	212.58	54
Two-factor model	0.90	0.88	0.07	0.12 [0.10–0.14]	171.61	53
IIASES-8						
One-factor model	0.89	0.85	0.05	0.21 [0.19–0.23]	294.34	20
Two-factor model	0.96	0.94	0.03	0.13 [0.10–0.15]	114.49	19

Note. IIASES = Internet Interventions Adherence Self-Efficacy Scale, CFI = Comparative Fit Index, TLI = Tucker-Lewis Index, RMSEA = Root Mean Square Error of Approximation, SRMR = Standardized Root Mean Residual, χ^2 = chi square, *df* = degrees of freedom.

Description was supplemented with screenshots of the intervention they were about to join. Participants were students (N = 155), part of the waitlist group in another RCT being conducted in our lab, about to gain access to a weeklong intervention aimed at improving students' well-being (called Stressbot). CFA showed suboptimal fit once again (Table 2). We were likely too conservative in reducing the number of items before pilot study 2. Thus, we consulted experts on enhancing self-efficacy in interventions and revised the scale again. We retained 8 items

Table 1
Development of the Internet Intervention Adherence Self-Efficacy Scale (IIASES) Items.

	IIASES-14		IIASES-12		IIASES-8 (Final)	
Factor I: Integration	1.	Integrate this program into your daily routine?	1.	Integrate this program into your daily routine?	1.	Integrate this program into your usual daily routine?
	2.	Stick to the program schedule even when your daily routine is disrupted?	2.	Stick to the program schedule when you aren't feeling well?	2.	Stick to the program schedule when you aren't feeling well?
	3.	Stick to the program schedule when you aren't feeling well?	3.	Continue with the program even if doing so interferes with your daily activities?	3.	Continue with the program even if doing so interferes with your daily activities?
	4.	Continue with the program even if doing so interferes with your daily activities?				
Factor II: Perseverance	5.	Complete the program even if your health and well-being don't improve immediately or even worsen at first?	4.	Complete the program even if your health and well-being don't improve immediately or even worsen at first?	4.	Complete the program, even if its effects are not immediately visible?
	6.	Complete the program even if you quickly feel sufficiently helped?	5.	Complete the program even if you quickly feel sufficiently helped?	5.	Complete the program even if you quickly feel sufficiently helped?
	7.	Complete the program even when you are feeling discouraged about your health and well-being?	6.	Complete the program even when attending sessions (online or in person) is a major hassle?	6.	Complete the program even if you encounter temporary technical difficulties? (e.g., while navigating the interface)
	8.	Complete the program even when attending sessions (online or in person) is a major hassle?	7.	Get something positive out of your participation in the program, even if it doesn't improve your health or well-being?	7.	Complete the program even if it is time-consuming?
	9.	Get something positive out of your participation in the program, even if it doesn't improve your health or well-being?	8.	Complete the program even if new commitments in your life take up your time?	8.	Complete the program even if its pace is occasionally too slow or too fast?
	10.	Complete the program even if new commitments in your life take up your time?	9.	Complete the program even if you encounter temporary technical difficulties?		
	11.	Complete the program even if you encounter temporary technical difficulties?	10.	Complete the program even if it is time-consuming?		
	12.	Complete the program even if it is time-consuming?	11.	Complete the program even if its pace is occasionally too slow or too fast?		
	13.	Complete the program even if its pace is occasionally too slow or too fast?	12.	Complete the program even if you think it could be more appealing visually?		
	14.	Complete the program even if you think it could be more appealing visually?				

Note. IIASES = Internet Intervention Adherence Self-Efficacy Scale. IIASES-14 = scale validated in pilot Study 1, IIASES-12 = scale validated in pilot Study 2, IIASES-8 = scale validated in pilot Study 3 (final version).

that were evaluated as clear, non-redundant, and crucial for capturing adherence in internet interventions (Table 1).

