



Efficacy of internet-based interventions for common mental disorder symptoms and psychosocial problems in older adults: A systematic review and meta-analysis

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ABSTRACT

Background: Although a high proportion of older adults suffer from common mental disorder symptoms and psychosocial problems, only a small number of older individuals seek psychological treatment. Internet-based interventions have the potential to bridge this treatment gap. However, while there is extensive literature on internet-based treatments in younger to middle-aged adults, research on older individuals is lacking.

Objective: We aimed to summarize narratively and empirically the existing literature on the efficacy of internet-based interventions for the treatment of common mental disorder symptoms and psychosocial problems (loneliness, stress) in older individuals.

Methods: This systematic review and meta-analysis was registered in PROSPERO (registration number: CRD42021235129). Systematic literature searches were conducted in PsycInfo, Ageline, Medline, CINHAL, and Psynex. Studies were eligible for inclusion if they a) focused on older adults, b) assessed the efficacy of an internet-delivered psychological intervention, c) included a control condition and d) assessed common mental disorder symptoms or psychosocial problems as outcomes. Meta-analyses were conducted based on studies that included a passive, minimally active or placebo control condition to estimate pooled effects on overall symptom severity as well as on specific psychological outcomes.

Results: 11 Studies met inclusion criteria, with the majority of interventions focusing on depression or anxiety symptoms and being based on CBT principles. Significant large effect of internet-based interventions for older adults were found for overall symptom severity (depression, anxiety, PTSD, stress) as well as for depression symptom severity. No significant effects were found for anxiety symptom severity.

Discussion: Our findings provide preliminary support that internet-based interventions might be a feasible and effective intervention method for the treatment of common mental disorder symptoms and stress in older adults. However, research in this area is still at an early stage. More studies are needed to shed light on the role of various treatment and patient characteristics in the efficacy of internet-delivered treatments.

1. Introduction

The global population is rapidly aging such that by 2050 about one in five individuals is expected to be older than 60 years (United Nations, 2015). The aging of the population has been described as the greatest social demographic and medical challenge worldwide (Rudnicka et al., 2020). In response, the World Health Organization (WHO) (2020) has emphasized the need for concrete actions to ensure a long and healthy life.

Research has shown that mental disorders are highly prevalent in

older adults. Andreas et al. (2017) revealed that half of adults aged 65 to 84 years have experienced a mental disorder in their lifetime, a third within the past year, and almost a fourth currently suffer from a mental disorder. Anxiety and mood disorders were found to be most prevalent (Andreas et al., 2017). Besides, a considerable number of older individuals also suffer from subclinical psychosocial problems, such as loneliness or stress (e.g., Perissinotto et al., 2012; Thapa et al., 2020). Although these are not disorders in themselves, they can cause substantial distress and have been found to increase risk for the development of a number of mental disorders (e.g., Cacioppo et al., 2006;

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Johansson et al., 2010; Kwag et al., 2011; Wilson et al., 2007).

Despite the prevalent and negative impact of mental disorders and psychosocial problems on older adults' well-being, only a small number of older individuals seek psychological treatment (Byers et al., 2012; Trollor et al., 2007). Lack of perceived need for mental health services as well as self-sufficiency beliefs have been identified as factors impeding the provision of psychotherapy to older individuals (Mackenzie et al., 2010). Moreover, a perceived age gap between patient and therapist as well as transportation and mobility restrictions could be additional barriers to mental health service use among this age cohort (Knaevelsrud et al., 2017). Thus, there is an urgent need for innovative treatment approaches, to close or at least reduce this treatment gap in mental health care.

Internet-based psychological interventions have been found to be a promising method to circumvent a number of barriers associated with face-to-face treatments. The term "internet-based interventions" covers a broad variety of different types of interventions, such as internet-based cognitive behavioral therapy (CBT) or internet-based mindfulness meditation. Importantly, these treatments all have in common that they are translated into a format which can mainly be delivered via the internet and involve some therapeutic tasks which are delegated to the computer (or smartphone/tablet) (Andersson and Titov, 2014). Advantages of this treatment method include lack of geographic boundaries (Kersting et al., 2009), cost-effectiveness (Squires and Hester, 2002) and anonymity (Bosworth et al., 1998). Additionally, they may reduce the stigma of seeing a psychotherapist (Cuijpers et al., 2008; Marks et al., 2007). To date, most research on internet-based treatment approaches has mainly been conducted in younger and middle-aged adults proving high effectiveness of these interventions (Andersson et al., 2019). However, the literature on internet-based treatments in older adults is limited (Andersson et al., 2013). As there is evidence that the number of older individuals using the internet is continuously increasing (Hunsaker and Hargittai, 2018), this treatment approach has the potential to bridge the existing treatment gap in mental health care among older individuals.

Although still scarce, there exist a few studies investigating the efficacy of internet-based psychological treatment approaches in older individuals. In order to inform both clinical practice as well as future research it is important to systematically summarize existing interventions as well as to assess their evidence base in older adults. To date, four reviews have overviewed the existing literature on internet-based psychological interventions in older adults, revealing that research in this field is still at an early stage (Crabb et al., 2012; Grossman et al., 2020; Preschl et al., 2011; Xiang et al., 2020). However, three of them (Crabb et al., 2012; Grossman et al., 2020; Preschl et al., 2011) did not calculate pooled effect estimates using meta-analysis methods and two out of those three (Crabb et al., 2012; Grossman et al., 2020) focused on specific disorders (e.g., depression), a specific mode of delivery (e.g., mhealth), or a specific treatment approach (e.g., CBT). When pooled effect estimates were calculated, Xiang et al. (2020) found that internet-based interventions were a promising approach for reducing psychopathological symptoms among older individuals. However, findings of the latter study are limited to internet-based CBTs for late-life depressive symptoms. So far, there is no study that summarizes both narratively as well as empirically the existing research on the efficacy of internet-based interventions for the treatment of common mental disorder symptoms and psychosocial problems among older individuals, taking into account a variety of different types of interventions as well as of psychopathological symptoms.

To address this gap, we conducted a systematic review and meta-analysis on the existing literature on internet-based psychological interventions for the treatment of common mental disorder symptoms and psychosocial problems in older adults. We were mainly interested in a) what kind of interventions already exist and b) how effective they are in improving older adults' mental health. In order to gain a broad overview as well as to capture all relevant literature, we decided to 1) include a

wide range of different types of internet-based psychological interventions (e.g., CBT, mindfulness meditation), 2) assess the efficacy of those interventions on a variety of common mental disorder symptoms (e.g., mood disorders, anxiety disorders) and psychosocial problems (loneliness, stress), as well as to 3) set the age of study participants to 50 years or older.

2. Methods

This systematic review and meta-analysis was registered in the international prospective register of systematic reviews (PROSPERO: CRD42021235129).

