Reducing daily stress: Breaking a habit

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Reducing worry and subjective health complaints: A randomized trial of an internet-delivered worry postponement intervention

02

ABSTRACT

Objectives
Several studies have shown that perseverative, worrisome thoughts are prospectively related to subjective health complaints (SHC) and that a short worry postponement intervention can decrease these complaints. As SHC and worry are prevalent and costly, we tested whether the intervention can be offered online to reduce these complaints in the general population.

Design
A randomized parallel-group trial was conducted with self-selected participants from the general population.

Methods
Via the research website, 996 participants were instructed to register their worrying for 6 consecutive days. The intervention group was instructed to postpone worry to a special 30-min period in the early evening. The Subjective Health Complaints inventory, as administered before and after the intervention, and daily worry frequency and duration were considered the primary outcomes.

Results
Three hundred and sixty-one participants completed the study. Contrary to our expectation, the registration group (n = 188) did not differ from the intervention group (n = 163) in SHC = .00, CI [0.000,0.003]), or in worry frequency or duration. Nevertheless, the different worry parameters were moderately related to SHC (r between .24 and .34, $p \leq .001$).

Conclusions
In contrast to previous studies using pen-and-pencil versions of the worry postponement intervention, this study suggests that a direct online implementation was not effective in reducing SHC and worry. Overall, participants had high trait worry levels and reported difficulty with postponing worrying. Reducing SHC and worries via the Internet might require more elaborate interventions that better incorporate the advantages of delivering interventions online.

INTRODUCTION

Worry is a common phenomenon and can be defined as a 'chain of thoughts and images, negatively affect-laden and relatively uncontrollable' [81, p. 10]. Although some people believe that worrying has benefits (e.g., problem solving), people generally report the negative sides related to worrying. Several studies have shown that excessive worry is an important aetiological element in different psychopathological conditions, for instance, generalized anxiety disorder (GAD), posttraumatic stress disorder (PTSD), anxiety, and depressive disorders [81, 82]. Furthermore, worrying has been related to heightened physiological activity, including cardiovascular and endocrinological activity, and dysregulation of immunological activity [25]. This is a concern, given that prolonged physiological activity carries health risks; for example, prolonged heart rate is predictive of coronary heart disease and even cardiovascular death [83]. Several studies found that worry may increase the risk for coronary heart disease [84, 85]. These findings are in line with the perseverative cognition (PC) hypothesis, which suggests that PC, such as worry and rumination, prolongs physiological activation beyond the presence of a direct stressor, and that this prolongation of the stress response may lead to health problems [25]. In other words, according to this hypothesis, PC acts as mediator by which psychosocial stress may produce negative health effects.

A review by Verkuil, Brosschot, Gebhardt, and Thayer [31] supports an association between PC and health. Specifically, most of the reviewed articles found that PC was positively associated with subjective health complaints (SHC) and cardiovascular activity. Moreover, an ambulatory study by Verkuil, Brosschot, Meerman, and Thayer [33] showed that worry acts as a mediator between stress and SHC. However, studies that looked at the causal relationship between PC and SHC are still limited [31]. The studies that have examined this causal relationship did so by manipulating worry using a worry postponement intervention [86-88]. In this intervention, participants are instructed to postpone their daily worries to a special 30-min worry period in the early evening [89]. Research has shown that it can reduce daily worrying [89] and decrease SHC [86-88]. The effectiveness of the procedure is attributed to similar mechanisms that underlie fear extinction [89]. Previously conducted studies using worry postponement were carried out amongst young people (i.e., < 18 years) [86, 88] and people suffering from work-related stress [87]. This study aimed to further investigate the causal relationship between PC and SHC in the general adult population.

Besides testing the causal relation between worrying and SHC, as predicted by the PC hypothesis, finding ways to reduce SHC is of great importance as SHC

are highly common in the general population. SHC are associated with large health care costs [90], with lower levels of health-related quality of life [91], and heightened psychological distress [92]. Given this, it is not only theoretically important to test the PC hypothesis (i.e., does reducing worry lead to a decrease in SHC?), but also important to find simple and cost-effective ways to reduce these SHC.

We therefore attempted to replicate the findings of the worry postponement intervention and tested whether it can reduce worry and SHC in the larger general population. In contrast to the previous studies that delivered this intervention on paper [86-88], the present intervention will be delivered over the Internet. Internet-based interventions are increasingly being used for treating various psychological disorders and health problems, and its use carries several advantages like being easily accessible and cost-effective [69]. A meta-analysis has now shown that Internet interventions can be effective in reducing psychological symptoms and result in good adherence [70]. These results seem promising and make it interesting to study the effects of the intervention online.

