Effects of worry postponement on daily worry: a meta-analysis

Annika Dippel[1]

Jos F. Brosschot[2]

Bart Verkuil[1*]

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[1] Clinical Psychology, Leiden University, The Netherlands

[2] Health, Medical and Neuropsychology, Leiden University, The Netherlands

* Corresponding author

Author contributions:

All authors contributed to the study conception and design. Literature search, data collection and analysis were performed by Annika Dippel and Bart Verkuil. The first draft of the manuscript was written by Annika Dippel and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Conflict of Interest:

The authors declare that they have no conflict of interest.

Data availability:

The datasets analyzed in the current study are available in the Open Science Framework repository: https://osf.io/4dm52/?view_only=1e14fcef281741a5aa78cc7f326dc9b9

Abstract

Worry postponement, also called stimulus control, is a simple and easy to administer intervention that often forms part of cognitive-behavioural treatments for worry. We conducted a meta-analysis to test if worry postponement is effective in reducing daily worry. Data from 7 randomized trials were included providing a total of 999 participants, of which 250 experienced worry as a burden and of which the majority was women. When comparing worry postponement to the mere registration of worries small effect sizes were observed for worry duration (d = 0.313) and for worry frequency (d = 0.189). Moderation analyses showed that the intervention yielded larger effect sizes in studies including more women. However, long term follow up studies are still lacking. Worry postponement, practiced between a week or a maximum of a month, was found to effectively reduce the frequency and duration of worry in daily life. This suggests that a simple intervention is available for people whose worries (temporarily) spiral out of control.

Keywords: worry postponement; stimulus control; worry; perseverative cognition; intervention

Introduction

In the past, worry was initially understood as an epiphenomenon of anxiety. However, since the 1980s the concept of worry is increasingly studied independent from anxiety (Purdon & Harrington, 2006). A commonly used working hypothesis of worry was proposed by Borkovec et al.,(1983) "*Worry is a chain of thoughts and images, negatively affect-laden and relatively uncontrollable. The worry process represents an attempt to engage in mental problem-solving on an issue whose outcome is uncertain but contains the possibility of one or more negative outcomes.*" (p. 10). Research has shown that worry plays a central part in several psychopathologies including anxiety disorders such as generalized anxiety disorder, posttraumatic stress disorder, social phobia, panic disorder (Purdon & Harrington, 2006), obsessive compulsive disorder (Comer et al.,2004), eating disorders (Sassaroli et al., 2005) and depression (Diefenbach et al., 2001; Hong, 2007). As such, worry and the related construct of rumination (both forms of repetitive negative thinking) are considered important transdiagnostic factors (Harvey et al., 2004).

Additionally, research showed that worry does not only influence mental health but can also have negative effects on somatic health. In 2006, Brosschot, Gerin, and Thayer proposed the 'perseverative cognition hypothesis' indicating that worry prolongs the bodily response to stress which results in additional negative health consequences. In this line, several studies found that worry can predict the number of somatic complaints that people report (Aasa Brulin et al.,2005; Brosschot & van der Doef, 2006; Jellesma et al., 2009; Verkuil et al.,2012; Versluis et al., 2016; Eggli et al., 2021). It was furthermore found that worry is associated with fatigue and lower back pain (Freeston et al., 1996; Verkuil et al., 2012), cardiovascular disease (Kubzansky et al., 1997), neck pain (Borkovec, 1994) as well as insomnia (Harvey & Greenall, 2003). Worry has also been associated with the prolongation of

the physiological stress response and its negative health consequences. A meta-analysis about the effects of worrying on physiological activity demonstrated that worrying about stressors is a mechanism that prolongs the body's stress responses (Ottaviani et al., 2016).

Evidence provided by previous research clearly demonstrates the negative aspects of prolonged worry. Interventions to reduce worry and other closely forms of repetitive negative thinking (rumination) are numerously presented throughout the literature (Bell et al., 2022; Monteregge et al., 2020; Querstret & Cropley, 2013) and range from short, preventive interventions to complete psychological treatment protocols focused on disrupting the process of worry and rumination (e.g., metacognitive treatment for generalized anxiety disorder (Wells, 2002), intolerance of uncertainty treatment (Dugas & Ladouceur, 2000), rumination focused CBT (Topper et al., 2017; Watkins et al., 2011)). One such short intervention is worry postponement, also known as stimulus control. It assumes that worry is a conditioned response to our initial sensation of fear, with worry being an (ineffective) problem-solving response aimed at avoiding future catastrophes (Borkovec et al., 1983). Because worry can occur under so many circumstances, there is a risk that worry becomes associated with a wide range of environmental stimuli.

In 1972 Bootzin (1972) described how a stimulus control treatment for insomnia was effectively offered to a 25-year old male who had troubles falling asleep due to worry. He was instructed to get out of bed and go to another room, in case he found himself worrying. In doing so, a clear distinction was made between stimuli associated with sleep (the bedroom) and stimuli associated with worry The stimulus control approach to worry was further studied by Borkovec et al. (1983). It nowadays is a component of a commonly used cognitive behavioural treatment for generalized anxiety disorder. Borkovec's stimulus control procedure focused on two main points: (a) worry mostly involves negative outcome

possibilities and hence, seldomly leaves room for actual problem solving; And (b), since worry can be elicited by internal as well as external stimuli (e.g., physical sensations, time of day, seeing your bed that has become associated with worry), it is relatively hard to control. To address both points, Borkovec proposed the stimulus control intervention in which worriers have to postpone their worries to a half an hour worry period, that has to be held at the same time and place each day. During that period, participants can address their worries and should engage in problem-solving to eliminate their concerns. Spontaneous worries that come up during the day have to be replaced with present-moment experiences. According to Borkovec et al . (1983) this would establish a better control over the occurrence of worry. To test whether this was the case, the authors conducted two experiments with self-identified worriers, which either received no treatment (but merely registered how often they worried) or the stimulus control treatment (Borkovec et al., 1983a). Results showed significant reductions in daily worry following these stimulus control instructions. In 2006, Brosschot and van der Doef introduced a revised version of the stimulus control intervention. While their worry postponement intervention also instructs to immediately terminate any worries that come up during the day and postpone them to a special 30-minute worry period in the evening, it did not include instructions for problem solving. To test this worry postponement intervention, Brosschot and van der Doef conducted a study in 2006 including 171 adolescents between 15 and 19 years of age that were either instructed to register their worries in a log (control group) or register their worries in a log *and* postpone them to a 30-minute 'worry-window' in the evening (intervention group). The results showed that participants of the intervention group had significantly shortened worry periods and a reduced number of health complaints, when compared to the control group.

Since Borkovec's initial study, worry postponement has been used in clinical practice to treat worry and insomnia (McGowan & Behar, 2013). It has also been incorporated in meta-cognitive therapy developed by Adrian Wells (Wells, 2002; Wells & Sembi, 2004b). It forms part of the strategy to test the uncontrollable nature of worry and enables patients to develop alternative beliefs about this supposedly uncontrollability. Studies conducted by Wells and colleagues showed that meta-cognitive therapy can reduce symptoms of PTSD, anxiety and depression (Wells, 1995; Wells et al., 2007; Wells & Sembi, 2004), but it is unclear if the worry postponement intervention adds to this effectiveness.