2.1. Eligibility criteria

Studies were eligible for inclusion if they (a) focused on older adults (all participants aged ≥ 50 years). In line with previous meta-analyses focusing on older adults (Gould et al., 2012a; Xiang et al., 2020), we decided to use a cut-off of 50 years or older as trials differ in the age-group categories they use to define "older adults" (e.g., some North American studies of older adults included participants aged 50/55 years or above). In addition, studies had to (b) assess the efficacy of an internet-delivered and "home-based" (i.e. completely feasible from home) psychological intervention for the treatment of common mental disorder symptoms (e.g., depressive symptoms) and psychosocial problems (loneliness and stress). Only (c) controlled studies (randomized controlled trials (RCTs) and non-randomized controlled trials (non-RCTs)) involving any form of control condition were included. Further, (d) outcomes eligible for inclusion were quantitative post-intervention measures of common mental disorder symptoms or psychosocial problems. Controlled pilot studies were included in case no results of larger trials had been published by the study team.

2.2. Search strategy and study selection

The following databases were searched: PsycInfo, Ageline, Medline, CINAHL, and Psynex. Four search concepts were combined in order to capture relevant literature: mode of delivery (e.g., internet-based), type of treatment (e.g., intervention), age (e.g., old age) and common mental disorders (e.g., depression) as well as psychosocial problems (e.g., loneliness). Data were retrieved on 22 July 2020. As the first search had not included both sleep disorders (as common mental disorders) as well as mobile-based interventions (as mode of delivery), two additional corresponding searches were conducted on 16 December 2020. Only journal articles and dissertations were included. No restrictions were imposed on the date of publication. The literature searches were conducted in English, French, German and Italian. The full search strategy in English is provided in Appendix A.

To identify eligible studies, two researchers independently screened titles and abstracts of retrieved studies according to the inclusion criteria, which were then applied to the full texts of the eligible publications. All disagreements were resolved through discussion and consultation of the third author (AM).

2.3. Data extraction

Relevant data was extracted by one researcher and checked for consistency by another. Data extracted included details about the population, intervention, study methods and outcomes related to the specific objectives and review questions.

2.4. Risk of bias assessment

The methodological quality of included studies was assessed independently by two reviewers and disagreements were resolved through discussion. To assess risk of bias in included RCTs, we used the revised

Cochrane risk-of-bias tool (RoB 2; Sterne et al., 2019) which addresses the following domains: (1) bias arising from the randomization process, (2) bias due to deviations from intended interventions, (3) bias due to missing outcome data, (4) bias in measurement of the outcome, (5) bias in the selection of the reported result. The included studies were rated as having “low risk”, “some concerns” or “high risk of bias” on each domain as well as overall.

To assess risk of bias in included non-RCTs, we used the Cochrane risk of bias in non-randomized studies of interventions tool (ROBINS-I; Sterne et al., 2016). According to this tool, the following domains were assessed: (1) bias due to confounding, (2) bias in selection of participants into the study, (3) bias in classification of interventions, (4) bias due to deviations from intended interventions, (5) bias due to missing data, (6) bias in measurement of outcomes, (7) bias in selection of the reported result. Each criterion as well as overall risk of bias was rated as “low risk”, “moderate risk”, “serious risk”, “critical risk” or “no information”.

It is important to note, that blinding of participants and personnel is hardly to be achieved in psychotherapy research (Munder and Barth, 2018) resulting in a “high risk of bias” rating in the respective domains.

2.5. Meta-analytical procedure

Data were analyzed using R version 4.1.0 (R Core Team, 2021). Only studies comparing the effect of an internet-based psychological intervention to a passive (e.g., wait-list control group), minimally active (e.g., weekly support) or placebo control condition were included in the analyses. All analyses were conducted using primary outcome data at posttreatment. If a study included more than one intervention group, effect sizes of these groups were aggregated into one single effect size according to Harrer et al. (2021).

First, one overall effect size for all psychological outcomes was computed. Since a few studies used multiple primary outcome measures and thus contributed more than one effect size, a multilevel meta-analysis (three-level meta-analysis) was conducted to account for the nesting of effect sizes (Harrer et al., 2021). In a three-level meta-analysis, three levels of variance are included in the model: (1) sample variance, (2) the within-study variance of effect sizes in the same study and (3) the between-study variance of effect sizes from different studies (Assink et al., 2018; Van den Noortgate et al., 2013). The three-level meta-analysis was conducted using the R package metafor (Viechtbauer, 2010). As effect size, Hedges' g , which corrects for biases due to small sample sizes (Cuijpers, 2016), was calculated. To evaluate model fit, we compared the three-level model to a two-level model with level three heterogeneity constrained to zero using the likelihood ratio test. Further, to assess statistical heterogeneity, we used the Cochran's Q and I^2 -statistic, which indicates the level of heterogeneity in percentages (Cuijpers, 2016; Higgins et al., 2003). An I^2 of 25% can be interpreted as low, 50% as moderate and 75% as high statistical heterogeneity (Higgins et al., 2003). In three-level meta-analysis models, this heterogeneity variance can be split into two parts, one attributable to level two and one to level three, resulting in two I^2 values (Cheung, 2014; Harrer et al., 2021).

Second, random effects meta-analyses were conducted to analyze the effect of internet-based interventions on specific psychological outcomes in older individuals (at least two studies per outcome) using the R package meta (Balduzzi et al., 2019) (Balduzzi et al., 2019). Hedges' g was calculated as effect size, and the Q and I^2 statistic as indicators of statistical heterogeneity.

To identify possible moderators, subgroup analyses were conducted in case of at least three studies per subgroup for: (1) treatment approach (CBT vs. other approaches), (2) level of guidance (therapist-guided vs. self-guided), (3) level of tailoring of the intervention to older adults (tailored vs. not tailored), and (4) study quality.

The possible influence of publication bias was investigated by Egger's regression test for funnel plot asymmetry if data permitted (Egger et al., 1997).

3. Results

3.1. Study selection

The database search provided a total of 3203 results. After removing duplicates, and screening titles, abstracts and full-texts against inclusion criteria, a total of 11 studies were included in this review. Fig. 1 illustrates the search and selection process and reasons for exclusion according to the PRISMA-guidelines.

3.2. Quality of studies

The methodological quality of the 10 RCTs included is visually depicted in Figs. 2 and 3. Among RCTs (10 studies), the criterion least met was blinding of outcome assessment, as most studies were rated with a high risk of bias on this domain (80%). In the other domains, RCTs were predominantly rated with low risk of bias (randomization process: 50%; deviations from intended interventions: 40%; missing outcome data: 0%; selection of the reported result: 0%). Overall, most randomized studies were rated with a high risk of bias (90%). Two aspects are important to note here: First, as mentioned before, blinding of participants and personnel is nearly impossible to achieve in psychotherapy research (Munder and Barth, 2018), resulting in a rating of “high risk of bias” in the respective domains. Second, according to the RoB 2 guidelines (Sterne et al., 2019) a rating of “high risk of bias” in at least one domain results in an overall judgment of “high risk of bias” for the respective study.