Study 3 was conducted on a student sample ($N = 305$), but this time, participants were not only provided with an example intervention description but also experienced a simulation: they had to complete one exercise from the internet intervention before filling out the scale. In study 3, we tested the scale's validity; therefore, participants were asked to complete the general self-efficacy scale and to participate in an actual internet intervention to enable us to measure their adherence. That intervention was a short version of Stressbot, lasting one day. We measured two types of adherence: objective adherence, assessed by the length of responses to open questions where participants were encouraged to provide as many details as possible, and subjective adherence, measured with a question: "In your opinion, how accurately have you completed all the tasks: have you followed the instructions, reflected on the questions, and responded to them exhaustively?" All indices showed satisfactory fit except for the root mean square error of approximation (RMSEA) (Table 2), which is much greater than the recommended cutoff of 0.80 (Hu and Bentler, 1999). However, RMSEA has been shown to indicate poor fit when the sample is insufficiently large and degrees of freedom are relatively few (Kenny et al., 2015). Based on the satisfactory values of the remaining indices, we found the fit adequate. The reliability of the scale's final version was 0.95, with 0.92 for Integration and 0.94 for Perseverance factor. As for criterion validity, we found IIASES-8 to correlate with general self-efficacy at $r = 0.14$, $p = 0.02$. The effect was significant but small. We believe the reason was once again the novelty of internet interventions for participants, despite our attempts to make them more familiar. IIASES-8 correlated significantly with both objective ($r = 0.17$, $p = 0.003$) and subjective adherence ($r = 0.25$, $p < 0.001$). These small effects are generally what we expected for both the pilot and main studies. Notably, the Perseverance factor predicted both types of adherence, while Integration significantly predicted only perceived adherence (Table 3). In Phase 1, while responding to scale items, participants will be instructed to think about a future internet intervention they might participate in. To enhance realism, they will be provided with details about the intervention, such as duration, number of exercises, and screenshots of example exercises. These details will be taken from an internet intervention called Med-Stress Student, which will be used in Phase 2 with a different sample of participants.

3.1.5. Statistical analysis

A posttest-only control group study will be conducted. To compare the means between experimental and control groups, we will conduct an analysis using a *t*-test for independent samples.

3.2. Phase 2

3.2.1. Study design and sample

We will conduct a randomized control trial with two parallel conditions to test whether an exercise that enhances self-efficacy adherence increases actual adherence and, secondarily, improves intervention outcomes when compared to an active control. Participants must meet the following criteria: 1) be at least 18 years old, and 2) be medical students in their final year or interns who already practice under supervision. Drawing from the correlations observed in Study 3 between self-efficacy for adherence to internet interventions and both objective and subjective adherence, we anticipate a small difference between the study arms for these primary outcomes. For this difference to hold clinical significance, it must be at least $d = 0.20$. Using the powerlmm package in R (Magnusson, 2019), assuming an effect size of $d = 0.20$ and $\beta = 0.90$ with three measurement points, and accounting for a 30 % dropout rate (Maciejewski and Smoktunowicz, 2023), we estimate that 476 participants will be needed for each condition ($N = 952$).

3.2.2. Procedure

The study flow for Phase 2 is presented in Fig. 1. Participants will be recruited mainly through medical universities, but also via targeted ads on social media. Our engagement approach involves close collaboration with medical university faculties. We aim to show students the potential positive influence of participating in proposed internet intervention on their future professional practice and personal well-being. Interested students will be invited to visit the study website to learn more about the study's goals. Those who sign the informed consent and complete baseline assessment online will be randomized (in a 1:1 block) to one of the two study conditions. The randomization sequence will be generated by a researcher who is not involved in the study. Participants in both groups will gain access to the Med-Stress Student internet intervention; a relevant link will be sent via e-mail by a research team. Those allocated to the experimental group will first complete an additional exercise designed to boost their adherence self-efficacy. After each week, they will receive a reminder of this exercise. Specifically, they will be reminded that, while completing the intervention may be challenging, it is worthwhile. They will also be prompted to recall the catchphrase that they devised prior to the intervention, which is intended to help them persevere through obstacles. Group allocation will not be revealed to participants but, given that they will be recruited from the same universities, masking might not be possible. Participants will be recruited not only from medical universities but also through other channels, such as targeted social media ads; therefore, there will be no stratification. Med-Stress Student will last for 4 weeks. Although participants in the experimental group have an additional exercise to complete, it is very short and does not warrant adding extra time. Subsequently, participants will fill out questionnaires (posttest) and then again at 6-month and 1-year follow-ups. At each measurement time, participants will receive an e-mail with a survey link and, to ensure a high response rate, two e-mail reminders will follow. After the study is fully completed, we will inform the participants about their group allocation, and those from the control group will gain access to the adherence self-efficacy-enhancing exercise. Participants can withdraw from the study at any time. Participants experiencing any psychological discomfort or