Taken together, this indicates that worry postponement may be a valuable stand-alone intervention and an addition to treatments for worry-related psychopathology. It is therefore perhaps surprising that there is no systematic analysis yet of the effectiveness of worry postponement in reducing its target behavior, namely worry in daily life. The present meta-analysis aims to (1) provide an overview of the literature on worry postponement when used as a stand-alone intervention, and (2) synthesize the effect sizes of worry postponement studies on its main outcome: worry in daily life. In doing so, we aim to provide a complete overview of the hypothesized effects of worry postponement, but also outline the different methods by which the intervention can be delivered (i.e., using a smartphone app, providing extra instructions on how to postpone worries (or not)). This overview may potentially aid further research and may also assist clinicians in treating maladaptive worry or related psychopathologies.

It is also yet unknown for whom the worry postponement intervention works best. It would for example be especially of interest whether it is effective for people with high levels of worry. The current meta-analysis aims to clarify this point and to provide explorations on possible target groups. For this, exploratory moderator analyses will be used. Based on past

research it was determined that gender, age, levels of trait worry, experiencing worry as a burden and duration of the intervention are most commonly reported and could be included in the moderation analyses.

To summarize, it is hypothesized that worry postponement will reduce daily worry (Borkovec et al., 1983; Brosschot et al., 2006). It is predicted that individuals who postpone their worries will report less worry episodes as well as reduced time spent worrying in daily life compared to those in the control group. Our secondary moderator analyses were exploratory and were focused on testing whether the effectiveness of worry postponement may be dependent on gender, mean age, mean level of trait worry, use of samples that experienced worry as a burden, or duration of the intervention.

Methods

Search strategy

Several databases were used to identify qualified research: PubMed, PsychINFO and Web of Science. This search was conducted from the 22nd of April 2020 up to and including 1st of June 2023. To construct the keyword profile, the method proposed by van der Ploeg, Brosschot, Versluis, & Verkuil (2017) was used. In line with this, the BOOLEAN logic was used to refine the search and combine the keyword sets relating to the main topics "worry postponement" and "stimulus control". At the beginning, the combined set of ("worry postponement") OR ("stimulus control" AND "worry") was used. Subsequently, for each set alternative keywords were gathered using Thesaurus of PsychINFO and the Synonym list of MS word. For instance, the search for worry produced 37 different alternative keywords such as "perseverative cognition", "anxiety" or "concern". From here on, each keyword was added to the keyword set individually to evaluate their contribution of new literature and their

relevance to the main search (i.e. (“perseverative cognition” AND “postponement”) OR (“stimulus control”)). If an alternative keyword or keyword phrase did not provide added value to the search, it was removed. To account for the variation in notation of the keywords across literature the word stem of keywords was included with the *-ending (i.e. (worr* AND postpon*)). Using this method, the final keyword profile was produced: (“stimulus control” AND worr*) OR (worr* AND postpon*) OR (“perseverative cognition” AND postpon*). All qualified studies were reviewed without imposing restrictions regarding the publication year or publication type. Additionally, a supplementary backwards search of the reference lists of the screened studies as well as a search of literature that cited included studies were conducted to check for further relevant research. Finally, to reduce publication bias authors of the field of worry postponement/stimulus control were contacted and asked whether unpublished data fitting the current search criteria existed. A detailed overview of the study selection process can be found in Figure 1.

Inclusion criteria

For research to be eligible for this meta-analysis, studies had to report on the effects of worry postponement (or alternatively stimulus control) on worry. Both pre-post designs as well as randomized controlled trials could be included, so that both within-subjects and between-subjects effect sizes could be examined. With regard to the outcome, worry had to be measured using daily or momentary assessments. With regard to participants, no age, ethnic or other restrictions were included. The articles must have been peer-reviewed and must have been available as full-text in English. Eligibility was first evaluated by one reviewer (AD) and when in doubt discussed with a senior investigator (BV). Additional reasons for exclusion can be found in Figure 1.

Data extraction

Effect sizes that demonstrate the effect of worry postponement versus a control group were extracted when reported in the study. If not reported, such effect sizes have been calculated using means and standard deviations of the worry outcomes or alternatively with the given *F* statistics (Lakens, 2013). If applicable, effect sizes have been converted into Cohen's *d* (Lenhard & Lenhard, 2016). In case these data were not reported sufficiently, the authors were approached respectively, and the required data was requested. When multiple outcomes were reported in a study (eg., duration of worry episodes as well as the frequency of worry episodes) we calculated effect sizes for the separate outcomes and synthesized the effect sizes for each outcome in separate meta-analyses.

To assess the overall risk of bias of the included studies, an assessment of bias was conducted, using the revised Cochrane risk of bias tool (RoB2) for randomized trials (Sterne et al., 2019). The risk of bias of each individual study was judged on five domains by answering a total of 22 signalling questions. Thus, a verdict of "Low risk of bias", "Some concerns" or "High risk of bias" can be reached. The evaluations within each domain add up to an overall risk of bias assessment for the assessed results per study.

