



## Internet- and mobile-based interventions for the treatment of specific phobia: A systematic review and preliminary meta-analysis

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### ABSTRACT

Internet- and mobile-based interventions (IMIs) are being developed for a wide range of psychological disorders and they showed their effectiveness in multiple studies. Specific phobia (SP) is one of the most common anxiety disorders, and research about IMIs for their treatment has also been conducted in recent years. The aim of this paper was to conduct a systematic review and preliminary meta-analysis exploring IMIs for the treatment of SP. A comprehensive search conducted in five different databases identified 9 studies (4 pre-post studies, 5 randomized controlled trials) with 7 Internet-based interventions and 2 mobile-based interventions. Results showed that exposure was the main component of all interventions, and that animal phobia was the most common subtype. Samples included children, adolescents, and adults. A preliminary meta-analysis of the included studies showed that participants receiving IMIs experienced a significant reduction of SP symptoms from pre- to post-treatment ( $g = 1.15$ ). This systematic review found that there is already some evidence in the literature supporting the potential benefits of IMIs for SP. However, the number of studies included is small and more research should be carried out in the field.

### 1. Introduction

Specific Phobia (SP) is one of the most common anxiety disorders, with an estimated lifetime prevalence of up to 7% (Eaton et al., 2018). Although it can be considered a less severe problem compared to some other psychological disorders, people suffering from it report severe impairment in different domains of their lives (Wardenaar et al., 2017). It has also been associated with a higher probability of developing another anxiety disorder (Trumpf et al., 2010) and physical problems, such as cardiac, respiratory, or gastrointestinal diseases (Witthauer et al., 2016). Taking all of this into consideration, there is a clear need to offer evidence-based psychological treatments for this problem.

Fortunately, the treatment of choice for SP, exposure therapy, has been well-established for decades (Marks, 1987). Furthermore, its mechanisms and how to improve its effectiveness have been studied and discussed over the years (Böhnlein et al., 2020; Craske et al., 2014; Sewart and Craske, 2019). Traditionally, in vivo exposure was the approach clinicians used to deliver treatment for SP, but as technology

advanced, research explored other ways to carry out exposure therapy. This is the case of Virtual Reality Exposure Therapy (VRET), which rapidly became a popular alternative for treating SP because it helped to overcome some of the limitations of in vivo exposure. It also presented some advantages for both the patient and the clinician, such as being able to deliver the treatment in the clinician's office. Many studies have been conducted in this field, and VRET has shown comparable results to in vivo exposure (Botella et al., 2017; Wechsler et al., 2019).

However, despite the evidence supporting exposure-based treatments, there are still barriers to their dissemination (Neudeck and Ein-sle, 2012). Following the guidelines for new ways to provide treatment to those in need of psychological help (Kazdin and Blase, 2011), the Internet became a new alternative to traditional face-to-face treatments. Internet-based interventions have been created, and their effectiveness has been shown for a wide range of psychological disorders, such as depression (Karyotaki et al., 2017, 2018), PTSD (Kuester et al., 2016; Lewis et al., 2018), or even somatic disorders (Carlbring et al., 2018; van Beugen et al., 2014) among others. Internet interventions for the

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treatment of anxiety disorders have also been widely studied, showing comparable results to face-to-face treatment and acceptance by patients (Andersson and Titov, 2014; Andrews et al., 2018; Arnberg et al., 2014; Kelson et al., 2019; Olthuis et al., 2016). In the case of SP, a self-help treatment with virtual reality components using the Intranet was used to treat animal phobia and showed promising results (Botella et al., 2008).

In recent years, with the further development of technologies, new options have been suggested to deliver psychological treatments in people's homes. This is the case of mobile-based interventions, which have shown evidence of reducing anxiety symptoms (Firth et al., 2017) and have been found to be well-accepted by patients (Menon et al., 2017). These new options have also made VRET more accessible by developing, for example, affordable head-mounted displays to use with smartphones (Kato and Miyashita, 2015), providing the opportunity to deliver mobile-based treatments using virtual reality in people's homes (Stupar-Rutenfrans et al., 2017). However, there is a lack of research and validation of many mental health apps, with only a limited number being evidence-based interventions (Miralles et al., 2020), and so there is a clear need for further research in this field.

Although still scarce, some research has been carried out in the field of Internet- and mobile-based interventions (IMIs) for SP. The aim of this paper is to conduct the first systematic review exploring IMIs in the field of SP, synthesizing the characteristics of the different interventions and their treatment outcomes.

## 2. Method

The present study was carried out following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009), was registered in the Open Science Framework (OSF) and was made public with the following ID: [osf.io/g5x6y](https://osf.io/g5x6y).

### 2.1. Inclusion and exclusion criteria

Studies were included if they met the following criteria: (1) Participants in the study were children, adolescents, or adults who had a diagnosis of SP or presented high scores on self-report measures for phobia; (2) The intervention was focused on SP, or SP was one of the disorders treated in the study, but specific data for SP were reported; (3) The psychological intervention was delivered through the Internet or mobile phone. The intervention could include virtual reality components; (4) Studies had to contain at least pre- and post-treatment measures of phobic symptomatology (randomized and non-randomized).

Studies where the sample had a diagnosis of social anxiety or agoraphobia and studies with a face-to-face component of the intervention were excluded from this review.

### 2.2. Information sources and searches

Searches were conducted in PubMed, PsycINFO, Web of Science, SCOPUS, and Cochrane to identify relevant studies published prior to December 2020. There were no exclusion criteria regarding the year of publication of the study or the language in which it was written. Due to the different terminology used in publications, variations of the terms "Internet-based treatment", "mobile-based treatment", and "phobia" were included in the search, combined with Boolean operators using "AND" and "OR". In addition, we included some common terms related to phobia, such as "dental anxiety", "claustrophobia", and "acrophobia" because we are aware that they are used in some papers in the field of SP. The complete search strings are included in the Appendix. The references of included studies and similar recent systematic reviews were also inspected to identify additional studies that might have been missing in the search.