One non-RCT was included. The results of the risk of bias assessment of this study are detailed in Fig. 4. The domains rated with a serious risk of bias were bias due to confounding as well as bias due to selection of participants. All other domains were rated with low risk of bias. Overall risk of bias was rated as serious.

3.3. Study characteristics

The main characteristics of included studies are detailed in Table 1. All studies were published between 2014 and 2018. Three studies were conducted in the US (Cook et al., 2015; Tomasino et al., 2017; Wahbeh, 2018), three in Australia (Dear et al., 2015; Titov et al., 2015, 2016), one in Canada (Jones et al., 2016), one in Sweden (Silfvernagel et al., 2018), one in the UK (Killen and Macaskill, 2015), one in Switzerland (Proyer et al., 2014), and one in Germany (Knaevelsrud et al., 2017). Types of study design included 10 RCTs (Cook et al., 2015; Dear et al., 2015; Jones et al., 2016; Knaevelsrud et al., 2017; Proyer et al., 2014; Silfvernagel et al., 2018; Titov et al., 2015, 2016; Tomasino et al., 2017; Wahbeh, 2018) and one non-RCT (Killen and Macaskill, 2015). Seven studies compared the effects of an internet-based intervention to a wait-list control condition (Cook et al., 2015; Dear et al., 2015; Jones et al., 2016; Knaevelsrud et al., 2017; Titov et al., 2015; Tomasino et al., 2017; Wahbeh, 2018), two to another active intervention (Killen and Macaskill, 2015; Titov et al., 2016), one to a placebo condition (Proyer et al., 2014) and one to a minimally active condition (weekly general support) (Silfvernagel et al., 2018). Sample size ranged from 40 to 433 ($M = 124.09$, $SD = 124.65$), for a total of 1365 older adults. Participants' age ranged between 50 and 93 years, with only three studies including individuals younger than 60 years of age (Cook et al., 2015; Proyer et al., 2014; Wahbeh, 2018). In most samples, participants were predominantly female, in a partnership, unemployed and rather highly educated (see Appendix B for detailed description).

Four studies targeted depression (Proyer et al., 2014; Titov et al., 2015; Tomasino et al., 2017; Wahbeh, 2018), two anxiety (Dear et al., 2015; Jones et al., 2016), two anxiety and depression (Silfvernagel et al., 2018; Titov et al., 2016), two stress (Cook et al., 2015; Killen and Macaskill, 2015), and one PTSD (Knaevelsrud et al., 2017). Treatment approaches and theoretical foundations evaluated were CBT (Dear et al., 2015; Jones et al., 2016; Knaevelsrud et al., 2017; Silfvernagel et al.,

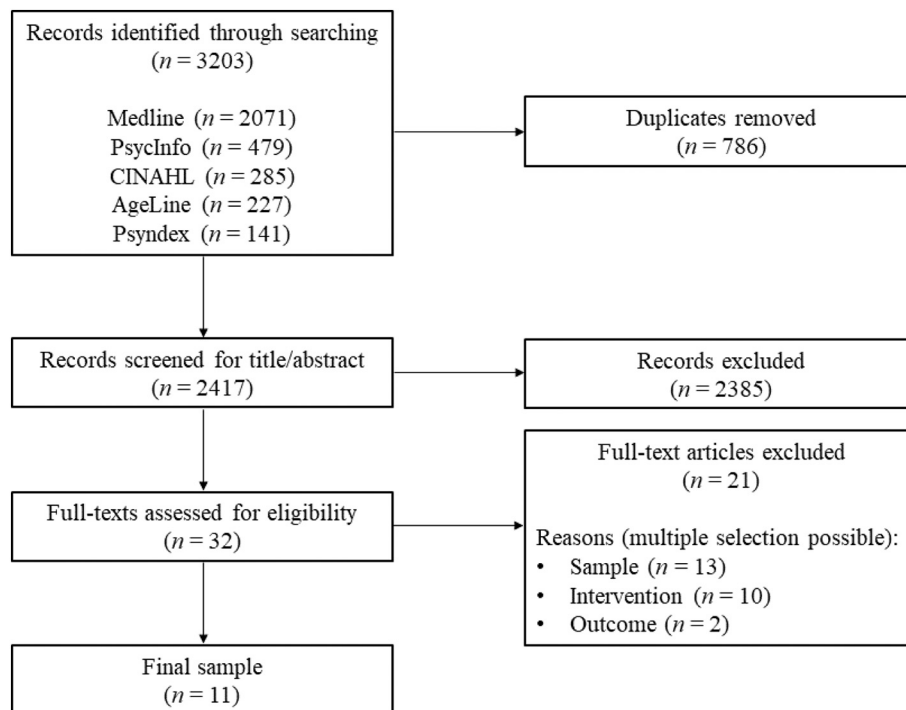


Fig. 1. PRISMA flow chart of study inclusion process.

2018; Titov et al., 2015, 2016; Tomasino et al., 2017), positive psychology (Killen and Macaskill, 2015; Proyer et al., 2014), social cognitive theory (Cook et al., 2015) and mindfulness (Wahbeh, 2018). Seven interventions included some level of therapist involvement (Dear et al., 2015; Jones et al., 2016; Knaevelsrud et al., 2017; Silfvernagel et al., 2018; Titov et al., 2015, 2016; Tomasino et al., 2017), whereas five studies examined self-guided treatment (Cook et al., 2015; Killen and Macaskill, 2015; Proyer et al., 2014; Titov et al., 2016; Wahbeh, 2018). Eight studies tested interventions that were specifically adapted for older adults (e.g., age-appropriate case stories) (Cook et al., 2015; Dear et al., 2015; Jones et al., 2016; Knaevelsrud et al., 2017; Silfvernagel et al., 2018; Titov et al., 2015, 2016; Tomasino et al., 2017), whereas three studies evaluated interventions without adaptations (Killen and Macaskill, 2015; Proyer et al., 2014; Wahbeh, 2018). Intervention duration ranged from one week to 12 weeks ($M = 7$, $SD = 3.19$). Aspects of feasibility such as treatment satisfaction were predominantly rated positively (see Appendix C for detailed description).

3.4. Intervention characteristics

Hereinafter included studies are presented in order of their main intervention focus. For an overview of all included studies, see Table 1.

3.4.1. Depression

The systematic search yielded four studies focused on depression. Proyer et al. (2014) evaluated the impact of four positive psychology interventions (i.e., *gratitude visit*, *three good things*, *three funny things*, and *using signature strengths in a new way*) in older adults. The main focus of treatment methods based on positive psychology is on fostering positive feelings, behaviors or cognitions (Sin and Lyubomirsky, 2009). The one-week interventions were self-guided and delivered via a free website. The effectiveness of each intervention was compared against a placebo control exercise (*early memories*) during which participants were asked to write down early childhood memories and look for similarities in these memories each evening before going to bed over a period of one week.