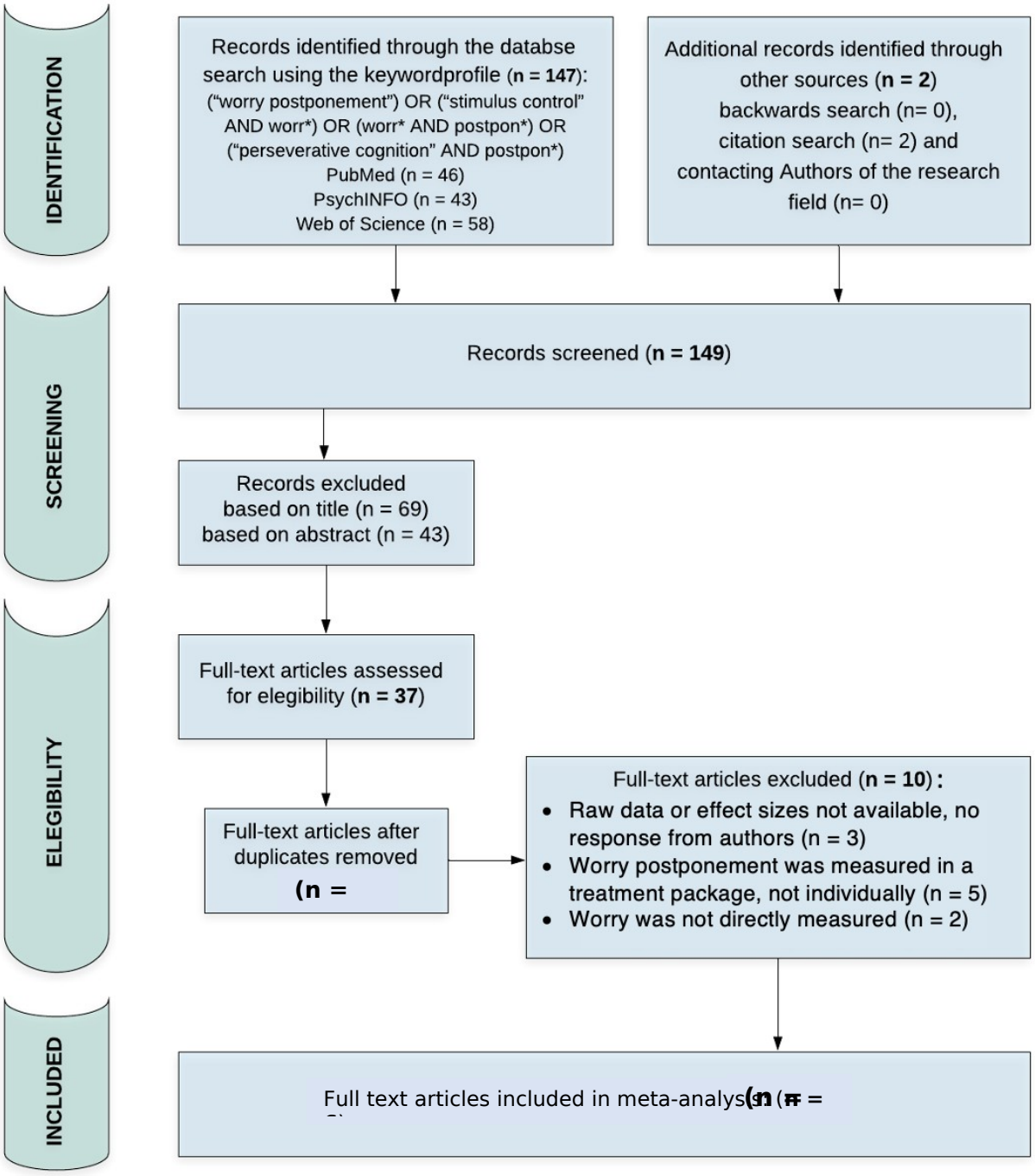

Figure 1 *Flow chart of study selection*

Statistical analyses

Analyses were performed using the metafor package (Viechtbauer, 2010) in R (R Core Team, 2021). The current meta-analysis used the effect sizes (Cohen's d) of all included studies to conduct a between group comparison. The standardized mean difference *d* was calculated and used as primary outcome measure of the treatment effect. Additionally, within-group changes were meta-analysed. Based on Cohen (1988) small, medium and large effects were indicated by *d*s between 0.20-0.50, 0.50-0.80 and >0.80 respectively. Variability between effect sizes was assumed, hence a random effect model was chosen.

To take clustering into account (i.e., multiple effect sizes from the same study) three level multilevel analyses were run and model fit was subsequently compared to two-level models. As two-level models provided the best fit, we reported the results from these models. To investigate the possibility of between-study differences, heterogeneity was tested, using the I^2 statistic. Low, medium or high statistical variation were respectively indicated by 25, 50 or 75% (Higgins, Thompson, Deeks, & Altman, 2003). In addition, the *Q*-statistic was calculated to assess the heterogeneity's significance. To visualize the between-group effect sizes and indicate the overall benefits of worry postponement on worry reduction a forest plot was constructed. To estimate the risk of publication bias, a funnel plot was constructed, and Egger's test was used. Funnel plots were constructed by using standard errors. For each study, standard errors were calculated from the lower bound of 95% confidence interval and the respective mean effect size.

We thereafter explored if worry postponement was more or less effective depending on sample and study characteristics (i.e., percentage of women, age, whether worry was experienced as a burden by the sample (selected versus unselected samples), mean level of trait worry) and duration of the intervention. The following proposed moderators were

included as moderator variables: gender was included as continuous variables expressing the percentage of females in the studies. Age was taken into account as a categorical variable (school children, university students and adults). Finally, mean level of trait worry was categorised into low to moderate levels and high levels, as different trait questionnaires were used. For the non-clinical sample of children, students and adults of the current meta-analysis, a cut-off score for the Penn State Worry Questionnaire (PSWQ) (Startup, & Erickson, 2006) was chosen at 45. Based on Korte, Allan and Schmidt (2016), this cut-off score best fits the current sample, as it identifies non-clinical participants as not having GAD in a sample of mixed age groups. The study of Jellesma et al. (2009) investigated samples of school children (divided into boys and girls) and hence did not use the PSWQ but instead the non-productive thoughts questionnaire for kids. For this questionnaire cut-off scores or norms do not exist yet. In the current meta-analysis, these samples were included with low to moderate trait worry levels because (a) the children were recruited from primary schools, (b) pupils were not selected on worry level and (c) the mean scores of trait worry were below the arithmetic mean of ten (*m*=9.43 for girls; *m*=6.55 for boys). The study of Mobach, van Schie and Nähring (2019) used the Perseverative Thinking Questionnaire (PTQ) which assesses perseverative thoughts independent from its content. Although it is not a specific worry-focused questionnaire, it correlates highly with the PSWQ (r = .70, Ehring et al., 2011) and – like the PSWQ – focusses on the process of experiencing repetitive, intrusive and disturbing negative thoughts. For this questionnaire cut-off scores or norms do not exist yet. Based on the facts that (a) the mean score of trait worry (M =27.26) was below the arithmetic mean of 30 and (b) that this score is comparable to a mean score of a population without a disorder (Ehring et al., 2011) the sample was included with low to moderate trait worry levels. Given, that the two studies of Borkovec et al. (1983) did not measure trait worry, they were excluded from the

moderator analysis of trait worry. Additionally, a categorical variable expressing the difference between selected versus unselected samples was created (worry burden). Studies that had selectively included participants that were experiencing worry as a burden, were compared to studies in which unselected samples were used. Finally, the moderating effect of the duration of the intervention period was examined. For this analysis, intervention duration was included as a continuous variable (length of treatment in days).

Results

Description of the included studies

A total of six papers was found, reporting on seven different studies. Because the study by Jellesma et al. (2009) reported the results separately for boys and for girls, we ultimately report the results derived from eight samples (see Table 1 for descriptions of these studies). Sample sizes varied between $n = 33$ and $n = 351$. All studies reported the gender distributions of their samples, which were largely female (71.4%). The mean age of the total sample of the individual studies ranged between 11.4 and 40 years of age. The study samples usually consisted of students (57%) but in some studies, children ($N = 2$) and working adults ($N = 2$) were included. The included studies were either conducted in the Netherlands ($N = 6$) or the United States of America ($N = 2$) and recruited their samples in the same country. All studies used randomization and were peer-reviewed. Two studies were conducted before 1985 and five studies were conducted after 2005.

In four studies samples were recruited with high levels of worry (a total of n = 250). In the two studies by Borkovec et al., (1983), students were included who reported that they worried more than 50% of the day and that worry was a problem for them. The study by

Mobach et al., (2019) selected students who had reported a minimum of two doctor visits in the past year as well a minimum score of 60 on a health worry-item: *'I worry about my health*' (ranging from 1 [never] to 100 [always]). In the Verkuil et al., (2011) study, outpatients were recruited who were awaiting a stress-management therapy at a mental health care center focused on severe workstress. In the remaining three studies, no selection criteria were used and samples could represent the whole worry continuum (n = 749).

All studies reported on the effects of worry postponement on worry in daily life. In most studies, worry was assessed by asking participants to indicate- on a daily basis - the number of worry episodes (worry frequency) during a day and the total duration of worry in minutes. Effects of worry postponement on worry frequency and worry duration were therefore analysed in separate meta-analyses. Borkovec et al. (1983) measured daily worry as the percentage of the daytime spent worrying, which translates best into worry duration measured in minutes. Thus, the Borkovec et al. (1983) studies I and II were only included in the meta-analysis of worry duration. The moderator trait worry was assessed in five studies using different questionnaires. The Penn State Worry Questionnaire was used in three studies and assesses trait worry on a 16-point Likert scale. Mobach et al. (2019) used the Perseverative Thinking Questionnaire (PTQ) because it is supposed to be less focused on worry content. Jellesma et al. (2009) adapted their trait worry measurement to their sample of children and used the Non-productive Thought Questionnaire for Kids.