### 2.3. Study selection

After carrying out the searches in the different databases and removing duplicates, two independent researchers (SM and JG) examined the titles and abstracts of the studies to select the records that potentially met the inclusion criteria. Differences in the selected studies and doubts were discussed with a third reviewer (SQ). Full texts of the selected studies that appeared to meet the inclusion criteria and those that were in doubt due to insufficient information in the title or abstract were retrieved and reviewed independently by two researchers to confirm that they were suitable for the current review.

### 2.4. Study quality assessment

The quality of the studies included in this review was assessed using The Study Quality Assessment Tools from the National Heart Lung and Blood Institute (NHLBI; <https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools>). This tool was chosen because the present systematic review aimed to explore any type of study that has been published for the treatment of SP using IMIs. The NHLBI includes specific criteria to assess six types of study designs: controlled intervention studies, systematic reviews and meta-analyses, observational cohort and cross-sectional studies, case-control studies, before-after studies with no control group, and case series studies. The studies' quality can be rated as "good", "fair", or "poor" after answering the different questions established depending on the study design. Two reviewers (SM and CT) independently rated the studies included in this paper. Disagreements were discussed with a third reviewer (SQ).

### 2.5. Data synthesis

Firstly, for all the included studies, data about the study design, sample, characteristics of the intervention, and treatment effects in terms of SP symptom reduction were independently extracted from the publications and narratively synthesized. The data extracted by the researchers were compared and discussed with a third researcher if discrepancies were found.

Also, for all the included studies (randomized and pre-post studies), within-group effect sizes were calculated to estimate symptom reduction from pre- to post-treatment. These effect sizes were computed as Hedges'  $g$ , assuming a pre-post correlation of 0.7. Sensitivity analyses using alternative pre-post correlations were conducted. A preliminary meta-analysis was conducted by pooling within-group effect sizes with a random-effects model, using a restricted maximum-likelihood estimator (Viechtbauer, 2005) and the Hartung-Knapp-Sidik-Jonkman (HKSJ) method (Int'Hout et al., 2014). Heterogeneity was explored with the  $I^2$  statistic and its 95% confidence interval. We conducted subgroup analyses based on type of design (randomized vs pre-post studies) with a mixed-effects model. Because the number of studies was too small, we did not conduct additional analyses.

Additionally, for the subset of randomized controlled trials (RCTs), we computed between-group effect sizes as standardized mean differences (Hedges'  $g$ ) at post-test. We pooled these effect sizes using the same meta-analytical procedures.

## 3. Results

### 3.1. Search results

Fig. 1 shows the Flow diagram for the study. Initially, 819 studies were identified upon completion of the search in the different electronic databases. Duplicates were removed, leaving a total of 421 papers that were examined. Finally, 29 full-text papers were retrieved and, after reading them independently and excluding studies that did not meet the inclusion criteria, a total of nine studies were included in the current systematic review.

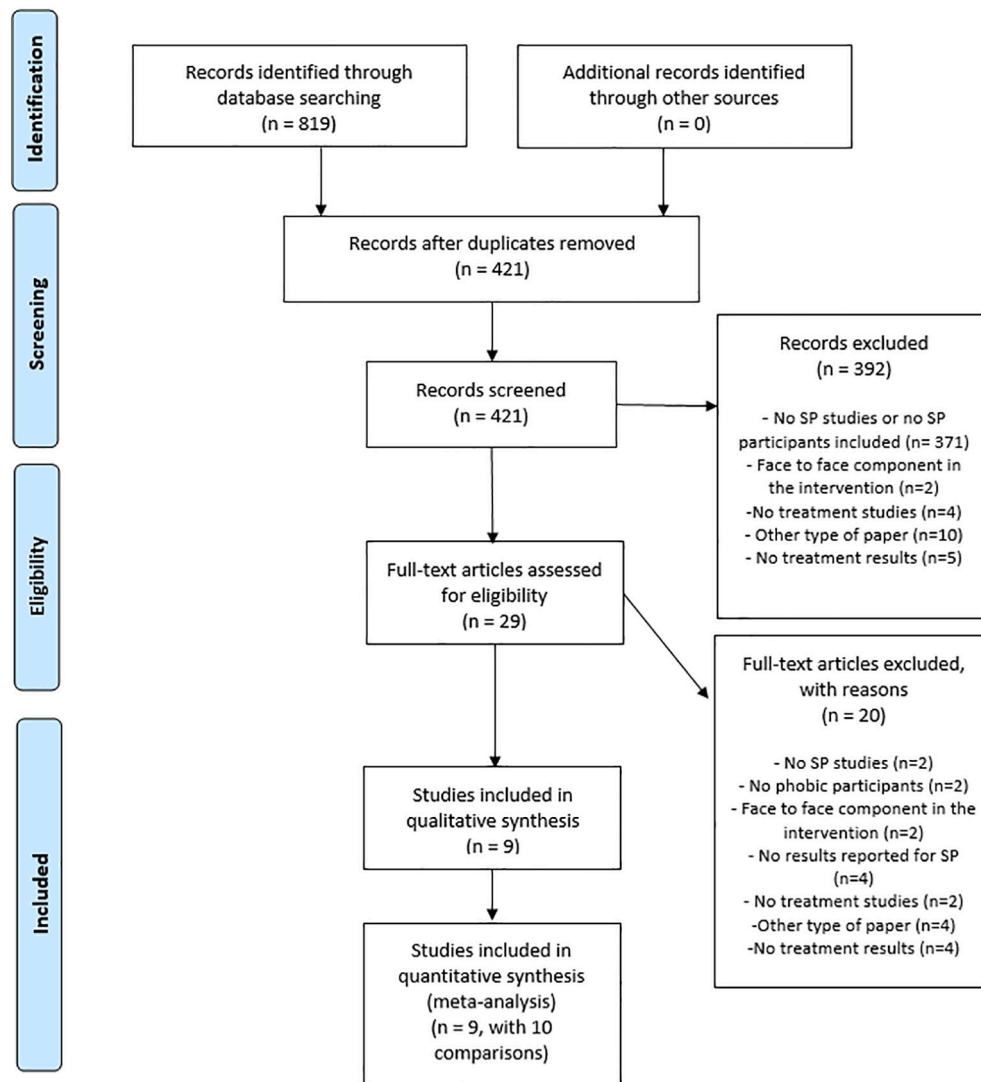


Fig. 1. Flow diagram for the systematic review.