Titov et al. (2015) developed and evaluated the *Managing Your Mood*

Course, an internet-based CBT program for older adults with depressive symptoms. The intervention comprises five online lessons, case stories reporting the experiences of older individuals recovering from depression as well as brief weekly contact with a clinical psychologist. Treatment duration is eight weeks.

Tomasino et al. (2017) tested the effects of two versions of *MoodTech* (individually vs. with peer support), an eight-week internet-based treatment for depression developed for older individuals. The intervention makes use of common CBT principles and includes 16 sessions that comprise didactic content and follow two character storylines. Both program versions involve contact with a clinical psychologist. In addition, the *MoodTech* version with peer support includes features such as profiles and an “activity feed” aimed to promote social engagement and accountability.

The *Internet Mindfulness Meditation Intervention* (IMMI) tested in the study by Wahbeh (2018) is a six-week self-guided standardized and structured program for depression. The aim of the intervention is to teach skills to modify stress reactions. Each of the six sessions includes both didactic content as well as practice in mindfulness meditation.

3.4.2. Anxiety

The search yielded two studies focused on anxiety. Dear et al. (2015) developed and evaluated the *Managing Stress and Anxiety Course*, an eight-week internet-based CBT program for older adults with symptoms of anxiety. The program includes five lessons and combines didactic content with case-enhanced learning examples. Participants interact with a clinical psychologist weekly via telephone or secure email.

The *GAD Online for older adults* intervention tested in the study by Jones et al. (2016) is an internet-delivered CBT for older adults with generalized anxiety. The program provides psycho-educational material as well as teaches strategies for coping with anxiety and comprises contact with a therapist.

3.4.3. Anxiety and depression

Two studies focused on combined depression and anxiety. The intervention tested by Silfvernagel et al. (2018) is an eight-week therapist-guided individually tailored internet-delivered CBT program for

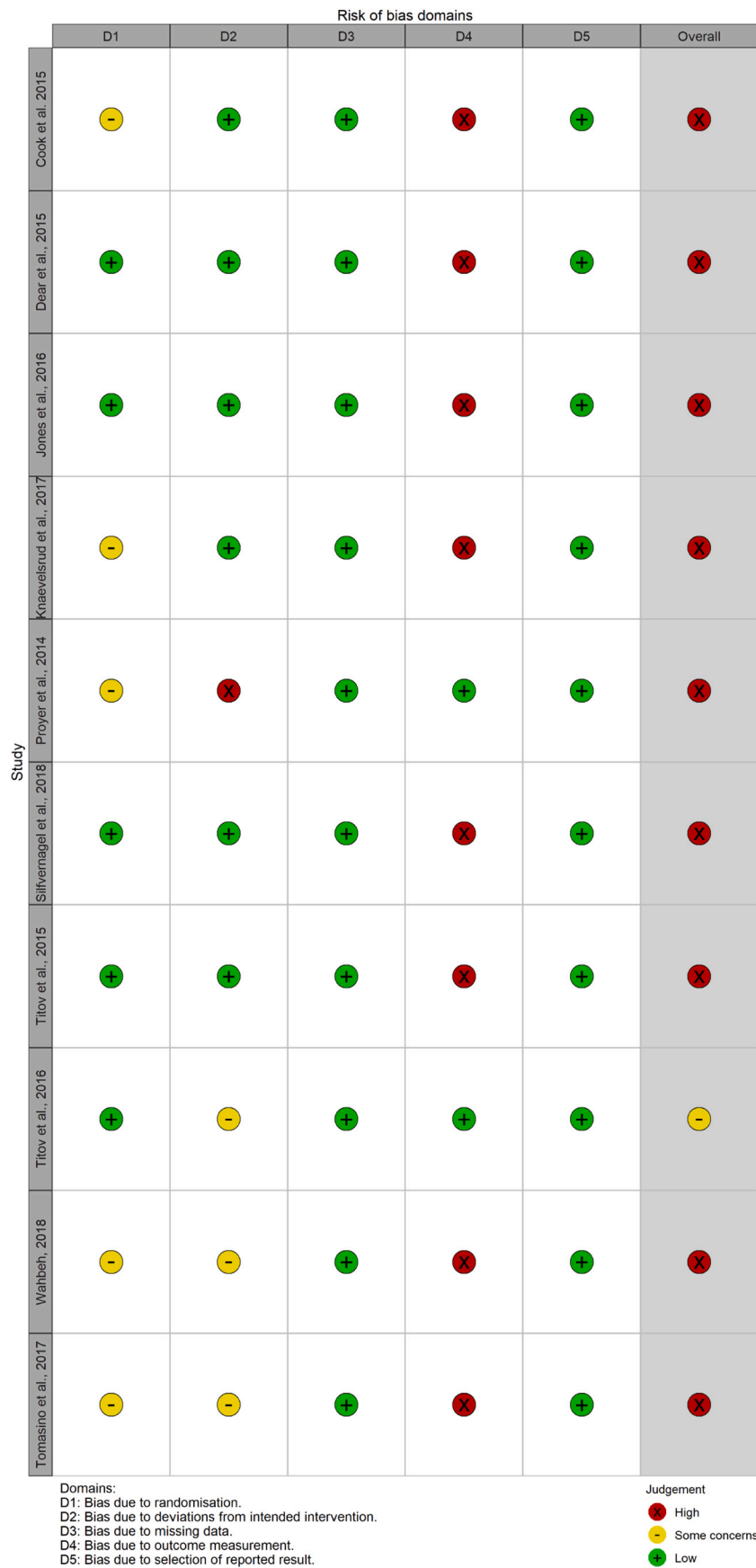


Fig. 2. Risk of bias assessment of included RCTs.