Table 3
Means, standard deviations and correlations of variables in pilot Study 3.

	M	SD	Range	1	2	3	4	5
1. IIASES	5.77	2.35	0–10	–				
2. IIASES_Integration	5.63	2.41	0–10	0.91***	–			
3. IIASES_Perseverance	5.86	2.51	0–10	0.97***	0.79***	–		
4. GSES	3.10	0.40	1–4	0.14*	0.14*	0.13*	–	
5. Objective adherence	21.82	11.20	0–53.44[a]	0.17**	0.11	0.19***	0.05	–
6. Subjective adherence	4.11	0.76	1–5	0.25***	0.21***	0.25***	0.21***	0.18**

Note. IIASES = Internet Interventions Adherence Self-Efficacy Scale, IIASES_Integration = Integration subscale, IIASES_Perseverance = Perseverance subscale, GSES = General Self-Efficacy, Objective adherence = mean number of words in open ended questions, Subjective adherence = perceived adherence to the intervention.

[a] The range reflects the minimum and maximum values provided by the participants.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

unintended effects from the study will be urged to contact the study team or a mental-health professional.

3.2.3. Intervention

Med-Stress Student: Med-Stress Student is a self-guided, CBT-based internet intervention designed to strengthen personal resources for coping with job stress and promoting well-being in medical settings. The program is a version of the clinically tested Med-Stress intervention (Smoktunowicz et al., 2021), specifically tailored to students and interns who already work in direct contact with patients. Med-Stress Student is based on exercises that enhance key resources, beginning with self-efficacy, followed by perceived social support. Such a sequence has previously been found to be the most effective (Smoktunowicz et al., 2021). Additionally, the intervention includes exercises to monitor and reflect on stress dynamics and overall well-being, as well as tasks aimed at directly reducing tension, such as relaxation, mindfulness, appreciation, and lifestyle adjustments. The program spans four weeks, divided into four parts provided to participants weekly. New exercises will be made available regardless of the completion of previous ones. Each week, participants receive two exercises. Completing each weekly part takes between 30 min and 1.5 h, depending on the participants' engagement.

Week 1: Participants will gain access to two exercises: self-monitoring and pleasant activities. The first exercise aims to measure daily stress and mood levels, with the primary goal of reflecting on day-to-day fluctuations in well-being. Participants will be encouraged to recognize direct and indirect factors contributing to stress and well-being, devise ways to mitigate and manage stressors effectively, and reflect on the sources of positive moods. The second exercise consists of tasks designed to support stress management through actionable strategies. In the first week, the exercise focuses on assisting participants in planning and implementing pleasant activities that foster stress reduction. Participants will be encouraged to reflect on the aspects that either supported or hindered the implementation of their plan.

Week 2: The second week consists of two exercises: mastery experiences and appreciation. The first exercise aims to reinforce beliefs about one's own efficacy in handling stressful situations at work by reflecting on previous successes and recognizing coping mechanisms that can be applied in the future. The appreciation exercise aims to promote an immediate enhancement of well-being. Participants will be instructed to identify positive aspects of their daily lives, which can be documented with either written descriptions or images.

Week 3: The third week of the intervention includes two exercises: vicarious experience as well as relaxation and mindfulness. The first exercise enhances self-efficacy to cope with stress through learning by observation. Participants will be encouraged to identify a real-life model in their professional environment and adopt their coping strategies. The relaxation and mindfulness exercise aims to facilitate coping by using stress-relieving techniques and activities. It involves various audio-guided techniques, such as progressive relaxation, breathing exercises, body scanning, visualization of the body's warmth and weight, and imagining a calm place.