The worry postponement interventions were delivered face-to-face ($N = 5$), online ($N = 1$), via a mobile app ($N = 1$) or via mail ($N = 1$; see also Table 1). Mobach et al. (2019) choose to provide face-to-face instructions prior to the intervention start and continued using a mobile app for further measurements. Daily reminders were sent to participants of three studies by either using a mobile app, telephone calls or online e-mail delivery.

All included studies used worry postponement as intervention to reduce daily worry. However, instructions on how to postpone one's worries varied between studies. The main instructions of worry postponement incorporated an explanation of worry, the instructions to terminate worries that come up during the day and postpone them to a self-chosen 30-minute worry window in the evening. Further instructions regarding the content of that worry window were not given. Three studies used these basic instructions adapted from Brosschot and Van Der Doef (2006). Jellesma et al. (2009) adapted these main instructions for children. That is, worry ('zorgen') was explained in a child-friendly manner and the children got assistance in choosing when to hold their 30-minute worry window so that night-time worries would not occur before bedtime. The study of Verkuil et al. (2011) included an additional instruction to help participants disengage from their worries. Four studies included additional instructions to log worries that came up during the night at the next morning in the log of the previous day (Brosschot et al., 2006; Jellesma, et al., 2009; Verkuil et al., 2011; Versluis, et al., 2016). Lastly, the two studies of Borkovec et al. (1983 a, b) that were included used somewhat different intervention instructions. These interventions did include instructions to postpone worries, and, additionally, instructions to attend to the present moment afterwards. Additionally, the participants were instructed that the 30-minute worry window should not be held in the evening. Participants of the first study (Borkovec et al., 1983a) in the intervention group were asked to actively engage in problem solving during the worry window and received a one-hour practice session to learn to focus on the present moment. Participants of the respective control group received weekly phone calls to be reminded to fill out the worry registration questionnaires. The second study of Borkovec et al. (1983b) included two treatment conditions: written worry postponement and mental worry postponement. In the current meta-analysis these conditions were combined and compared to the non-treatment

group. Participants of the intervention group received a practice session in which they heard a 20-minute therapy rationale targeting present moment focus but did not practice this. Contrary to Borkovecs' first study (1983a), participants in the second study were not instructed to problem solve during the worry time window. Additionally, all participants received weekly phone calls to discuss any questions that came up during the previous week.

All included studies used a control group for comparison (see Table 1). Participants in the control conditions were instructed to participate in a daily registration of their worries. That is, they were asked to report their worry frequency and worry duration in a paper log (N = 5), or by using an app (N = 1) or were asked to report the percentage of the day spent worrying on a questionnaire (N = 2).

Intervention durations varied across studies. Worry postponement was administered during a minimum of six or seven days (N = 5), 14 days (N = 1) or a maximum of 28 days (N = 2).

Table 1. *Studies included in the meta-analysis*

	Borkovec et al. (study 1) (1983)	Borkovec et al. (study 2) (1983)	Brosschot and Van Der Doef (2006)	Mobach, van Schie & Näring (2019)	Jellesma, Verkuil & Brosschot (2009)[a]	Verkuil et al. (2011)	Versluis, Verkuil & Brosschot (2016)
Sample	Students who reported that they worried at least 50% of the day and that worry was a problem for them		High school students (unselected)	University students with health complaints and worries about health	Pupils from primary schools (unselected)	Adults outpatients suffering from high levels of workstress	Adults from the general population (unselected)
Mean age	-	-	16.7	20.2	11.4	40	36
N	51	52	171	114	227	33	351
(intervention/control)	(26/25)	(36/16)	(83/88)	(57/57)	(138/89)	(19/14)	(163/188)
Female %	80%	80%	81.4%	87.7%	56.8%	42.4%	85.2%
Worry measurement	Daily worry questionnaire (% of daytime spent	Daily worry questionnaire (% of daytime	Worry registration (log; frequency	Worry registration (app;	Worry registration (log; frequency and duration)	Worry registration (log;	Worry registration (log;

	worrying)	spent worrying)	and duration)	frequency and duration)		frequency and duration)	frequency and duration)
Trait worry measure	-	-	PSWQ	PTQ-15-NL	Non-productive thoughts questionnaire for Kids	PSWQ	PSWQ
Mean trait worry (SD)	-	-	44.2 (10.8)	27.26 (10.42)	8.18 (4.25)	55.7 (-)	56.72 (11.38)
Including nightly worries	No	No	Yes	No	Yes	No	Yes
Delivery method	Face-to-face	Face-to-face	Written per mail	Mobile App	Face-to-face	Face-to-face	Online
Intervention condition	WP*	Written WP*; Mental WP*	WP*	WP*	WP*	WP*	WP*
Additional instructions	Problem solving + present moment focus	Present moment focus	none	none	none	Problem solving + present moment focus	none
Control condition	Worry registration	Worry registration	Worry registration	Worry registration	Worry registration	Worry registration	Worry registration
Intervention duration	28 days	28 days	6 days	6 days	7 days	14 days	6 days

Intervention	No	Weekly phone calls	No	Daily app messages	No	No	Daily e-mails
Compliance check	No	No	No	1 Question	No	No	1 Question
Follow-up measurement	No	No	No	No	No	No	No
Country	United States	United States	Netherlands	Netherlands	Netherlands	Netherlands	Netherlands

Note. *WP = Worry postponement ; [a] The Jellesma study reported the results for the worry postponement intervention separately for boys and girls

Meta-analysis on the association between worry frequency/duration and worry postponement

The results of the between group comparison of worry postponement on worry duration indicated a small but significant effect (d = 0.358, 95% CI = .17 - .54, p < .001; see Table B2). Heterogeneity was moderate as indicated by the I^2 statistic of 51.38% (Q(7) = 14.63, p < .041). The funnel plot shows no indication for publication bias, as the distribution of effects is symmetrical (see Figure S15). This is supported by a non-significant Egger's test (z = -0.085, p = .932). A forest plot of this analysis can be found in Figure 2.

Additionally, the effect of worry postponement on worry frequency was small and significant, as indicated by the results of the between group comparison (d = 0.189, 95% CI = .05 - .32, p < .01 .005). Assessment of heterogeneity was low (I^2 = 0.0% Q(5) = 2.46, p < .782). The funnel plot shows no indication for publication bias, as the distribution of effects is symmetrical (see Figure S2). This is supported by a non-significant Egger's test (z = 0.087, p = .930). A forest plot of this analysis can be found in Figure 3.