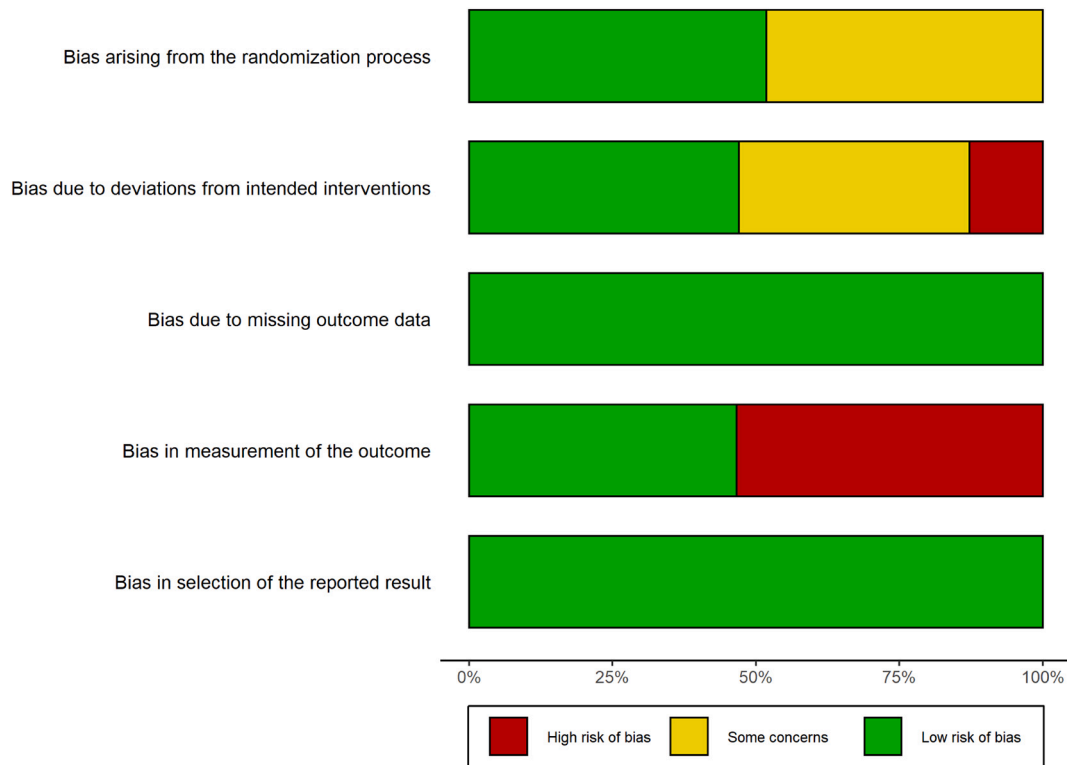


Fig. 3. Risk of bias assessment of included RCTs presented as percentages (studies weighted by sample size).

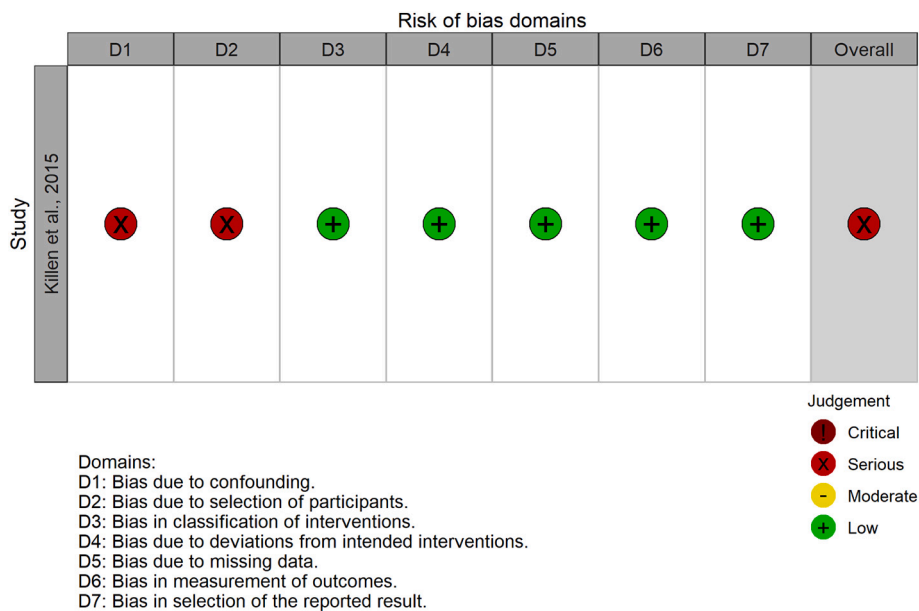


Fig. 4. Risk of bias assessment of included non-RCTs.

older adults with anxiety and depression. Within this program, the therapist composes the modules individually for each participant (except the first and last modules) in order to tailor the treatment to the patient. The modules comprise relevant CBT components, such as psychoeducation, exposure exercises and behavioral experiments.

Another internet-based intervention aimed at treating anxiety and depression in older adults is the *Wellbeing Plus Course* by Titov et al. (2016). This eight-week CBT program aims at teaching core transdiagnostic psychological principles and skills in order to reduce symptoms of depression and anxiety. It includes five online lessons, case-

enhanced stories as well as homework assignments. In their study, Titov et al. (2016) compared the impact of three versions of the Wellbeing Plus Course with varying levels of clinical guidance (clinician-guided treatment vs. initial clinician interview followed by self-guided treatment vs. self-guided treatment).

3.4.4. PTSD

There was one study that focused on PTSD. In their study, Knaevelsrud et al. (2017) evaluated the *Integrative Testimonial Therapy*, a therapist-guided internet-delivered intervention for older adults with

Table 1
Main characteristics of included studies.

	Country	Intervention					Design	Conditions	N	Age (years)	Primary outcome
		Focus	Type	Duration (weeks)	Guidance	Tailored to older adults?					
Cook et al. (2015)	USA	Health Promotion (Stress)	Web-based health promotion program for older workers (<i>HealthyPast50</i>)	12	SG	Yes	RCT	1. <i>HealthyPast50</i> , 2. WL	278	50–68	Symptoms of Distress (15-item scale developed by Orioli et al. (1991))
Dear et al. (2015)	AUS	Anxiety	Internet-delivered CBT (<i>Managing Stress and Anxiety Course</i>)	8	TG	Yes	RCT	1. <i>Managing Stress and Anxiety Course</i> , 2. WL	70	60–81, EG: $M = 65.39$ ($SD = 4.68$), CG: $M = 65.51$ ($SD = 5.81$)	Anxiety (GAD-7), Depression (PHQ-9)
Jones et al. (2016)	CAN	Anxiety	Internet-delivered CBT (<i>GAD Online for Older Adults</i>)	7–10	TG	Yes	RCT	1. <i>GAD Online for Older Adults</i> , 2. WL	41	60–80, EG: $M = 64.8$ ($SD = 3.67$), CG: $M = 65.5$ ($SD = 4.77$)	Anxiety (GAD-7), Depression (PHQ-9)
Killen and Macaskill (2015)	GBR	Well-being (Stress)	Positive psychology intervention (<i>Three good things in life</i>)	2	SG	No	Non-RCT	1. Online delivery of <i>three good things in life</i> , 2. Paper delivery of <i>three good things in life</i>	88	60–91, $M = 70.84$ ($SD = 7.51$)	Stress (PSS10)
Knaevelsrud et al. (2017)	GER	PTSD	Internet-delivered CBT (Integrative Testimonial Therapy)	6	TG	Yes	RCT	1. Integrative Testimonial Therapy, 2. WL	94	63–85, $M = 71.4$ ($SD = 4.7$)	Post-traumatic stress disorder (PDS)
Proyer et al. (2014)	SUI	Well-being and Depression	Internet-delivered positive psychology interventions (four interventions: <i>Gratitude Visit</i> , <i>Three good things</i> , <i>Three funny things</i> , <i>Using signature strengths in a new way</i>)	1	SG	No	RCT	1. <i>Gratitude Visit</i> , 2. <i>Three good things</i> , 3. <i>Three funny things</i> , 4. <i>Using signature strengths in a new way</i> , 5. placebo	163	50–79, $M = 55.58$ ($SD = 5.16$) (only females)	Depression (CES-D in the German adaptation by Hautzinger and Bailer (1993))
Silfvernel et al. (2018)	SWE	Anxiety and Depression	Internet-delivered CBT	8	TG	Yes	RCT	1. Internet-delivered CBT, 2. Weekly general support	66	60–77, $M = 66.1$ ($SD = 4.15$)	Anxiety (BAI)
Titov et al. (2015)	AUS	Depression	Internet-based CBT (<i>Managing Your Mood Course</i>)	8	TG	Yes	RCT	1. <i>Managing Your Mood Course</i> , 2. WL	52	61–76, EG: $M = 64.52$ ($SD = 2.58$), CG: $M = 66.16$ ($SD = 3.80$)	Depression (PHQ-9)
Titov et al. (2016)	AUS	Anxiety and Depression	Internet-delivered CBT (3 versions with varying level of guidance; <i>Wellbeing Plus Course</i>)	8	TG/SG	Yes	RCT	1. <i>Wellbeing Plus Course</i> clinician-guided, 2. <i>Wellbeing Plus Course</i> initial clinician interview followed by self-guided treatment, 3. <i>Wellbeing Plus Course</i> self-guided	433	60–93, $M = 66$ ($SD = 4.7$)	Depression (PHQ-9), Anxiety (GAD-7)
Tomasino et al. (2017)	USA	Depression	Internet-delivered intervention based on CBT principles (two versions; <i>MoodTech</i>)	8	TG	Yes	Pilot RCT	1. <i>MoodTech</i> delivered individually, 2. <i>MoodTech</i> with peer support, 3. WL	40	$M = 69.6$ ($SD = 4.1$)	Depression (PHQ-9)
Wahbeh (2018)	USA	Depression	Internet-delivered mindfulness meditation intervention (<i>IMMI</i>)	6	SG	No	RCT	1. <i>IMMI</i> , 2. WL	40	$M = 64.8$ ($SD = 6.2$)	Depression (CESD)