### 3.2. Participants

Table 1 shows selected characteristics of the participants in each study. Overall, participants' mean ages ranged from 9.9 to 41.3 years, with a mean age of 33.58 years across the studies, except for one study (Matthews et al., 2012) where the mean age was not reported. Six studies (66.7%) involved adults suffering from SP, two studies included children or adolescents (22.2%), and one study admitted participants of any age. Almost all the studies had a majority of women participants, and one of them (Matthews et al., 2011) only included female participants in its sample.

As for participants' diagnosis, the studies usually addressed one type of SP, and only one study (Vigerland et al., 2013) accepted participants with different types of fears as long as they met the diagnostic criteria for SP. Related to this, the recruitment method in 66.7% ( $n = 6$ ) of the papers was a diagnostic interview, whereas the remaining studies recruited participants based on questionnaire scores. The subtypes of SP were animal phobia (spider phobia  $n = 3$ ; snake phobia  $n = 1$ ), situational phobia (flying phobia  $n = 1$ ; dental phobia  $n = 2$ ), and natural environment phobia (acrophobia  $n = 1$ ). In the study by Vigerland et al. (2013), which included children with various types of phobias, the sample presented claustrophobia (23%), darkness phobia (40%), acrophobia (13%), animal phobia (47%), and blood injury and injection phobia (10%). Comorbidity with other disorders was only mentioned in

three papers (Campos et al., 2019; Shahnavaaz et al., 2018; Vigerland et al., 2013), which meant that participants could present other types of phobias, anxiety problems, or psychological problems in general, as long as they were not severe psychological disorders and the principal diagnosis was SP. Sample sizes in the studies ranged from 13 to 351.

### 3.3. Study design and characteristics

Five of the included studies were RCTs (Andersson et al., 2009, 2013; Arias and McNeil, 2020; Campos et al., 2019; Donker et al., 2019), and the four remaining studies were pre-post investigations with no control group (Matthews et al., 2011, 2012; Shahnavaaz et al., 2018; Vigerland et al., 2013). Regarding the comparators used in the RCTs, three studies had a waitlist control group, and two studies had another SP treatment. The studies were conducted in five different countries: the Netherlands ( $n = 1$ ), Spain ( $n = 1$ ), Australia ( $n = 2$ ), the USA ( $n = 1$ ), and Sweden ( $n = 4$ ). The papers included were published between 2009 and 2020. Detailed study information is shown in Table 1.

### 3.4. Intervention characteristics

Of the nine studies, seven carried out an Internet-based intervention, and the other two used an app to deliver the treatment through the participant's mobile phone. Table 2 shows the intervention

**Table 1**  
Participant and study characteristics.

Study	Country	Study type	Population	N	Age M (SD)	Women (%)	Phobia subtype
Donker et al. (2019)	The Netherlands	RCT	Adults	Total: 193 IG: 96 CG: 97	41.32 (13.67)	65.83	Acrophobia
Campos et al. (2019)	Spain	RCT	Adults	Total: 69 IG 1: 23 IG 2: 23 CG: 23	36.43 (10.23)	72.47	Flying Phobia
Andersson et al. (2009)	Sweden	RCT	Adults	Total: 27 IG: 13 CG: 14	25.6 (4.1)	84.8	Spider phobia
Shahnavaz et al. (2018)	Sweden	Pre-post	Children and adolescents	Total: 18 IG: 18	11 (2)	61	Dental phobia
Andersson et al. (2013)	Sweden	RCT	Adults	Total: 26 IG: 13 CG: 13	27.2 (8.1)	84.6	Snake phobia
Vigerland et al. (2013)	Sweden	Pre-post	Children	Total: 30 IG: 30	9.9 (1.4)	57	Specific phobia (various types)
Matthews et al. (2011)	Australia	Pre-post	Adults	Total: 17 IG: 17	38 (12)	100	Spider phobia
Matthews et al. (2012)	Australia	Pre-post	All ages	Total: 351 IG 1: 176 IG 2: 124 Total: 36 CG 2: 18	Not referred.	53	Spider phobia
Arias et al. (2020)	USA	RCT	Adults	Total: 36 IG 1: 18 CG 2: 18	26.15 (11.25)	61.1	Dental phobia

RCT: Randomized Controlled Trial; IG: Intervention Group; CG: Control Group.

**Table 2**  
Characteristics of the intervention, outcome measures, attrition, and follow-up data.

Reference	Format	Intervention program characteristics	Length	Comparator	Outcome measures	Attrition (%)	Follow-up
Donker et al. (2019)	App	Six animated modules, 360° videos and a gamified immersive VR environment covering the entire exposure spectrum	3 weeks	Waitlist	AQ	Post: 41 F-U: 59	Exploratory results showed that changes were maintained at 3-month follow-up
Campos et al. (2019)	Internet	Six exposure scenarios with real photographs and sounds related to different parts of the flying process	6 weeks (maximum)	Waitlist	FFQ-II FFS	Post: 28.26 F-U: 52.2 (3 months) and 71 (1 year)	Maintenance of changes at 3- and 12-month follow ups with larger effect sizes than those obtained for pre-to-post change
Andersson et al. (2009)	Internet	Five text modules with psychoeducational information and images, and videos with instructions to carry out the exposure in real life	4 weeks	One-session treatment face-to-face	BAT SPQ	Post: 0 F-U: 7.7	Changes maintained at 1-year f-u, with equal results than the ones obtained with the OST condition
Shahnavaz et al. (2018)	Internet	Twelve modules of guiding text for parents and children, exposure to dentistry-related video clips and audio files and a package with different dental material sent at their homes for exposure purposes	12 weeks	NA	PG-BAT (child and parental version)	Post: 11.1 F-U: 16.7	Clinical changes in the primary outcome measure were maintained at 1-year f-u
Andersson et al. (2013)	Internet	Four text modules with psychoeducational information and images, and videos with instructions to carry out the exposure in real life	4 weeks	One-session treatment face-to-face	BAT SNAQ	Post: 0 F-U: 23.1	There was an improvement in BAT from post-treatment to 1-year f-u and a maintenance of changes in SNAQ
Vigerland et al. (2013)	Internet	Eleven modules for parent and children with psychoeducation about SP and exposure tasks for children to carry out in real life guided by their parents	6 weeks	NA	CSR	Post: 3 F-U: 0	Improvement was maintained at 3-month f-u, with even an additional decrease in the CSR
Matthews et al. (2011)	Internet	Six-stage hierarchy of images presented for exposure purposes. Images appeared on screen when participants followed a moving circle with their mouse pointer	30 days	NA	SUDS FSQ SPQ	Post: 64.7	NA
Matthews et al. (2012)	Internet	Ten stages of moving or static images presented for exposure purposes. Images appeared on screen when participants followed a moving circle with their mouse pointer	4 months	NA	FSQ SUDS	Post: 98.2	NA
Arias and McNeil (2020)	App	Exposure video displaying a preventive dental visit that participants had to watch at least once per day	7 days	Waitlist	SUDS during BAT	Post: 0	NA