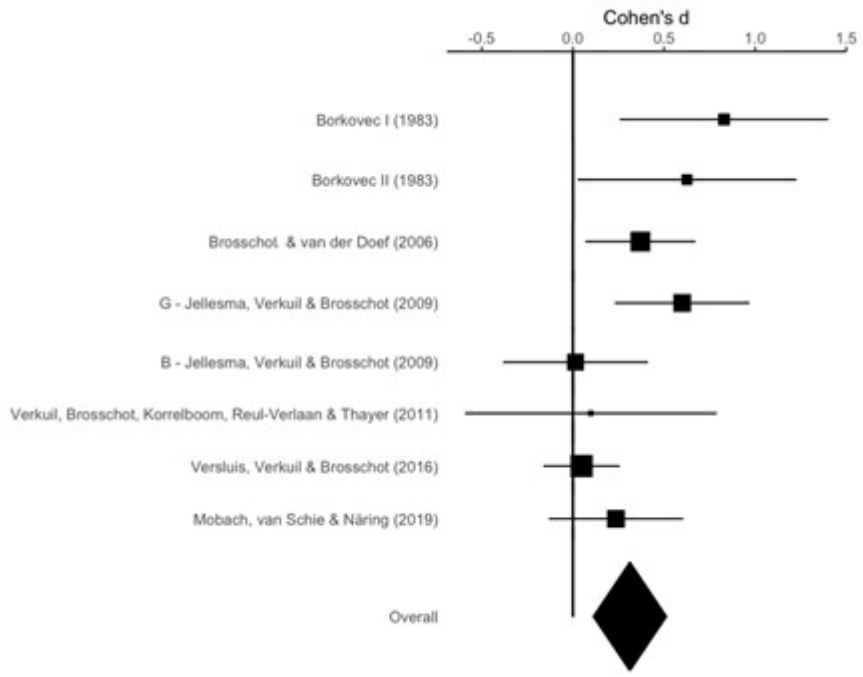

Figure 2. *Forest plot displaying the effect sizes of studies assessing the effectiveness of worry postponement for reducing worry duration.*

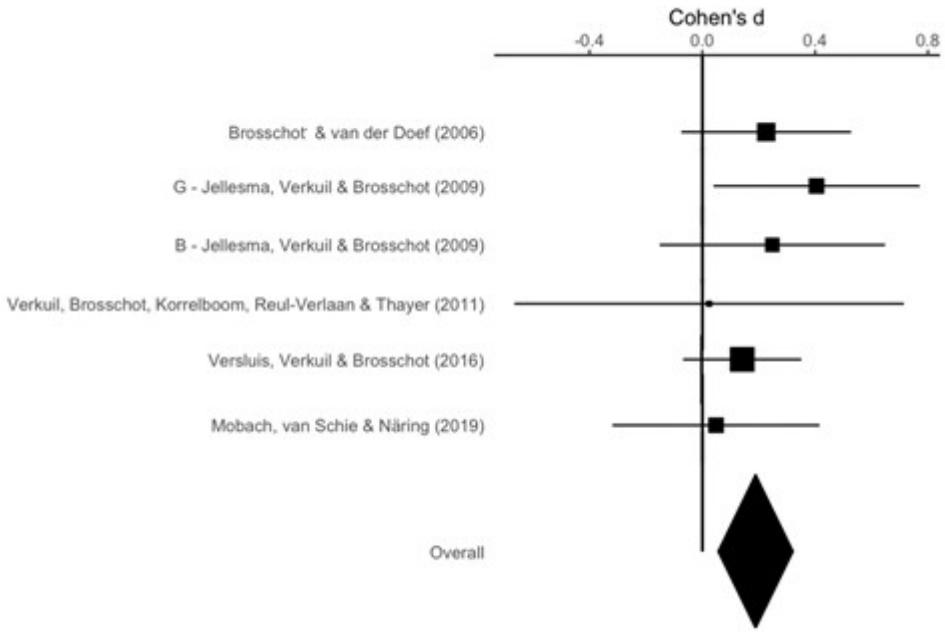

Figure 3. *Forest plot displaying the effect sizes of studies assessing the effectiveness of worry postponement for reducing worry frequency.*

Moderation analyses

Subsequently, moderation analyses were performed to examine if effect sizes depended on study and sample characteristics. Age group, trait worry level, worry burden nor duration of the intervention moderated the effects of worry postponement on worry duration. A moderating effect of gender was observed ($Q_m(1) = 4.2235$, $p = .0399$), with studies with a higher percentage of females obtaining larger effects. For worry frequency no moderation analyses were conducted as heterogeneity was zero.

Quality assessment

The results indicated some risk of bias for most of the included studies. Risks were most commonly found in the category "Measurement of the outcome", where 71.4% of the included studies reported "some concerns" regarding the risk of bias. The main risk of bias in this domain arose from the included self-report measures of daily worry. Self-report measures can pose some degree of unreliability. However, daily worry cannot be measured in a more objective manner. Therefore, the assessment of the risk of bias regarding the measurement of the outcome was based on the authors judgement (Some concerns) as opposed to the computer programs judgement (High Risk). This was followed by the categories "Deviations from the intended interventions" and "Selection of the reported results", where 28.6% of the included studies reported "some concerns" regarding the risk of bias. Only one study (14.3%) was found to have a high risk of bias for "Deviations from the intended interventions" due to missing information about drop-out rates and respective analyses. A complete summary of the quality assessment can be found in Figure 4 and the individual quality assessment per study can be found in the Suuplement (See Table S1).

Additionally, to assess whether participants actually performed their worry postponement or worry registration, compliance checks were performed by two studies at the end of the intervention.

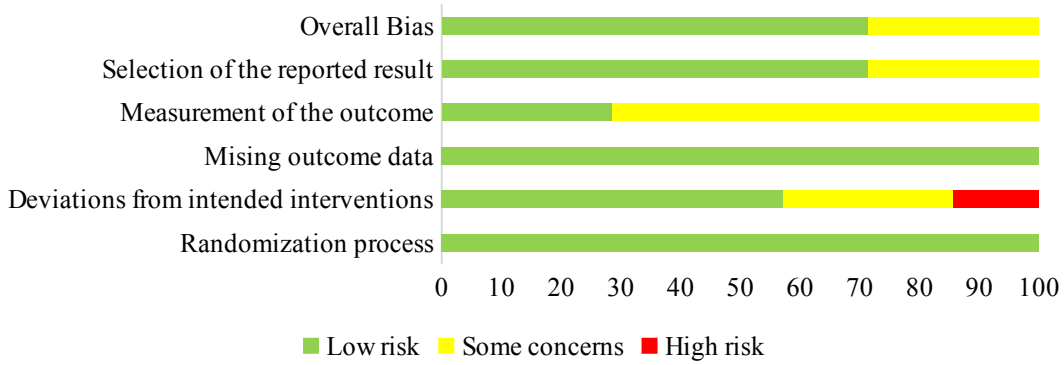

Figure 4. *Overall risk of bias per domain*

Discussion

Worry is a common phenomenon in daily life and when excessive it can pose a risk to mental and somatic health. The current study is the first meta-analysis investigating if a simple and easy to administer intervention, worry postponement, is effective in reducing the level of worry when compared to the mere registering of worries. The results of the between group meta-analyses of worry postponement indicate that worry postponement is associated with small but significant effects on the reduction of both the frequency and the duration of worries in daily life. In line with the proposed hypothesis, worry postponement worked better in terms of reducing worry duration and frequency for the intervention group compared to the control groups which merely registered their worries. Nevertheless, this finding should be interpreted with caution, as the effects of worry postponement that were found were significant but relatively small.