Week 4: Participants will be given access to two exercises: perceived social support and physical activity. The first exercise is designed to enhance perceived support by challenging distorted assumptions regarding seeking and obtaining support. Participants will be then encouraged to practice communication skills for requesting help by identifying and planning effective communication strategies. Similar to week 1, the second exercise supports stress management through actionable strategies and lifestyle adjustments, encouraging participants to plan and integrate stress-reducing physical activities into their daily routines. The task involves creating a weekly schedule of activities and reflecting on the reasons for success or failure in its implementation.

3.2.4. Outcome measures

Primary outcomes.

Adherence to intervention

Since it is beneficial to measure adherence in multiple ways within a study (Beatty and Binnion, 2016), we will measure both objective and subjective adherence. Objective adherence will be based on quantifiable metrics, specifically the absolute number and percentage of completed exercises within the program. Subjective adherence will be assessed weekly using the following question after each set of exercises: “How accurately, in your opinion, have you completed all tasks? For example, did you follow the instructions, reflect on the questions, and respond to them exhaustively?” Participants will be asked to respond on a scale from 1 (not accurately at all) to 5 (very accurately). Subjective adherence will be determined by averaging these weekly scores with higher total scores indicating higher adherence. This weekly assessment ensures that participants evaluate each week individually, rather than just the most recent one. Adherence will be evaluated at the posttest only.

Secondary outcomes.

Job stress will be measured using the Perceived Stress Scale-4 (PSS-4; Cohen et al., 1983). The brief version of the scale consists of four items, rated on a scale ranging from 0 (never) to 4 (very often). A higher total score indicates a heightened level of stress perception. The questionnaire's instructions have been modified to align with the occupational context. Job stress will be measured at baseline, posttest, and at 6 months and 1 year follow ups.

Work engagement will be measured using the Utrecht Work Engagement Scale with nine items (UWES-9; Schaufeli et al., 2006). The response range varies between 0 (never) and 6 (always), with a higher total score signifying greater work engagement. Work engagement will be measured at baseline, posttest, and at 6 months and 1 year follow ups.

3.2.5. Statistical Analyses

We will first conduct a preliminary data analysis, including a randomization check and a dropout analysis. Study dropout will be defined as attrition to posttest. Objective and subjective adherence will be compared between conditions at posttest with *t*-tests or Mann-Whitney *U* test depending on the normality assumption. To verify our hypotheses regarding intervention outcomes (i.e., reduced stress and increased work engagement) we will build Linear Mixed Effects Models (West et al., 2015) consisting of the interaction between measurement time and condition. The analyses will be conducted on both completers and multiply imputed data to test for the robustness of the findings. Finally, we will conduct sensitivity analyses to test for discrepancies in effects between the completers and non-completers samples. All analyses will be conducted in R.

4. Discussion

To the best of our knowledge, this is the first study that aims to improve adherence to internet interventions and intervention outcomes by enhancing context-specific self-efficacy. It builds on previous successful programs that strengthened self-efficacy in similar work-related contexts (Cieslak et al., 2016; Smoktunowicz et al., 2021), which increases the probability that our current efforts to boost internet intervention adherence self-efficacy will be effective. Current study builds also on prior work addressing the challenges faced by interventions aimed at improving adherence, particularly those involving acceptance-facilitation interventions (AFIs) as reported in studies such as Lin et al. (2018) and Batterham et al. (2021). These earlier studies tested whether adding content designed to enhance acceptance would subsequently increase both uptake and adherence but reported no significant differences in acceptance or adherence. A potential reason for these null effects could be the passive delivery of acceptance-enhancing content, offered in a format requiring only watching or listening. In our study participants will be asked to actively engage in a self-efficacy-enhancing exercise through self-reflection and planning. Previous adherence improvement attempts were also often content-specific. Participants received detailed content on the forthcoming intervention, potentially