Note. *N* = Sample size (total number of participants included in the outcome analysis in each study; this number may differ from the number of eligible participants who went through treatment allocation); Age: Age information based on participants included in the outcome analysis (except for [Tomasino et al. \(2017\)](#) and [Wahbeh \(2018\)](#): Age information based on participants randomized); *CBT* = Cognitive behavior therapy; *CG* = Control group; *EG* = Experimental group; *M* = Mean; *Non-RCT*: Non-randomized controlled trial; *PTSD*=Post-traumatic stress disorder; *RCT* = Randomized controlled trial; *SD*=Standard deviation; *SG* = Self-guided; *TG* = Therapist-guided; *WL* = Wait-list control condition; *BAI*=Beck Anxiety Inventory ([Beck et al., 1988](#)); *CES-D* = The Center for Epidemiologic Studies Depression Scale ([Radloff, 1977](#)); *GAD-7* = Generalized Anxiety Disorder 7-Item Scale ([Spitzer et al., 2006](#)); *PDS*=Post-traumatic Stress Diagnostic Scale ([Foa, 1995](#); [Foa et al., 1997](#)); *PHQ-9* = Patient Health Questionnaire-9 Item ([Kroenke et al., 2001](#)); *PSS10* = Perceived Stress Scale ([Cohen, 1988](#)).

childhood traumatization. This six-week therapy program combines components of CBT with a narrative approach. The main treatment element are structured writing assignments which are delivered via a secured web-based platform.

3.4.5. Stress

We identified two studies which focused on perceived stress. [Cook et al. \(2015\)](#) evaluated the effect of *HealthyPast50*, an internet-based health promotion program aimed at workers aged 50 years and older. The self-guided intervention is based on social cognitive theory and includes information and guidance on the major health promotion topics, such as healthy aging and stress management. The program includes an assessment across major health topics, based on which participants receive recommendations on specific program segments to visit.

[Killen and Macaskill \(2015\)](#) tested the effect of an internet-delivered *three good things in life* gratitude intervention in older adults. Every evening for the duration of two weeks, participants were asked to report three positive events that happened that day and why they viewed them positively. This self-guided intervention is based on positive psychology principles.

3.5. Effectiveness

3.5.1. Pooled post-intervention effect on overall symptom severity

An overall effect size was calculated for all psychological and psychosocial outcomes combined, resulting in a significant large effect of Hedges' *g* = -0.80 favoring internet-based interventions over control conditions (95% CI, -1.34, -0.26; *p* < .01; *k* = 11 effect sizes/9 studies; *n* = 955; *I*²_{Level 2} = 0%; *I*²_{Level 3} = 89.46%; [Fig. 5](#)). When comparing the three-level model to a two level-model with level 3 heterogeneity constrained to zero, we found that the three-level model did not provide a significantly better fit ($\chi^2_1 = 2.49, p = .114$). However, in line with [Harrer et al. \(2021\)](#) we decided to keep the nested model since it more adequately represented the data-generating process as well as the theoretical assumptions.

3.5.2. Pooled post-intervention effect on depression symptom severity

For depression symptom severity at post-intervention, pooling of data resulted in a statistically significant large effect of Hedges' *g* = -1.13 favoring internet-based interventions over control conditions (95%CI, -1.97, -0.30; *p* < .05; *k* = 6 effect sizes/6 studies; *n* = 406; *I*² = 88.80; [Fig. 6](#)).