The results from the moderation analyses indicated the effects of worry postponement on worry duration were not moderated by age group, trait worry levels, worry burden or duration of the intervention. However, larger effect sizes were obtained in studies with a higher percentage of women. In Verkuil et al. (2011) and Jellesma et al., (2009) effect sizes were lower, as were the percentages of men (Jellesma reported results separately for boys and girls). Given the small amount of studies with men, it remains a question whether the intervention is indeed less effective in men, and if so, what might be the cause. Given that men usually experience lower levels of worry, it might be that the intervention reached a floor effect in these studies. However, we cannot rule out that other study characteristics influenced this finding, nor can we rule out that this was a chance finding. More research is clearly warranted.

We also observed that there were several differences between the studies in how the intervention was delivered. This leaves one to wonder what the essential ingredients are that provide the working mechanism of postponement. With the current limited dataset we could not test whether instructions to focus on the present moment when postponing worries, or to engage in problem solving during the worry half-an-hour, were crucial components or not. Clinical experience also teaches us that for different patients, different ingredients are considered relevant (eg., some learn that the worry half an hour is not necessary because the worries are not pivotal anymore, others mention that writing down their worries in order to engage in problem solving is helpful). In this sense, a more qualitative approach to the worry postponement intervention could provide more insight into possible crucial ingredients.

Overall, the quality of the studies was satisfactory. However, to get a better understanding of how the intervention works, future studies on worry postponement should more closely monitor whether participants followed the instructions of the intervention and

actually postponed their worries every day to a 30-minute worry window. That is, only two of the included studies used a one-time compliance check which makes it more difficult to determine adherence throughout this meta-analysis. Non-adherence could also have led to an underestimation of the intervention effect and could explain the small effect size of the overall intervention effect. For this, future research should include regular maybe even daily compliance checks. For instance, this could be done by sending short online notifications or smartphone messages that remind patients of the task at hand and ask them to confirm whether they postponed their worries in the evening.

Another reason for why the effect sizes were overall small could be found in the nature of the included studies and their control conditions. Because the participants of the control conditions were also instructed to register their worries, an change in the duration and frequency of worry episodes could occur not only in the intervention groups, but also in the control groups. Indeed, inspection of the available raw means suggest that worry duration decreased in the control groups too. This could result in an underestimation of the overall effect of the worry postponement treatment when it would have been compared to no intervention at all. This would call for a study in which no registration of worries is conducted, but since the worry registration is needed to yield the dependent variables worry frequency and duration, this would only be possible if the outcome of the study would become retrospective, which has its own limitations.

It is also important to note that in this meta-analysis we only included peer reviewed studies that examined the effects of worry postponement on worry in daily life, in comparison to the mere registering of worries. We therefore had to exclude an interesting study by McGowan and Behar (2013), who compared worry postponement to a control intervention in which participants were instructed to worry as they normally do and to make this worry as

intense as possible. The results were in line with this meta-analysis: the worry postponement intervention was associated with stronger reductions in worry, as measured with the PSWQ, and anxiety. An online search using Google Scholar also pointed us to an unpublished dissertation in which worry postponement was compared to the registering of worries (Tallon, 2019). In this study daily, worry duration was not significantly reduced by worry postponement (Cohen's d = 0.10), nor was worry frequency (Cohen's d = 0.18). Including this unpublished study into the current meta-analysis did not alter the current results.

Limitations

When interpreting the presented results of this meta-analysis, some limitations should be kept in mind. Based on the limited amount of research and the small sample sizes of the included studies the statistical power is low, and heterogeneity may be biased. In small meta-analyses, the heterogeneity statistic I^2 can be biased as indicated by findings of von Hippel (2015). Thus, the small number of included samples ($N = 8$) of the current meta-analysis most likely caused the current I^2 statistic to be biased. Meaning, that even though heterogeneity was indicated to be low to medium (0% – 51%) it could be underestimated. Both, a low power and an underestimation of heterogeneity highlight the need for cautious interpretation of the current results.

A second limitation of the current meta-analysis is that none of the studies used a follow up assessment. It therefore remains unknown whether treatment effects of worry postponement can be maintained over time. In order to examine the duration of such treatment gains, future research needs to include at least one follow up assessment.

Furthermore, the intervention instructions varied between the included studies. Thus, results cannot clearly indicate whether the reduction of worry can be attributed to one, several

or a combination of instructions of worry postponement. For example, Verkuil et al. (2011) used the most basic instructions of worry postponement (Brosschot & van der Doef, 2006) and added instructions for disengagement for the intervention group. It cannot be clearly indicated whether worry postponement, disengagement or the combination of both led to the reduction of worry. Additionally, the instructions of Borkovec et al. (1983) included instructions to engage in problem solving and to focus on the present moment to be able to postpone worries. Thus, the effects found in these studies cannot purely be attributed to the instructions to postpone worries to a 30-minute worry period. Future research should therefore include a simple worry postponement group, a control group and if needed include an intervention group that combines worry postponement with other intervention components (i.e., disengagement, stimulus control, problem solving instructions).

Conclusion

The current study was the first meta-analysis to investigate whether a worry postponement intervention can effectively reduce daily worry compared to worry registration control groups. Based on the presented results, it can be suggested that worry postponement has the potential to be an effective strategy in reducing daily worry frequency and duration. Nevertheless, the small number of included studies and their small sample sizes make it seem necessary to conduct further research and to keep updating the current meta-analysis. Even though worries form part of common human experience, for those whose worries become a burden, a simple and (cost-)effective intervention is available.

References

Aasa, U., Brulin, C., Angquist, K., & Barnekow-Bergkvist, M. (2005). Work-related psychosocial factors, worry about work conditions and health complaints among female and male ambulance personnel. *Scandinavian Journal of Caring Sciences*, *19*, 251-258. https://doi.org/10.1111/j.1471-6712.2005.00333.x

Bell, I. H., Marx, W., Nguyen, K., Grace, S., Gleeson, J., & Alvarez-Jimenez, M. (2022). The effect of psychological treatment on repetitive negative thinking in youth depression and anxiety: a meta-analysis and meta-regression. *Psychological Medicine,* 1-11.

Bootzin, R. R. (1972). A stimulus control treatment for insomnia. *Proceedings of the American Psychological Association*, *7*, 395-396.

Borkovec, T. D. (1994). The nature, functions and origins of worry. In G. C. Davey & F. Tallis (Eds.), *Worrying. Perspectives on theory, assessment and treatment* (pp. 5-33). NY: Wiley.

Borkovec, T. D., Robinson, E., Pruzinsky, T., & DePree, J. A. (1983). Preliminary exploration of worry: Some characteristics and processes. *Behaviour Research and Therapy*, *21*, 9-16. doi:10.1016/0005-7967(83)90121-3

Brosschot, J. F., Gerin, W., & Thayer, J. F. (2006). The perseverative cognition hypothesis: A review of worry, prolonged stress-related physiological activation, and health. *Journal of Psychosomatic Research*, *60*, 113-124. doi:10.1016/j.jpsychores.2005.06.074

Brosschot, J. F., & van der Doef, M. (2006). Daily worrying and somatic health complaints: Testing the effectiveness of a simple worry reduction intervention. *Psychology & Health*, *21*, 19-31. doi:10.1080/14768320500105346

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences*. New Jersey, NJ: Lawrence Erlbaum Associates.