producing a counterproductive effect by discouraging users, as noted by Batterham et al. (2021). To address this problem, our exercise focuses on enhancing self-efficacy for adherence by identifying and overcoming common barriers to maintaining consistent use and completion of internet interventions. For instance, presented testimonials will discuss general challenges, like managing time for tasks, without focusing on specific intervention content. Finally, Lin et al. (2018) suggested that high acceptance didn't necessarily guarantee sustained adherence, indicating the need to explore alternatives to AFIs, especially those securing adherence throughout various intervention stages. In response, in our study we depart from focusing on increasing acceptance and instead will strive to bolster specific self-efficacy. Although our approach aims to enhance self-efficacy just once, we will incorporate reminders of the self-efficacy boosting exercise throughout the intervention.

The study also has a secondary goal: The intervention, Med-Stress Student, is dedicated to medical students and interns with the hope that we can help them learn to cope with stress before they enter their jobs full time. Previously, it was found that Med-Stress was helpful in reducing occupational stress in medical professionals but did not decrease their job burnout (Smoktunowicz et al., 2021). This suggests that equipping future medical workers with skills to cope with stressful situations before they fully enter working life might be beneficial. While this does not guarantee immunity to job burnout and other health problems, understanding occupational stress and knowing strategies to cope with it might help in identifying factors in the working environment that can potentially lead to destructive outcomes. Sometimes, it might be possible for them to flag these factors and have them changed, or it might help young people decide whether to stay or change workplaces if that option is available. The long-term impact of Med-Stress Student will not be tested in this study, but the results of the one-year follow-up measurement should provide some indication of whether this intervention is helpful in boosting participants' resilience.

We expect several challenges and limitations. First, we can likely anticipate only small gains in adherence and intervention outcomes as a result of enhancing adherence self-efficacy. As we argued earlier, even small effects can translate into significant benefits, yet we want to be clear that bolstering adherence self-efficacy potentially represents just one way to address the problem of adherence. Second, we expect that Phase 1 might not be initially successful and could require modifications to the self-efficacy enhancement exercise, which would make the study more resource-consuming. Nevertheless, dividing the study into two phases limits potential resource losses, as only the first part might need to be repeated. We also expect that recruiting the required sample of medical students will be challenging. We have already established cooperation with several medical universities, and we anticipate that involving a group of students in the creation of the intervention (through their reviewing the exercises and having them better reflect the working environment in medicine) will encourage others to participate in the main trial. Finally, the current study will be conducted on specific samples of educated, relatively young and privileged people. If the self-efficacy-enhancing exercise turns out to be effective it would still need to be tested in other populations before we can deem it universally applicable.

5. Conclusions

Our overarching aim with this study is to test the potency of an exercise designed to enhance adherence self-efficacy to improve actual adherence to internet interventions. Because the study is based on evidence-based means to improve self-efficacy, if successful, other researchers and practitioners should be able to recreate the adherence self-efficacy bolstering exercise for the purpose of their own interventions, perhaps as an add-on prior to the main program. We hope to contribute to addressing the problem of adherence, one of the main issues in the field of internet interventions.

Funding

This research was supported by the institutional research grant SUB/IPsy/2019/23 awarded to Ewelina Smoktunowicz. The funder does not and will not have a role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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.2023.100697.

References

Bandura, A., 1977. Self-efficacy: toward a unifying theory of behavioral change. Psychol. Rev. 84, 191–215. https://doi.org/10.1037/0033-295X.84.2.191.

Bandura, A., 1997. Self-efficacy: The Exercise of Control (1997-08589-000). W H Freeman/Times Books/Henry Holt & Co.

Batterham, P.J., Calear, A.L., Sunderland, M., Kay-Lambkin, F., Farrer, L.M., Christensen, H., Gulliver, A., 2021. A brief intervention to increase uptake and adherence of an internet-based program for depression and anxiety (enhancing engagement with psychosocial interventions): randomized controlled trial. J. Med. Internet Res. 23 (7), e23029 https://doi.org/10.2196/23029.