3.5.3. Pooled post-intervention effect on anxiety symptom severity

For anxiety symptom severity at post-intervention, pooling of effect

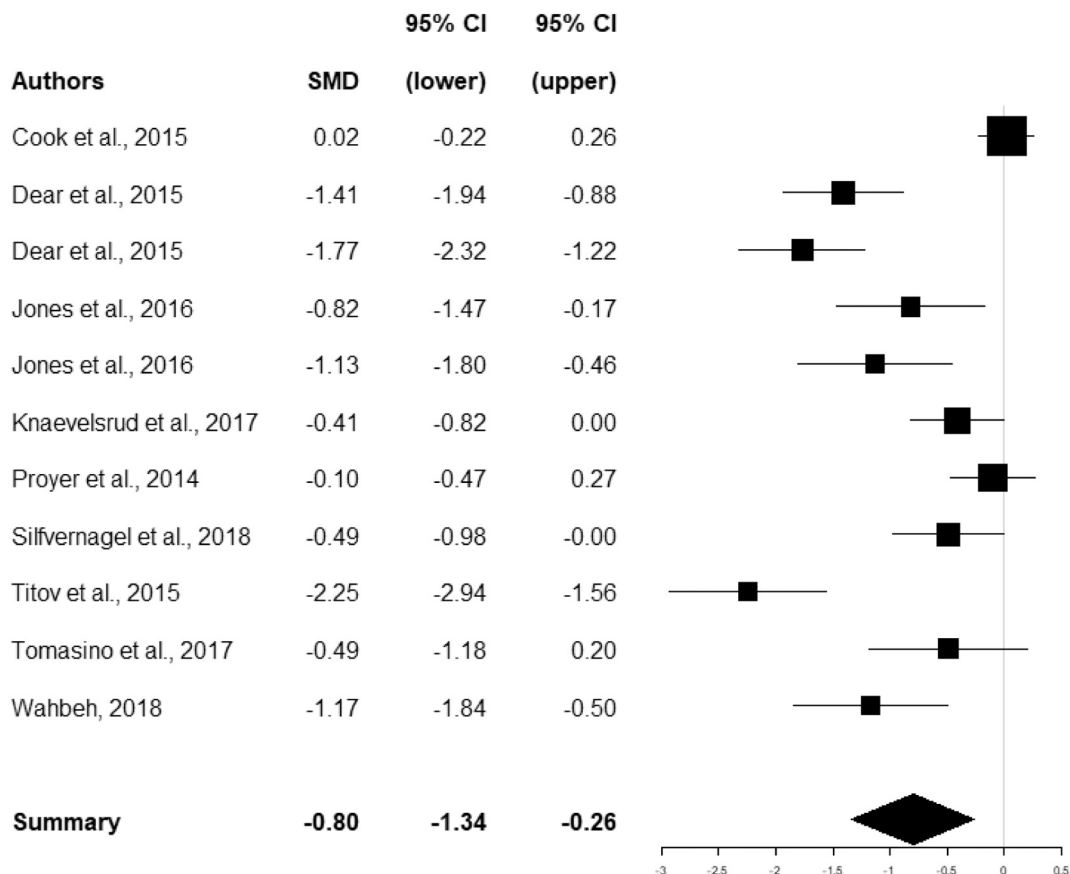


Fig. 5. Multilevel meta-analysis of internet-based interventions on overall symptom severity in older adults.

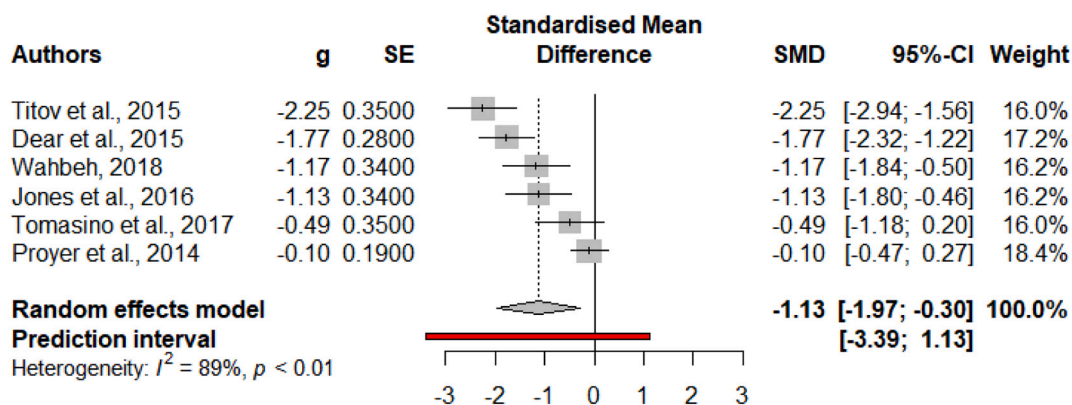


Fig. 6. Random effects meta-analysis of internet-based interventions on depression symptom severity in older adults.

sizes resulted in a non-significant Hedges' g of -0.90 (95%CI, -2.09, 0.28; $p = .082$; $k = 3$ effect sizes/studies; $n = 177$; $I^2 = 68.30$; Fig. 7).

3.5.4. Subgroup analyses and publication bias

Due to the limited number of trials per subgroup for the analyses on anxiety and depression symptom severity, subgroup analyses could only be conducted for the three-level meta-analysis on overall symptom severity. Comparing studies investigating internet-based interventions based on CBT vs. other treatment approaches did not result in significant differences in overall symptom severity at post-intervention ($F(1,9) = 1.85$, $p = .207$). Further, we did not find any difference in overall symptom severity by level of guidance (therapist-guided intervention vs. self-guided intervention; $F(1,9) = 1.85$, $p = .207$).

As sample size was small and between-study heterogeneity high, we followed recommendations of Sterne et al. (2011) and decided not to test for funnel plot asymmetry (publication bias).

4. Discussion

The goal of this review and meta-analysis was to systematically summarize the existing literature on internet-based interventions for the treatment of common mental disorder symptoms and psychosocial problems in older adults. We were mainly interested in a) what kind of interventions already exist and b) how effective they are in improving older individuals' mental health. Our findings show that research in this area is still in its infancy, but results on the efficacy of internet-based psychological interventions for older adults are promising.

4.1. Summary of findings

The early stage of research in this area was reflected in the number of studies included in this review. Only 11 studies met our inclusion criteria and all of them were conducted in western countries. Most studies were RCTs and compared the intervention group to a waitlist-

control condition. Overall, study quality was low as most studies were rated with a "high risk of bias". Participants' age ranged between 50 and 93 years and only three studies included individuals aged younger than 60 years (Cook et al., 2015; Proyer et al., 2014; Wahbeh, 2018).

Addressing the first of our research questions, namely what kind of internet-based psychological interventions already have been developed for older adults, we found that there exist 11 interventions aiming at improving older adults' common mental disorder symptoms (depression, anxiety, PTSD) and subclinical psychosocial problems (stress). The majority of interventions targeted anxiety and depression, which coincides with prevalence rates of epidemiological studies showing that among all mental disorders anxiety and mood disorders are most prevalent in the group of older individuals (Andreas et al., 2017). In addition, most interventions were developed based on CBT principles. This is according to previous research showing that CBT is an effective approach for the treatment of common mental disorders in later life (e.g., Gould et al., 2012a, 2012b; Hall et al., 2016) as well as the most studied approach in the context of internet-delivered treatments (Andersson, 2009). Other treatment approaches included positive psychology, social cognitive theory and mindfulness. The majority of interventions were tailored to older adults to varying degrees (e.g., age-appropriate case stories) and included some level of therapist involvement.