Comer, J. S., Kendall, P. C., Franklin, M. E., Hudson, J. L., & Pimentel, S. S. (2004). Obsessing/worrying about the overlap between obsessive–compulsive disorder and generalized anxiety disorder in youth. *Clinical Psychology Review*, *24*, 663-683. doi:10.1016/j.cpr.2004.04.004

Diefenbach, G. J., McCarthy-Larzelere, M. E., Williamson, D. A., Mathews, A., Manguno-Mire, G. M., & Bentz, B. G. (2001). Anxiety, depression, and the content of worries. *Depression and Anxiety*, *14*, 247-250. doi:10.1002/da.1075

Dugas, M. J., & Ladouceur, R. (2000). Treatment of GAD: Targeting intolerance of uncertainty in two types of worry. *Behavior Modification, 24*(5), 635-657.

Eggli, A., Romano-Pereira, D., & Elfering, A. (2021). Short-term effects of social stressors at work on rumination and physical symptoms in social workers. *Industrial Health*, *59*, 220-228. https://doi.org/10.2486/indhealth.2020-0192

Ehring, T., Zetsche, U., Weidacker, K., Wahl, K., Schönfeld, S., & Ehlers, A. (2011). The Perseverative thinking questionnaire (PTQ): Validation of a content-independent measure of repetitive negative thinking. *Journal of Behavior Therapy and Experimental Psychiatry*, *42*, 225-232. doi:10.1016/j.jbtep.2010.12.003

Freeston, M. H., Dugas, M. J., Letarte, H., Rhéaume, J., Blais, F., & Ladouceur, R. (1996). Physical symptoms associated with worry in a nonclinical population. *Journal of Anxiety Disorders*, *10*, 365-377. doi:10.1016/0887-6185(96)00017-5

Harvey, A. G., & Greenall, E. (2003). Catastrophic worry in primary insomnia. *Journal of Behavior Therapy and Experimental Psychiatry*, *34*, 11-23. doi:10.1016/s0005-7916(03)00003-x

Harvey, A., Watkins, E., Mansell, W. and Shafran, R. (2004). *Cognitive behavioral processes across psychological disorders: A transdiagnostic approach to research and treatment*. Oxford University Press Inc., New York.

Higgins, J. P., Thompson, S. G., Deeks, J. J., & Altman, D. G. (2003). Measuring inconsistency in meta-analyses. *The British Medical Journal*, *327*(7414), 557-560. Retrieved from https://dx.doi.org/10.1136%2Fbmj.327.7414.557

Hong, R. Y. (2007). Worry and rumination: Differential associations with anxious and depressive symptoms and coping behavior. *Behaviour Research and Therapy*, *45*, 277-290. doi:10.1016/j.brat.2006.03.006

Jellesma, F. C., Verkuil, B., & Brosschot, J. F. (2009). Postponing worrisome thoughts in children: The effects of a postponement intervention on perseverative thoughts, emotions and somatic complaints. *Social Science & Medicine*, *69*, 278-284. doi:10.1016/j.socscimed.2009.04.031

Korte, K. J., Allan, N. P., & Schmidt, N. B. (2016). Factor mixture modeling of the Penn State Worry Questionnaire: Evidence for distinct classes of worry. *Journal of Anxiety Disorders*, *37*, 40-47. doi:10.1016/j.janxdis.2015.11.001

Kubzansky, L. D., Kawachi, I., Spiro, A., Weiss, S. T., Vokonas, P. S., & Sparrow, D. (1997). Is worrying bad for your heart? *Circulation*, *95*, 818-824. doi:10.1161/01.cir.95.4.818

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: A practical primer for T-Tests and ANOVAs. *Frontiers in Psychology*, *4*. doi:10.3389/fpsyg.2013.00863

Lenhard, W. & Lenhard, A. (2016). Calculation of Effect Sizes (3478). Dettelbach, Germany: Psychometrica. Retrieved from: https://www.psychometrica.de/effect_size.html.

McGowan, S. K., & Behar, E. (2013). A preliminary investigation of stimulus control training for worry. *Behavior Modification*, *37*, 90-112. doi:10.1177/0145445512455661

Mobach, L., Van Schie, H. T., & Näring, G. W. (2019). Application of a worry reduction

intervention in a medically unexplained symptoms-analogue student-sample. *Psychology & Health*, *34*, 677-694. doi:10.1080/08870446.2018.1562066

Monteregge, S., Tsagkalidou, A., Cuijpers, P., & Spinhoven, P. (2020). The effects of different types of treatment for anxiety on repetitive negative thinking: A meta-analysis. *Clinical Psychology: Science and Practice, 27*(2), e12316.

Ottaviani, C., Thayer, J. F., Verkuil, B., Lonigro, A., Medea, B., Couyoumdjian, A., & Brosschot, J. F. (2016). Physiological concomitants of perseverative cognition: A systematic review and meta-analysis. *Psychological Bulletin*, *142*, 231-259. doi:10.1037/bul0000036

Purdon, C., & Harrington, J. (2006). Chapter 3: Worry in Psychopathology. In G. C. Davey & A. Wells (Eds.), *Worry and its psychological disorders: Theory, assessment and treatment*. Hoboken, NJ: Wiley Publishing.

Querstret, D., & Cropley, M. (2013). Assessing treatments used to reduce rumination and/or worry: A systematic review. *Clinical Psychology Review*, *33*, 996-1009. doi:10.1016/j.cpr.2013.08.004

R Core Team (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.Sassaroli, S., Bertelli, S., Decoppi, M., Crosina, M., Milos, G., & Ruggiero, G. (2005). Worry and eating disorders: A psychopathological association. *Eating Behaviours*, *6*, 301-307. doi:10.1016/j.eatbeh.2005.05.001

Startup, H. M., & Erickson, T. M. (2006). The penn state worry questionnaire (PSWQ). In G. C. Davey & A. Wells (Eds.), *Worry and its psychological disorders: Theory, assessment and treatment* (pp. 101-120). Chichester, West Sussex: John Wiley and sons.

Sterne, J. A., Savović, J., Page, M. J., Elbers, R. G., Blencowe, N. S., Boutron, I., …

Higgins, J. P. (2019). Rob 2: A revised tool for assessing risk of bias in randomized trials. *BMJ*, 366. doi:10.1136/bmj.l4898

Topper, M., Emmelkamp, P. M., Watkins, E., & Ehring, T. (2017). Prevention of anxiety disorders and depression by targeting excessive worry and rumination in adolescents and young adults: A randomized controlled trial. *Behaviour Research and Therapy, 90*, 123-136.