Beatty, L., Binnion, C., 2016. A systematic review of predictors of, and reasons for, adherence to online psychological interventions. Int. J. Behav. Med. 23 (6), 776–794. https://doi.org/10.1007/s12529-016-9556-9.

Bouchard, S., Bastien, C., Morin, C.M., 2003. Self-efficacy and adherence to cognitive-behavioral treatment of insomnia. Behav. Sleep Med. 1 (4), 187–199. https://doi.org/10.1207/S15402010BSM01042.

Butcher, N.J., Monsour, A., Mew, E.J., Chan, A.W., Moher, D., Mayo-Wilson, E., Terwee, C.B., Chee-A-Tow, A., Baba, A., Gavin, F., Grimshaw, J.M., Kelly, L.E., Saeed, L., Thabane, L., Askie, L., Smith, M., Farid-Kapadia, M., Williamson, P.R., Szatmari, P., Tugwell, P., Offringa, M., 2022. Guidelines for reporting outcomes in trial protocols: the SPIRIT-outcomes 2022 extension. JAMA 328 (23), 2345–2356. https://doi.org/10.1001/jama.2022.21243.

Carlbring, P., Hadjistavropoulos, H., Kleiboer, A., Andersson, G., 2023. A new era in Internet interventions: the advent of chat-GPT and AI-assisted therapist guidance. Internet Interv. https://doi.org/10.1016/j.invent.2023.100621 (in press).

Castro, A., López-Del-Hoyo, Y., Peake, C., Mayoral, F., Botella, C., García-Campayo, J., Baños, R.M., Nogueira-Arjona, R., Roca, M., Gili, M., 2018. Adherence predictors in an Internet-based intervention program for depression. Cogn. Behav. Ther. 47 (3), 246–261. https://doi.org/10.1080/16506073.2017.1366546.

Cieslak, R., Benight, C.C., Rogala, A., Smoktunowicz, E., Kowalska, M., Zukowska, K., Yeager, C., Luszczynska, A., 2016. Effects of Internet-based self-efficacy intervention on secondary traumatic stress and secondary posttraumatic growth among health and human services professionals exposed to indirect trauma. Front. Psychol. 7 https://doi.org/10.3389/fpsyg.2016.01009.

Cohen, S., Kamarck, T., Mermelstein, R., 1983. A global measure of perceived stress. J. Health Soc. Behav. 24 (4), 385–396.

Donkin, L., Christensen, H., Naismith, S.L., Neal, B., Hickie, I.B., Glozier, N., 2011. A systematic review of the impact of adherence on the effectiveness of e-therapies. J. Med. Internet Res. 13 (3), e52 https://doi.org/10.2196/jmir.1772.

Edge, D., Watkins, E.R., Limond, J., Mugadza, J., 2023. The efficacy of self-guided internet and mobile-based interventions for preventing anxiety and depression – a systematic review and meta-analysis. Behav. Res. Ther. 164, 104292 https://doi.org/10.1016/j.brat.2023.104292.

Eysenbach, G., 2005. The law of attrition. J. Med. Internet Res. 7 (1), e11 https://doi.org/10.2196/jmir.7.1.e11.

French, D.P., Olander, E.K., Chisholm, A., Mc Sharry, J., 2014. Which behaviour change techniques are most effective at increasing older adults' self-efficacy and physical activity behaviour? A systematic review. Ann. Behav. Med. 48 (2), 225–234. https://doi.org/10.1007/s12160-014-9593-z.

Hobfoll, S.E., Halbesleben, J., Neveu, J.-P., Westman, M., 2018. Conservation of resources in the organizational context: the reality of resources and their consequences. Annu. Rev. Organ. Psych. Organ. Behav. 5, 103–128. https://doi.org/10.1146/annurev-orgpsych-032117-104640.

Hu, L.T., Bentler, P.M., 1999. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Struct. Equ. Model. 6 (1), 1–55. https://doi.org/10.1080/10705519909540118.