AQ: Acrophobia Questionnaire; FFQ-II: Fear of Flying Questionnaire-II; FFS: Fear of Flying Scale; BAT: Behavioral Avoidance Test; SPQ: Spider Phobia Questionnaire; PG-BAT: Picture Guided Behavioral Avoidance Test; SNAQ: Snake Phobia Questionnaire; CSR: Clinician Severity Rating; SUDS: Subjective Units of Distress; FSQ: Fear of Spiders Questionnaire; F-U: Follow-up; NA: Not Applicable.

characteristics for each study.

#### 3.4.1. Internet-based interventions

Exposure was the main treatment component of the seven studies on Internet-based interventions, and all of them except one (Vigerland et al., 2013) included images, videos, or audios of the phobic situation or stimuli in the program. However, only three intervention programs (Campos et al., 2019; Matthews et al., 2011, 2012) carried out the entire exposure to the phobic object within the program using this media content; that is, participants could do the exposure sessions in the intervention webpage confronting these images or videos. In these studies, after the exposure scenarios were presented, participants were asked to rate their anxiety level in order to continue with the next scenarios. Although most of the other studies also included some kind of media content related to the feared object or situation, the main focus was on encouraging participants to do the exposure exercises in the real world. This is the case of the two Andersson et al. (2009, 2013) interventions, which included videos to show the participants how to carry out the exposure to spiders or snakes in a real environment; Vigerland et al. (2013), who included written instructions for parents to help their children to establish and work towards the most feared level together in their everyday life; or Shahnavaz et al. (2018), who even sent a practice package of dental tools to participants' homes so that parents and children could do the exposure tasks together.

Psychoeducation about the problem and other related important information was also included in most of the interventions (Andersson et al., 2009, 2013; Campos et al., 2019; Shahnavaz et al., 2018). The time required for the interventions ranged from one to four months. It is important to note that the study with the longest time requirement (Matthews et al., 2012) only asked participants to log in at least once before a four-month period had ended, but the intervention did not last the whole time. The most common length was four to six weeks.

Regarding therapist support, all the studies except Matthews et al. (2011, 2012) included this component. Therapist guidance was delivered by phone or e-mail, depending on the intervention. In four studies (Andersson et al., 2009, 2013; Shahnavaz et al., 2018; Vigerland et al., 2013), participants had to send the homework exercises to the therapist by email or write them on the web platform, and in two of these studies, the therapist provided feedback about the homework (Shahnavaz et al., 2018; Vigerland et al., 2013). Campos et al. (2019) included two experimental conditions in this line: one condition with therapist support consisting of a brief weekly phone call to encourage participants to continue the intervention or resolve doubts, and a completely self-applied condition where participants did not talk with the therapist until they finished the intervention. It is the only study in this review that presents results for therapist guidance, and the data show that both conditions appeared to have comparable efficacy on the phobic outcome measures.

#### 3.4.2. Mobile-based interventions

Two of the studies included in this review were mobile-based interventions, and the main component was also the exposure technique. Both studies used videos related to the phobic situation that the participant had to watch, but one of them (Donker et al., 2019) included a Virtual Reality approach using 360° videos. This study was also the only one of the two that intended to deliver a traditional intervention over the phone, that is, by including different modules the participant had to complete with psychoeducation and CBT components. The other intervention (Arias and McNeil, 2020) only relied on the participant watching the videos for exposure purposes.

The time required for the interventions ranged from seven days to three weeks. Therapist support was included in both studies, via e-mail, in the form of daily or weekly encouragement.

### 3.5. Narrative synthesis of treatment outcomes

Outcome measures were different in the included studies, given that they were directed towards different types of SP, but overall the results of the interventions were assessed with specific questionnaires for the subtype of SP being investigated, or with other general assessment tools commonly used for phobic disorders, such as the Behavioral Avoidance Test (BAT), its analogous picture-guided version (PG-BAT), the Subjective Units of Distress Scale (SUDS), or the Clinician Severity Rating (CSR; Silverman and Albano, 1996). The questionnaires that assessed the different types of phobic symptomatology in the studies included in this review were the following: Acrophobia Questionnaire (AQ; Cohen, 1977), Fear of Flying Questionnaire-II (FFQ-II; Bornas et al., 1999), Fear of Flying Scale (FFS; Haug et al., 1987), Spider Phobia Questionnaire (SPQ; Klorman et al., 1974), Fear of Spiders Questionnaire (FSQ; Szymanski and O'Donohue, 1995), and the Snake Phobia Questionnaire (SNAQ; Fredrikson, 1983). Table 2 shows the corresponding assessment tools for each study.