Van der Ploeg, M. M., Brosschot, J. F., Versluis, A., & Verkuil, B. (2017). Peripheral physiological responses to subliminally presented negative affective stimuli: A systematic review. *Biological Psychology*, *129*, 131-153. doi:10.1016/j.biopsycho.2017.08.051

Verkuil, B., Brosschot, J. F., Korrelboom, K., Reul-Verlaan, R., & Thayer, J. F. (2011). Pretreatment of worry enhances the effects of stress management therapy: A randomized clinical trial. *Psychotherapy and Psychosomatics*, *80*(3), 189-190. doi: 10.1159/000320328

Verkuil, B., Brosschot, J. F., Meerman, E. E., & Thayer, J. F. (2012). Effects of momentary assessed stressful events and worry episodes on somatic health complaints. *Psychology & Health*, *27*, 141-158. doi:10.1080/08870441003653470

Versluis, A., Verkuil, B., & Brosschot, J. F. (2016). Reducing worry and subjective health complaints: A randomized trial of an internet-delivered worry postponement intervention. *British Journal of Health Psychology*, *21*, 318-335. doi:10.1111/bjhp.12170

Viechtbauer W (2010). Conducting meta-analyses in R with the metafor package. *Journal of Statistical Software*, *36*(3), 1–48. doi:10.18637/jss.v036.i03

Von Hippel, P. T. (2015). The heterogeneity statistic I2 can be biased in small

meta-analyses. *BMC Medical Research Methodology*, *15*, 1-8. doi:10.1186/s12874-015-0024-z

Watkins, E. R., Mullan, E., Wingrove, J., Rimes, K., Steiner, H., Bathurst, N., ... & Scott, J. (2011). Rumination-focused cognitive–behavioural therapy for residual depression: Phase II randomised controlled trial. *The British Journal of Psychiatry, 199*(4), 317-322.

Wells, A. (1995). Meta-cognition and worry: A cognitive model of generalized anxiety disorder. *Behavioural and Cognitive Psychotherapy*, *23*, 301-320. doi:10.1017/s1352465800015897

Wells, A. (2002). *Emotional Disorders and Metacognition: Innovative Cognitive Therapy*. Chichester, UK: John Wiley & Sons.

Wells, A., Fisher, P., Myers, S., Wheatley, J., Patel, T., & Brewin, C. R. (2007). Metacognitive therapy in recurrent and persistent depression: A multiple-baseline study of a new treatment. *Cognitive Therapy and Research*, *33*, 291-300. doi:10.1007/s10608-007-9178-2

Wells, A., & Sembi, S. (2004a). Metacognitive therapy for PTSD: A preliminary investigation of a new brief treatment. *Journal of Behavior Therapy and Experimental Psychiatry*, *35*, 307-318. doi:10.1016/j.jbtep.2004.07.001

Wells, A., & Sembi, S. (2004b). Metacognitive therapy for PTSD: A core treatment manual. *Cognitive and Behavioral Practice*, *11*, 365-377. doi:10.1016/s1077-7229(04)80053-1

SupplementFigures

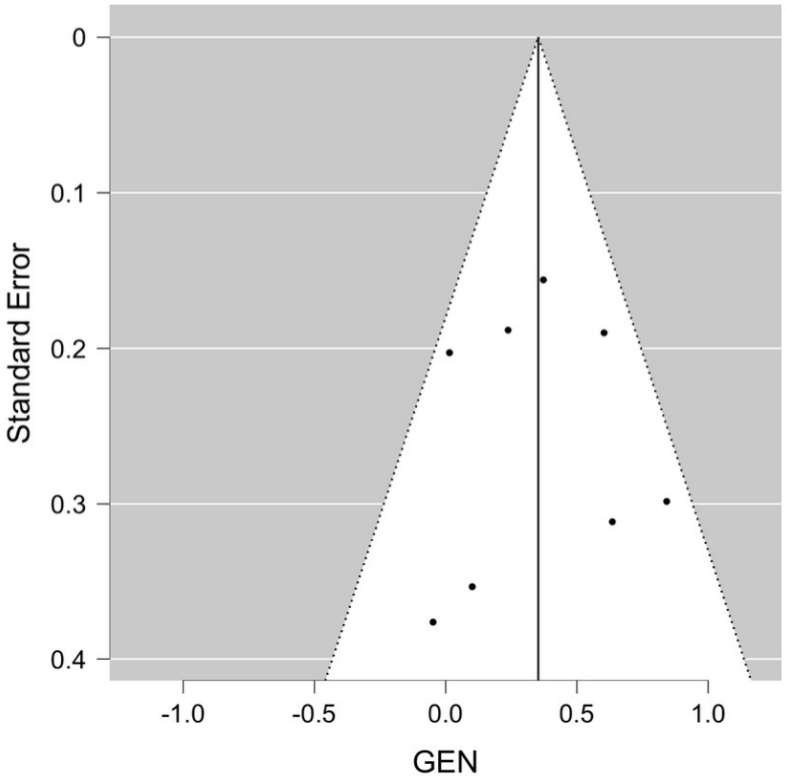

Figure S1. Begg's funnel plot for studies on the effect of worry postponement on worry duration

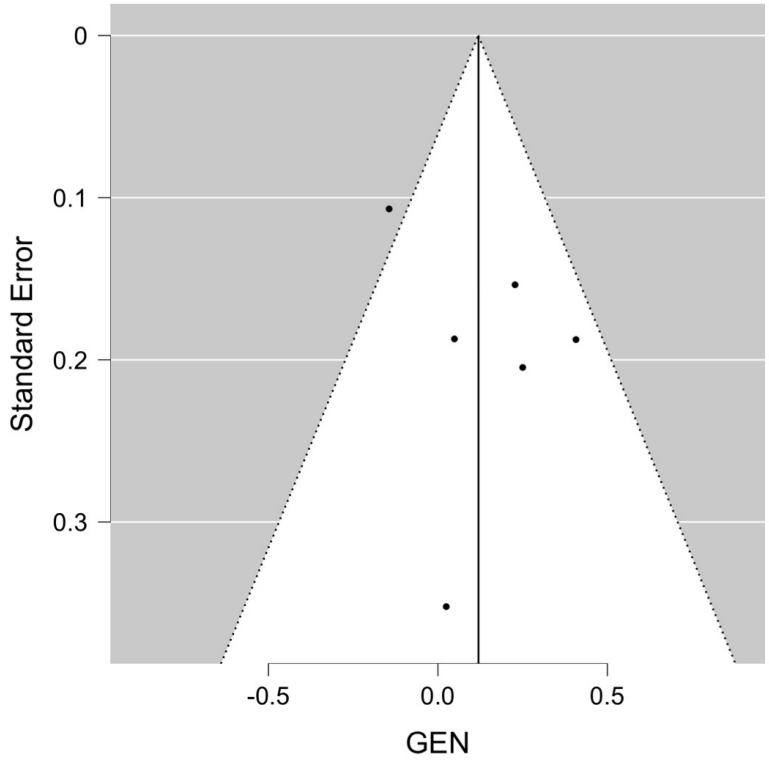

Figure S2. Begg's funnel plot for studies on the effect of worry postponement on worry frequency

Table S1. Quality assessment per study

Study	D1	D2	D3	D4	D5	Overall
Borkovec et al. (study 1) (1983)	+	-	+	!	!	!
Borkovec et al. (study 2) (1983)	+	+	+	+	!	+
Brosschot and Van Der Doef (2006)	+	!	+	!	+	!
Mobach, van Schie and Nähring (2019)	+	!	+	+	+	+
Jellesma, Verkuil and Brosschot (2009)	+	+	+	!	+	+
Verkuil et al. (2011)	+	+	+	!	+	+
Versluis, Verkuil & Brosschot (2016)	+	+	+	!	+	+

Note. D1 = Randomization process; D2 = Deviations from the intended interventions; D3 = Missing outcome data; D4 = Measurement of the outcome; D5 = Selection of the reported result.

+ = low risk of bias; ! = some concerns; - = high risk of bias