Johnson, M.O., Neilands, T.B., Dilworth, S.E., Morin, S.F., Remien, R.H., Chesney, M.A., 2007. The role of self-efficacy in HIV treatment adherence: validation of the HIV Treatment Adherence Self-Efficacy Scale (HIV-ASES). J. Behav. Med. 30 (5), 359–370. https://doi.org/10.1007/s10865-007-9118-3.

Karyotaki, E., Kleiboer, A., Smit, F., Turner, D.T., Pastor, A.M., Andersson, G., Berger, T., Botella, C., Breton, J.M., Carlbring, P., Christensen, H., de Graaf, E., Griffiths, K., Donker, T., Farrer, L., Huibers, M.J.H., Lenndin, J., Mackinnon, A., Meyer, B., Cuijpers, P., 2015. Predictors of treatment dropout in self-guided web-based interventions for depression: an 'individual patient data' meta-analysis. Psychol. Med. 45 (13), 2717–2726. https://doi.org/10.1017/S0033291715000665.

Karyotaki, E., Efthimiou, O., Miguel, C., Bermpohl, F.M.G., Furukawa, T.A., Cuijpers, P., Riper, H., Patel, V., Mira, A., Gemmil, A.W., Yeung, A.S., Lange, A., Williams, A.D., Mackinnon, A., Geraedts, A., van Straten, A., Meyer, B., Björkelund, C., Forsell, Y., Individual Patient Data Meta-Analyses for Depression (IPDMA-DE) Collaboration, 2021. Internet-based cognitive behavioral therapy for depression: a systematic review and individual patient data network Meta-analysis. JAMA Psychiatry 78 (4), 361–371. https://doi.org/10.1001/jamapsychiatry.2020.4364.

Kazlauskas, E., Eimontas, J., Olff, M., Zelviene, P., Andersson, G., 2020. Adherence predictors in internet-delivered self-help intervention for life stressors-related adjustment disorder. Front. Psychol. 11, 137. https://doi.org/10.3389/fpsyt.2020.00137.

Kelders, S.M., Kok, R.N., Ossebaard, H.C., Gemert-Pijnen, J.E.V., 2012. Persuasive system design does matter: a systematic review of adherence to web-based interventions. J. Med. Internet Res. 14 (6), e2104 https://doi.org/10.2196/jmir.2104.

Kenny, D.A., Kaniskan, B., McCoach, D.B., 2015. The Performance of RMSEA in Models With Small Degrees of Freedom. Sociol. Methods Res. 44 (3), 486–507. https://doi.org/10.1177/0049124114543236.

Lin, J., Faust, B., Ebert, D.D., Krämer, L., Baumeister, H., 2018. A web-based acceptance-facilitating intervention for identifying patients' acceptance, uptake, and adherence of internet- and mobile-based pain interventions: randomized controlled trial. J. Med. Internet Res. 20 (8), e9925 https://doi.org/10.2196/jmir.9925.

Maciejewski, J., Smoktunowicz, E., 2023. Low-effort internet intervention to reduce students' stress delivered with meta's messenger chatbot (Stressbot): A randomized controlled trial. Internet Interv. 33, 100653 https://doi.org/10.1016/j.invent.2023.100653.

Maeda, U., Shen, B.-J., Schwarz, E.R., Farrell, K.A., Mallon, S., 2013. Self-efficacy mediates the associations of social support and depression with treatment adherence in heart failure patients. Int. J. Behav. Med. 20 (1), 88–96. https://doi.org/10.1007/s12529-011-9215-0.

Magnusson, K., 2019. *Methodological Issues in Psychological Treatment Research: Applications to Gambling Research and Therapist Effects*. Karolinska Institutet.

Marks, R., Allegrante, J.P., Lorig, K., 2005. A review and synthesis of research evidence for self-efficacy-enhancing interventions for reducing chronic disability: implications for health education practice (part II). Health Promot. Pract. 6 (2), 148–156. https://doi.org/10.1177/1524839904266792.