Regarding the effectiveness of the interventions, in the RCTs that used a waitlist as a comparator, the intervention condition showed significant reductions in the phobic symptomatology compared to the control group (Arias and McNeil, 2020; Campos et al., 2019; Donker et al., 2019). In the two RCTs that had an active control condition (Andersson et al., 2009, 2013), in this case a treatment for specific phobia whose effectiveness had already been established (Öst, 1989), the Internet condition also showed a significant improvement in the phobic symptoms. Four of these studies reported large within-group effect sizes for the IMI condition (Andersson et al., 2009, 2013; Campos et al., 2019; Donker et al., 2019).

Two of the studies that did not have a control condition also showed significant improvements in the outcome measures, with large within-group effect sizes (Shahnavaz et al., 2018; Vigerland et al., 2013). The remaining two studies without comparators, both by the same author (Matthews et al., 2011, 2012), showed a decrease on the SUDS over time, but only one study showed significant differences on one of the questionnaires after the intervention (Matthews et al., 2011).

### 3.6. Preliminary meta-analysis of randomized trials

A preliminary meta-analysis of the nine included studies, with 10 intervention groups, showed that participants receiving IMIs experienced a significant reduction of phobic symptomatology from pre- to post-treatment. The pooled within-group effect size for IMIs was  $g = 1.15$  (95% CI 0.81 to 1.49), with high heterogeneity ( $I^2 = 79\%$ ; 95% CI 62 to 89). The forest plot summarizing the results of the meta-analysis is presented in Fig. 2. In sensitivity analyses, the pooled effect size ranged between  $g = 1.26$  (95% CI 0.87 to 1.65) and  $g = 1.22$  (95% CI 0.85 to 1.59), assuming pre-post correlations of 0.25 and 0.5, respectively, and decreased to  $g = 0.77$  (95% CI 0.54 to 1.01) when assuming a correlation of 0.95. Subgroup analyses revealed significant differences based on type of design ( $Q = 43.19$ ,  $df = 9$ ,  $p < 0.0001$ ), with RCTs showing significantly larger within-group effects ( $g = 1.40$ ; 95% CI 0.98 to 1.83) than pre-post designs ( $g = 0.80$ ; 95% CI 0.32 to 1.27).

For the subgroup of RCTs, between-group effect sizes were computed and pooled separately for those with active and inactive comparators. The three trials (with four intervention groups) that compared IMIs to waitlist control conditions yielded a pooled effect of  $g = 1.07$  (95% CI 0.51 to 1.62). However, no evidence of a significant effect was obtained in two trials comparing IMIs against a face-to-face well-established SP treatment ( $g = 0.02$ ; 95% CI -1.50 to 1.54).

### 3.7. Follow-ups

Seven of the nine studies had at least one follow-up, but one of them (Matthews et al., 2012) will not be included in these results because the study presented large drop-out rates and the follow-up was only

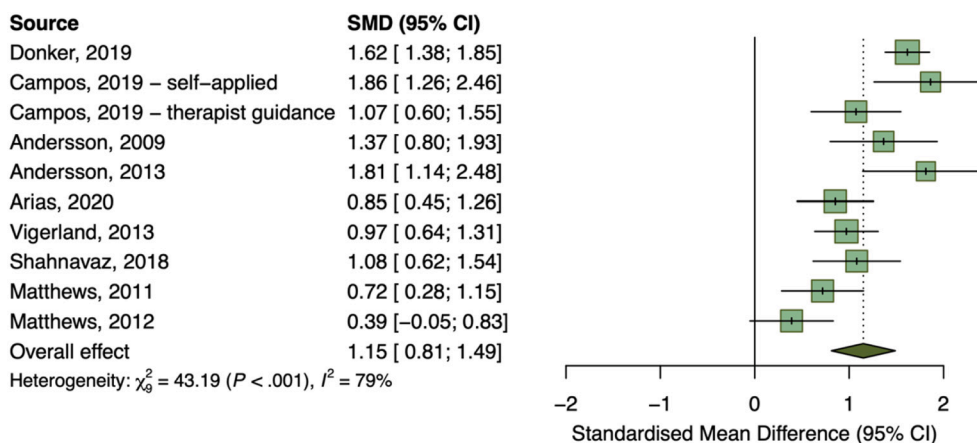


Fig. 2. Meta-analysis on Internet- and mobile-based interventions for Specific Phobia, based on within-group effect sizes.

completed by three participants. Regarding the rest of the studies, three of them carried out a three-month follow up (Campos et al., 2019; Donker et al., 2019; Vigerland et al., 2013) where clinical outcomes for the intervention seemed to be maintained. Four studies had a follow-up after one year (Andersson et al., 2009, 2013; Campos et al., 2019; Shahnavaz et al., 2018), and they also showed maintenance or improvement on some of the measures. The study by Campos et al. (2019) was the only one that included two follow-ups, at three and 12 months, and they found larger within-group effect sizes than the ones obtained for pre-to-post change.

### 3.8. Satisfaction and attrition

Four of the studies presented data about patients' satisfaction with the intervention, and all of them reported a high satisfaction rate (Arias and McNeil, 2020; Donker et al., 2019; Shahnavaz et al., 2018; Vigerland et al., 2013). Although in one of the parent-child interventions (Vigerland et al., 2013) the parent satisfaction was much lower, the results showed that they would still recommend the treatment to a friend.

The attrition rates for the studies ranged from low (0%) to very high (98%), as reported in Table 2. The highest drop-out rate was found in the study by Matthews et al. (2012), where 351 participants were enrolled but only six completed all the intervention stages. However, this study was an exception, and most of the other studies had low or moderate attrition rates at post-treatment. The attrition rates in the follow-ups were higher overall than at post-treatment in the studies that included them, with up to 71% dropping out at the one-year follow-up, as Table 2 shows.

### 3.9. Study quality assessment

Tables 3 and 4 show the results of the study quality assessment carried out with the NHLBI tool. Two of the categories were used for the studies in this review, specifically, the categories of controlled intervention studies and before-after studies. The RCTs included in this review (Andersson et al., 2009, 2013; Arias and McNeil, 2020; Campos et al., 2019; Donker et al., 2019) were assessed in the category of controlled intervention studies. Three of them were rated "good", and the other two were rated "fair". The reason for rating the two Andersson studies (Andersson et al., 2009, 2013) "fair" was that they did not include power calculations for the sample size, and they did not conduct intent-to-treat analyses. Apart from that, the only issue with the studies in this category was the moderate drop-out rate in two of the papers (Campos et al., 2019; Donker et al., 2019), but overall, they met the quality criteria.