With regard to our second research question, namely how effective internet-based interventions are for the treatment of common mental disorder symptoms and psychosocial problems in older adults, we found promising results. Significant large effects of internet-based interventions for older adults were found for overall symptom severity (depression, anxiety, PTSD, stress) as well as for depression symptom severity. These results are in line with meta-analytic findings of Xiang et al. (2020), who reported a large effect size of 1.18 for internet-based CBTs on depressive symptoms in older individuals. Our findings suggest, that internet-delivered psychological interventions might be an effective alternative for the treatment of both common mental disorder symptoms

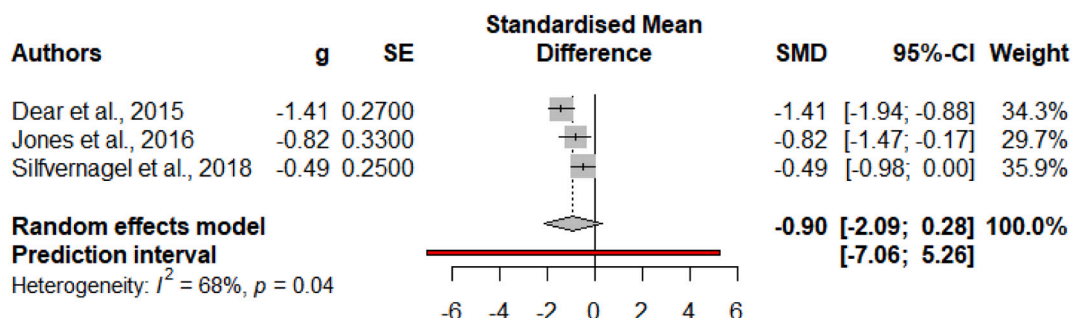


Fig. 7. Random effects meta-analysis of internet-based interventions on anxiety symptom severity in older adults.

as well as subclinical problems (stress) in older adults. In addition, we found feasibility aspects such as treatment satisfaction to be predominantly rated positively. In line with this, Mewton et al. (2013) found adherence to internet-based treatments to be higher in older individuals compared to younger adults. Additionally, in a study by Choi et al. (2014), an internet-delivered treatment was found to be more effective in improving depressive symptoms in older adults compared to when the intervention was delivered face-to-face. A major advantage of internet-based treatments is their lack of geographic boundaries (Kersting et al., 2009), which significantly increases their reach to older individuals (e. g., those with limited mobility) compared to traditional face-to-face treatment methods. Given that a growing proportion of older adults has been found to increasingly use the internet (Hunsaker and Hargittai, 2018) as well as to turn to the internet for health information seeking (Anderson and Perrin, 2017), this intervention method has the potential to bridge the existing treatment gap in mental health care among older adults. However, despite those promising findings, older individuals are still underrepresented in internet-based treatment studies (Crabb et al., 2012) and research is at an early stage. Thus, more studies are needed in order to further develop, evaluate and finally provide such treatment to this age cohort.

Interestingly, we did not find a significant effect of internet-based psychological interventions on anxiety symptom severity in older adults. To date, no such meta-analysis has been conducted in older individuals. However, previous meta-analyses in mixed-aged adult samples reported moderate to large effects of internet-based psychological interventions for the treatment of anxiety symptoms (narrative review of meta-analyses: Andersson et al., 2019). From a methodological perspective, our non-significant finding could be due to power issues, as we had only three studies included in this meta-analysis revealing moderate to high study heterogeneity ($I^2 = 68.30$). In addition, overall quality of all three studies was judged as “high risk of bias”, which could have impeded the achievement of relevant effect sizes. More studies as well as meta-analyses are needed in order to shed light on the efficacy of internet-based psychological interventions for the treatment of anxiety symptoms in older individuals.

When it comes to treatments, it is crucial to not only know the fact that an intervention is effective in the first place, but also which specific characteristics make it effective. In the current meta-analysis, we were able to investigate two of such characteristics, namely the level of guidance (therapist-guided vs. self-guided) as well as the treatment approach (CBT vs. other) using subgroup analyses on overall symptom severity. With regard to the former, we did not find any significant effect of the level of guidance on overall symptom severity. Previous research on the role of guidance in internet-based interventions is mixed. While Baumeister et al. (2014) found guided internet-delivered mental health interventions to be more effective in improving symptom severity than unguided treatments, Xiang et al. (2020) did not find such an effect on depressive symptom severity in older adults. However, given that some degree of support has been found to increase motivation (Bendelin et al., 2011), even minimal therapist involvement in internet-based interventions for older adults might be beneficial.

With regard to the latter characteristic, we did not find any significant effect of the treatment approach (CBT vs. other) on overall symptom severity. The majority of past research on internet-based treatments has been conducted in the field of CBT (Andersson, 2009). There is little research directly comparing the effects of different treatment techniques in internet-delivered psychological interventions. In their meta-analysis, Harrer et al. (2019) found CBT interventions to be most effective in the treatment of depression and anxiety in university student compared to interventions training one specific mental health related skill or other types of interventions. Andersson et al. (2012) compared the effects of internet-delivered CBT and internet-based psychodynamic treatment on generalized anxiety disorder symptoms and did not find any significant difference among the two treatment approaches. Much more research comparing different types of treatment approaches in internet-based

interventions is needed to draw any conclusion on which treatment techniques are most effective in this format and whether CBT is the superior approach.

4.2. Practical implications

Although further studies are needed to draw definitive conclusions, results of our systematic review and meta-analysis provide preliminary evidence, that internet-based treatments might be a promising approach for treating common mental disorder symptoms as well as stress in older adults. Given those promising results, it is important to dispel the common misconception that this treatment method is not appropriate for older adults, as shown by the underrepresentation of this age cohort in internet-based CBT trials (Crabb et al., 2012). On the long term, it is crucial to increasingly implement internet-based interventions in mental health care and make them accessible to older individuals. Interestingly, among this age cohort, general practitioners (GPs) have been found to be the first point of contact in case of mental problems (Wang et al., 2005). Given GPs key role as “gate keepers” to mental health care, it is important that they are aware of existing effective internet-based interventions and know where to refer their patients to increase the accessibility of evidence-based psychological treatment among this age cohort.

4.3. Limitations

Findings of our review and meta-analysis have to be considered in the light of several limitations. First, generalizability of our results might be curtailed, as all studies were conducted in western countries. Second, findings of this meta-analysis are limited to short term effects only. Due to variability in follow-up time points, we could only assess effects of internet-based psychological interventions at post-assessment. Future studies are needed in order to shed light on the long-term effects of internet-delivered treatments on common mental disorder symptoms and psychosocial problems in older adults. Third, results of our study have to be interpreted with caution as we were not able to test for publication bias due to the limited number as well as high heterogeneity of included studies. Fourth, generalizability of our results to older adults might be curtailed, as an age cut-off criterion of 50 years or above (instead of 60/65 years or older) was used (three of the eleven studies included participants younger than 60 years of age). Lastly, we investigated only the role of treatment characteristics in the efficacy of internet-based psychological interventions for older adults, but not patient characteristics. More studies are needed in order to gain a more fine-grained understanding of what works best for whom and under which circumstances.

4.4. Conclusions

The current systematic review and meta-analysis is the first one investigating the efficacy of a variety of different types of internet-based interventions for the treatment of a number of common mental disorder symptoms and psychosocial problems in older adults. Overall, our findings suggest that internet-delivered treatments might be a feasible and promising approach for improving common mental disorder symptoms and psychosocial problems in older individuals and have the potential to bridge the current treatment gap in mental health care among this age cohort. However, research in this field is still at an early stage as only 11 studies met our inclusion criteria. Future studies are needed in order to shed light on which treatment as well as patient characteristics significantly impact the efficacy of internet-based psychological treatments for older adults. We hope that our systematic review and meta-analysis might be a catalyst for increasing research on internet-based treatments in this age cohort as well as for clinicians to provide such interventions to older individuals.

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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.

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Supplementary data

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