Nokes, K., Johnson, M.O., Webel, A., Rose, C.D., Phillips, J.C., Sullivan, K., Tyer-Viola, L., Rivero-Méndez, M., Nicholas, P., Kemppainen, J., Sefcik, E., Chen, W.-T., Brion, J., Eller, L., Kirksey, K., Wantland, D., Portillo, C., Corless, I.B., Voss, J., Holzemer, W.L., 2012. Focus on increasing treatment self-efficacy to improve human immunodeficiency virus treatment adherence. J. Nurs. Scholarsh. 44 (4), 403–410. https://doi.org/10.1111/j.1547-5069.2012.01476.x.

Polsook, R., Aungsuroch, Y., Thongvichean, T., 2016. The effect of self-efficacy enhancement program on medication adherence among post-acute myocardial infarction. Appl. Nurs. Res. 32, 67–72. https://doi.org/10.1016/j.apnr.2016.05.002.

Rogala, A., Smoktunowicz, E., Żukowska, K., Kowalska, M., Cieślak, R., 2016. The helpers' stress: effectiveness of a web-based intervention for professionals working with trauma survivors in reducing job burnout and improving work engagement. Med. Pr. 67 (2), 223–237 cmedm. 10.13075/mp.5893.00220.

Ryan, C., Bergin, M., Wells, J.S., 2018. Theoretical perspectives of adherence to web-based interventions: a scoping review. Int. J. Behav. Med. 25 (1), 17–29. https://doi.org/10.1007/s12529-017-9678-8.

Schaufeli, W.B., Salanova, M., González-Romá, V., Bakker, A.B., 2002. The measurement of engagement and burnout: a two sample confirmatory factor analytic approach. J. Happiness Stud. 3 (1), 71–92. https://doi.org/10.1023/A:1015630930326.

Schaufeli, W.B., Bakker, A.B., Salanova, M., 2006. The measurement of work engagement with a short questionnaire: a cross-national study. Educ. Psychol. Meas. 66 (4), 701–716. https://doi.org/10.1177/0013164405282471.

Schwarzer, R. (Ed.), 1992. Self-Efficacy: Thought Control of Action. Hemisphere Publishing Corp (pp. xiv, 410).

Smoktunowicz, E., Lesnierowska, M., Carlbring, P., Andersson, G., Cieslak, R., 2021. Resource-based internet intervention (med-stress) to improve well-being among medical professionals: randomized controlled trial. J. Med. Internet Res. 23 (1), e21445 https://doi.org/10.2196/21445.

Stanton, J.M., Sinar, E.F., Balzer, W.K., Smith, P.C., 2002. Issues and strategies for reducing the length of self-report scales. Pers. Psychol. 55 (1), 167–194. https://doi.org/10.1111/j.1744-6570.2002.tb00108.x.

Topooco, N., Riper, H., Araya, R., Berking, M., Brunn, M., Chevreul, K., Cieslak, R., Ebert, D.D., Etchmendy, E., Herrero, R., Kleiboer, A., Krieger, T., García-Palacios, A., Cerga-Pashoja, A., Smoktunowicz, E., Urech, A., Vis, C., Andersson, G., 2017. Attitudes towards digital treatment for depression: a European stakeholder survey. Internet Interv. 8, 1–9. https://doi.org/10.1016/j.invent.2017.01.001.

Vandelanotte, C., Müller, A.M., Short, C.E., Hingle, M., Nathan, N., Williams, S.L., Lopez, M.L., Parekh, S., Maher, C.A., 2016. Past, present, and future of eHealth and mHealth research to improve physical activity and dietary behaviors. J. Nutr. Educ. Behav. 48 (3), 219–228.e1. https://doi.org/10.1016/j.jneb.2015.12.006.

West, B., Welch, K., Galecki, A., 2015. Linear Mixed Models. A Practical Guide Using Statistical Software, Second edition. Chapman and Hall/CRC, Boca Raton, Florida. https://doi.org/10.1201/b17198.

Zrinyi, M., 2003. Dietary self-efficacy: determinant of compliance behaviours and biochemical outcomes in haemodialysis patients. Nephrol. Dial. Transplant. 18 (9), 1869–1873. https://doi.org/10.1093/ndt/gfg307.