In the case of the uncontrolled studies, two of them were rated

"good" (Shahnavaz et al., 2018; Vigerland et al., 2013), and the other two were rated "poor" (Matthews et al., 2011, 2012). In the latter studies, there was no power calculation for the sample size, they had a high or very high drop-out rate, or the inclusion criteria were vague. Therefore, two studies were rated as having a high risk of bias.

The criterion of blinded assessment of the treatment outcomes was not met by any of the studies, but this can be difficult in psychological interventions. However, this was also taken into consideration in the assessment of the quality of the studies.

## 4. Discussion

The aim of the present study was to summarize the characteristics and treatment outcomes of IMIs for SP in a systematic review. To the best of our knowledge, this is the first review to address this topic.

As previously stated, research in this field has been scarce so far, which was reflected in the number of papers included in this review. Only nine papers met the inclusion criteria, seven Internet-based interventions and two mobile-based interventions. Therefore, the following conclusions should be interpreted with caution. However, despite the small number of studies, the results seem promising. The results of the majority of the studies included in the current review indicate that significant improvements in phobic symptoms can be achieved with IMIs. These promising results are also supported by a preliminary meta-analysis of the nine included studies, where a large effect size for IMIs was observed.

Regarding the characteristics of the samples included, there were more women than men, which coincides with epidemiological studies suggesting that there is a higher prevalence of SP among females (Wardenaar et al., 2017). The most common subtype of SP in the studies was animal phobia; four of the studies included treated this type of phobia, and even in the study that included different subtypes of SP in the sample (Vigerland et al., 2013), animal phobia was the most frequent one. Animal phobia is also the subtype with the highest prevalence in epidemiological studies (Eaton et al., 2018; Wardenaar et al., 2017). Additionally, the different interventions show that it is possible to have IMIs for the treatment of SP in different populations because interventions for children, adolescents, and adults have been developed and used. However, no studies were found for older people, and this could be a field in need of more research because some data show a peak in the incidence of phobias in this age group (Eaton et al., 2018).

Exposure was the main component of all the intervention programs included, which was expected because exposure-based treatments for SP are well known in the literature as the best approach to treat this problem in adults (Wolitzky-Taylor et al., 2008) and children (Ollendick and Davis, 2013). In all the studies, the exposure was delivered from a traditional habituation perspective, that is, by presenting the phobic

**Table 3**  
Quality assessment for controlled studies.

	Donker et al. (2019)	Campos et al. (2019)	Andersson et al. (2009)	Andersson et al. (2013)	Arias and McNeil (2020)
1. Was the study described as randomized, a randomized trial, a randomized clinical trial, or an RCT?	Yes	Yes	Yes	Yes	Yes
2. Was the method of randomization adequate (i.e., use of randomly generated assignment)?	Yes	Yes	Yes	Yes	Yes
3. Was the treatment allocation concealed (so that assignments could not be predicted)?	Yes	Yes	Yes	Yes	Yes
4. Were study participants and providers blinded to treatment group assignment?	No	No	No	No	NR
5. Were the people assessing the outcomes blinded to the participants' group assignments?	No	No	NR	NR	No
6. Were the groups similar at baseline on important characteristics that could affect outcomes (e.g., demographics, risk factors, comorbid conditions)?	Yes	Yes	NR	NR	Yes
7. Was the overall drop-out rate from the study at endpoint 20% or lower of the number allocated to treatment?	No	No	Yes	Yes	Yes
8. Was the differential drop-out rate (between treatment groups) at endpoint 15 percentage points or lower?	No	Yes	Yes	Yes	Yes
9. Was there high adherence to	Yes	Yes	Yes	Yes	Yes

**Table 3 (continued)**

	Donker et al. (2019)	Campos et al. (2019)	Andersson et al. (2009)	Andersson et al. (2013)	Arias and McNeil (2020)
the intervention protocols for each treatment group?					
10. Were other interventions avoided or similar in the groups (e.g., similar background treatments)?	Yes	Yes	Yes	Yes	No
11. Were outcomes assessed using valid and reliable measures, implemented consistently across all study participants?	Yes	Yes	Yes	Yes	Yes
12. Did the authors report that the sample size was sufficiently large to be able to detect a difference in the main outcome between groups with at least 80% power?	Yes	Yes	No	No	Yes
13. Were outcomes reported or subgroups analyzed prespecified (i.e., identified before analyses were conducted)?	Yes	Yes	Yes	Yes	Yes
14. Were all randomized participants analyzed in the group to which they were originally assigned, i.e., did they use an intention-to-treat analysis?	Yes	Yes	No	No	Yes
Quality rating	Good	Good	Fair	Fair	Good

NR: Not Reported.

stimulus and waiting until the anxiety levels decreased, and they did not seem to include more contemporary approaches such as inhibitory learning (Craske et al., 2014). Images, audios, and videos of the phobic stimuli were also an important component of the intervention programs, with five of the studies (Arias and McNeil, 2020; Campos et al., 2019; Donker et al., 2019; Matthews et al., 2011, 2012) carrying out the exposure inside the program or app with these media resources. Representations of the phobic stimuli, such as pictures, elicit fear reactions in phobic patients. For this reason, therapists also use them in their clinical settings to start exposure therapy or when the feared situation is

**Table 4**  
Quality assessment for before and after studies.

	Shahnavaz et al. (2018)	Vigerland et al. (2013)	Matthews et al. (2011)	Matthews et al. (2012)
1. Was the study question or objective clearly stated?	Yes	Yes	Yes	Yes
2. Were eligibility/selection criteria for the study population prespecified and clearly described?	Yes	Yes	Yes	No
3. Were the participants in the study representative of those who would be eligible for the test/service/intervention in the general or clinical population of interest?	Yes	Yes	Yes	Yes
4. Were all eligible participants that met the prespecified entry criteria enrolled?	Yes	Yes	NR	No
5. Was the sample size sufficiently large to provide confidence in the findings?	Yes	Yes	Yes	No
6. Was the test/service/intervention clearly described and delivered consistently across the study population?	Yes	Yes	Yes	No
7. Were the outcome measures prespecified, clearly defined, valid, reliable, and assessed consistently across all study participants?	Yes	Yes	Yes	Yes
8. Were the people assessing the outcomes blinded to the participants' exposures/interventions?	No	No	No	NR
9. Was the loss to follow-up after baseline 20% or less? Were those lost to follow-up accounted for in the analysis?	Yes	Yes	No	No
10. Did the statistical methods examine changes in outcome measures from before to after the intervention? Were statistical tests done that provided <i>p</i> values for the pre-to-post changes?	Yes	Yes	Yes	Yes
11. Were outcome measures of interest	No	Yes	No	No

**Table 4 (continued)**

	Shahnavaz et al. (2018)	Vigerland et al. (2013)	Matthews et al. (2011)	Matthews et al. (2012)
taken multiple times before the intervention and multiple times after the intervention (i. e., did they use an interrupted time-series design)?				
12. If the intervention was conducted at a group level (e.g., a whole hospital, a community, etc.) did the statistical analysis take into account the use of individual-level data to determine effects at the group level?	NA	NA	NA	NA
Quality rating	Good	Good	Poor	Poor

NR: Not reported; NA: Not applicable.

difficult to access. Thus, IMIs have the potential of delivering interventions for phobias if they have an adequate structure and clear guidelines for patients.

Overall, treatment outcomes for phobic symptomatology were positive in most of the studies, reporting significant pre-to-post treatment changes in participants and, in some cases, large effect sizes. A preliminary meta-analysis of the nine included studies suggested that IMIs contributed to a significant reduction of SP symptoms from pre- to post-treatment, showing large pooled effect size. Particularly large reductions were observed in participants allocated to IMI groups in RCTs, compared to participants taking part in pre-post studies. This could suggest that RCTs might optimize treatment effects, as compared to the effects observed in more naturalistic designs that might be closer to routine care. However, the small number of studies hinders the interpretation of these differences.

Given that RCTs are the gold-standard design to examine treatment effects, we further estimated the efficacy of IMIs by focusing only on between-group effect sizes derived from RCTs. Compared to participants allocated to waiting list control groups, participants receiving IMIs experienced significantly lower SP symptoms at post-treatment. A large pooled effect size was observed for IMIs, although only three RCTs were available in this analysis. On the other hand, no significant effects were observed when comparing IMIs against a face-to-face well-established SP treatment. Nevertheless, only two trials with small sample sizes were included in this comparison, which limits considerably the statistical power that is needed for detecting differences between two effective treatments.

Regarding the maintenance of the clinical changes over time, the studies also reported some promising evidence (Andersson et al., 2009, 2013; Campos et al., 2019; Donker et al., 2019; Shahnavaz et al., 2018; Vigerland et al., 2013). The only study that did not report significant changes after the intervention on the outcome measures was the one by Matthews et al. (2012). However, this study has the largest drop-out rate (98%), and, therefore, these results are probably biased, given that the study was also rated as having “poor” quality. A possible explanation for this would be that therapeutic support, one of the factors that has been related to better treatment outcomes and higher adherence rates (Domhardt et al., 2019), was not included in the treatment. Furthermore, it was the study that gave participants the most time to complete the treatment, even though the treatment only consisted of 10 stages. Participants in the other interventions included in this review also had flexibility and freedom to access the program, as is common in self-help



interventions, but the time span to complete the intervention was significantly shorter, and they also had more specific instructions (i.e. to complete one module each week). This aspect should be taken into consideration when developing future interventions, in order to overcome high drop-out rates.

The study by Campos et al. (2019) explored the role of therapist support and did not find significant differences between the completely self-applied group and the one that received weekly calls. Nevertheless, no conclusions can be drawn because most of the other programs had some type of therapist support, and those that did not (Matthews et al., 2011, 2012) were rated as having insufficient quality. However, previous research on Internet-based interventions for anxiety also suggests that there are no differences between guided and unguided interventions in terms of treatment outcomes (Olthuis et al., 2016), and that even though guided interventions might be more beneficial, the differences might be smaller than previously thought (Baumeister et al., 2014). As mentioned above, mobile-based interventions are still a relatively new field, and evidence about the role of guidance is still scarce.

Finally, the mean drop-out rate in the studies in this review at post-test was 27.36%, and 29.58% at follow-up, which is lower than the drop-out rate found in IMIs for other emotional disorders such as depression (Josephine et al., 2017). However, the attrition rates varied across the different studies, and so this result must be interpreted with caution. Furthermore, it is also important to note that the follow-up periods were also different in the studies, with some of them including follow-ups after three months and others after one year.

Some limitations of this review should be acknowledged. First, the important heterogeneity in the studies included, in terms of sample size, study design, and outcome measures, makes it difficult to generalize the results. Second, the small number of studies included does not allow us to draw firm conclusions. Specifically, the results of the preliminary meta-analysis should be viewed with caution. Related to this point, the number of mobile-based interventions was very low, with only two

studies included, and it was not compensated by the number of Internet-based interventions. Third, this review only included published studies, which can lead to an overestimation of treatment results due to publication bias. Finally, the interpretation of the results is limited to the authors who conducted this systematic review.

## 5. Conclusions

This systematic review found that interventions for the treatment of SP through IMIs have been developed, and there is already some evidence in the literature supporting the potential benefits of these treatments. However, the number of studies is still small, and firm conclusions cannot be drawn. There is still a need to explore the specific components an IMI for SP should have, use active comparators with larger sample sizes, examine the role of therapeutic guidance and to what degree it is necessary in these interventions, and determine what factors should be considered to improve adherence to these treatments.

Although relatively few studies have been conducted, we aimed to summarize what researchers have found so far, in order to create more interest in this field and guide future research.

## 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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## Appendix A. Search strings used in the systematic review

Phobia block	Phobi* OR "Phobic Disorders" OR "Specific Phobia" OR "Dental Anxiety" OR "Acrophobia" OR "Claustrophobia"
Intervention block	"Internet-based intervention" OR "Internet-based treatment" OR "Internet-delivered treatment" OR "Internet-delivered intervention" OR "online treatment" OR "Mobile App*" OR "mhealth" OR "android" OR "iphone" OR "Smartphone" OR "mobile-based" OR "App" OR "Cell phone" OR "Web-based intervention" OR "Web-based treatment" OR "internet intervention" ("Phobi*" AND "Internet-based intervention") OR ("Phobi*" AND "Internet-based treatment") OR ("Phobi*" AND "Internet-delivered treatment") OR ("Phobi*" AND "Internet-delivered intervention") OR ("Phobi*" AND "online treatment") OR ("Phobi*" AND "online intervention") OR ("Phobi*" AND "mobile app*") OR ("Phobi*" AND "mhealth") OR ("Phobi*" AND "android") OR ("Phobi*" AND "iphone") OR ("Phobi*" AND "smartphone") OR ("Phobi*" AND "mobile-based") OR ("Phobi*" AND "app") OR ("Phobi*" AND "cell phone") OR ("Phobi*" AND "web-based intervention") OR ("Phobi*" AND "web-based treatment") OR ("Phobi*" AND "Internet intervention") OR ("Phobi*" AND "Internet treatment") OR ("phobic disorder" AND "Internet-based intervention") OR ("phobic disorder" AND "internet-based treatment") OR ("phobic disorder" AND "internet-delivered treatment") OR ("phobic disorder" AND "internet-delivered intervention") OR ("phobic disorder" AND "online treatment") OR ("phobic disorder" AND "online intervention") OR ("phobic disorder" AND "mobile app*") OR ("phobic disorder" AND "mhealth") OR ("phobic disorder" AND "android") OR ("phobic disorder" AND "iphone") OR ("phobic disorder" AND "smartphone") OR ("phobic disorder" AND "mobile-based") OR ("phobic disorder" AND "app") OR ("phobic disorder" AND "cell phone") OR ("phobic disorder" AND "web-based intervention") OR ("phobic disorder" AND "web-based treatment") OR ("phobic disorder" AND "internet intervention") OR ("phobic disorder" AND "internet treatment") OR ("Specific phobia" AND "Internet-based intervention") OR ("Specific phobia" AND "internet-based treatment") OR ("Specific phobia" AND "internet-delivered treatment") OR ("Specific phobia" AND "internet-delivered intervention") OR ("Specific phobia" AND "online treatment") OR ("Specific phobia" AND "online intervention") OR ("Specific phobia" AND "mobile app*") OR ("Specific phobia" AND "mhealth") OR ("Specific phobia" AND "android") OR ("Specific phobia" AND "iphone") OR ("Specific phobia" AND "smartphone") OR ("Specific phobia" AND "mobile-based") OR ("Specific phobia" AND "app") OR ("Specific phobia" AND "cell phone") OR ("Specific phobia" AND "web-based intervention") OR ("Specific phobia" AND "web-based treatment") OR ("Specific phobia" AND "internet intervention") OR ("Specific phobia" AND "internet treatment") OR ("Dental Anxiety" AND "Internet-based intervention") OR ("Dental Anxiety" AND "internet-based treatment") OR ("Dental Anxiety" AND "internet-delivered treatment") OR ("Dental Anxiety" AND "internet-delivered intervention") OR ("Dental Anxiety" AND "online treatment") OR ("Dental Anxiety" AND "online intervention") OR ("Dental Anxiety" AND "mobile app*") OR ("Dental Anxiety" AND "mhealth") OR ("Dental Anxiety" AND "android") OR ("Dental Anxiety" AND "iphone") OR ("Dental Anxiety" AND "smartphone") OR ("Dental Anxiety" AND "mobile-based") OR ("Dental Anxiety" AND "app") OR ("Dental Anxiety" AND "cell phone") OR ("Dental Anxiety" AND "web-based intervention") OR ("Dental Anxiety" AND "web-based treatment") OR ("Dental Anxiety" AND "Internet Intervention") OR ("Dental Anxiety" AND "Internet treatment") OR ("Acrophob*" AND "internet-delivered intervention") OR ("Acrophob*" AND "online treatment") OR ("Acrophob*" AND "online intervention") OR ("Acrophob*" AND "mobile app*") OR ("Acrophob*" AND "mhealth") OR ("Acrophob*" AND "android") OR ("Acrophob*" AND "iphone") OR ("Acrophob*" AND "smartphone") OR ("Acrophob*" AND "mobile-based") OR ("Acrophob*" AND "app") OR ("Acrophob*" AND "cell phone") OR ("Acrophob*" AND "web-based
Word combination for search in databases	

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intervention”) OR (“Acrophob\*” AND “web-based treatment”) OR (“Acrophob\*” AND “Internet Intervention”) OR (“Acrophob\*” AND “Internet treatment”) OR (“Claustrophob\*” AND “Internet-based intervention”) OR (“Claustrophob\*” AND “Internet-based treatment”) OR (“Claustrophob\*” AND “Internet-delivered treatment”) OR (“Claustrophob\*” AND “Internet-delivered intervention”) OR (“Claustrophob\*” AND “online treatment”) OR (“Claustrophob\*” AND “online intervention”) OR (“Claustrophob\*” AND “mobile app”) OR (“Claustrophob\*” AND “mhealth”) OR (“Claustrophob\*” AND “android”) OR (“Claustrophob\*” AND “iphone”) OR (“Claustrophob\*” AND “smartphone”) OR (“Claustrophob\*” AND “mobile-based”) OR (“Claustrophob\*” AND “app”) OR (“Claustrophob\*” AND “cell phone”) OR (“Claustrophob\*” AND “web-based intervention”) OR (“Claustrophob\*” AND “web-based treatment”) OR (“Claustrophob\*” AND “Internet intervention”) OR (“Claustrophob\*” AND “Internet treatment”)

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