Individuals in the present study were randomly allocated to either the worry postponement condition or a control condition, in which individuals were asked to merely register their worry frequency and duration (i.e., identical to the previous studies). It was first investigated whether trait worry and worry in daily life (i.e., worry frequency and duration) were related to SHC. Next, the effects of the online worry postponement intervention on SHC and worry in daily life were examined. In case of positive outcomes, this would confirm the causal relationship between worrying and SHCs and—secondly—would make a simple and easily accessible intervention available for a wider audience. Additionally, the effect of the intervention on positive and negative affects was studied. Affect was included, because this intervention manipulates worrying, and worry intensity has been shown to predict the level of negative affect [33]. If the intervention is capable of reducing worry, it may in turn also decrease the level of negative affect. Furthermore, it is important to confirm earlier findings that effects of worry on SHC are independent of negative affect [88]. Based on earlier findings with the 'regular' offline version of the intervention, it was expected that the online intervention would reduce the number of SHC and the level of daily worrying (both frequency and duration). Furthermore, it was expected that the intervention would lead to a decrease in negative affect.

METHOD

Design

A non-stratified randomized parallel-group trial was conducted with self-selected participants from the general population. The study was conducted between 2005 and 2012 and was not pre-registered. The institutional review board approved the study.

Participants

Dutch participants were recruited to participate in an online study on daily worrying via advertisements in local and national newspapers, and the Internet (e.g., websites of popular magazines). People who were interested in volunteering were directed towards the website of the study http://www.piekeren.com ('piekeren' is the Dutch word for worrying). The website was typically in the top 10 results when the word worrying was entered into a search engine. The website was described as 'Participate in a scientific study on worry and being concerned.' On the website, participants were instructed to attentively read the information about the study. It clarified that the research aimed to compare two different techniques to deal with worrying and that worry registration would be central in both techniques. Everyone was informed that, for 6 days, they would have to use registration forms to record the amount of worrying that occurred during the day. It was explained that registering worrying is easy and helps to provide insight into ones worry behavior. People were asked to complete the whole study, which consisted of (a) completing questionnaires and (b) registering frequency and duration of worry episodes for 6 consecutive days. However, people were informed about their freedom to exit the study at any given point without consequences.

To be included in the study, participants had to be 18 years of age or older. No further exclusion criteria were used. A total of 1,035 people registered on the website, of whom 996 were 18 years of age or older. Of this group, 361 completed the entire study. High dropout rates are commonly seen in online interventions that are open to the entire community [93]. The final population consisted of 55 males and 306 females, with a mean age of 36.36 years (SD = 12.97).

Questionnaires

Penn state worry questionnaire. This 16-item self-report measure assesses trait worry; specifically, it measures the tendency, intensity, and uncontrollability of pathological worry [94, 95]. It is a psychometrically sound instrument, with high internal consistency, good test-retest reliability, and good predictive validity [94-96]. Internal consistency (Cronbach's α = .89) was high in the present study. This questionnaire was

administered before the start of the worry registration.

Subjective health complaints inventory. This inventory makes it possible to easily and reliably measure the amount of SHC during the last 30 days in the general population using 29 items [97]. For each of the 29 complaints, participants have to rate the severity and the number of days that the health problems were troubling them. Instead of asking about complaints during the past 30 days, we asked about the presence of these problems during the past three days. Moreover, in line with Verkuil et al. [33], two items regarding anxiety and depression were removed, because these do not represent *physical* complaints. As in the previous studies, the total number of complaints was used as outcome variable in this study. The internal consistency was good at pre- and post-intervention (both Cronbach's α of .83).

Positive and negative affect schedule. The Positive and Negative Affect Schedule (PANAS) is a valid and reliable measure of positive and negative affect in both clinical and non-clinical populations [98, 99]. Participants have to score the extent to which they experience the different emotions (e.g., interested, afraid) using a 5-point scale, ranging from 'very slightly' to 'very much.' The time frame that was used was 'in general' before the worry registration (T1) and 'during the past 6 days' after the worry registration (T2). Internal consistency, as measured by Cronbach's alpha, was considered high for both positive and negative affects at both T1 (.88 and .88, respectively) and T2 (.89 and .89, respectively).

Worry log. Whenever participants were worrying, they were instructed to note this down on a form that participants had to download from the website (see Appendix 1). At the end of each day and each morning, participants estimated the total number of worry episodes (i.e., worry frequency) and duration of these episodes. Participants had to follow these instructions for 6 consecutive days. The form has previously been used by Brosschot and van der Doef [88] and Verkuil et al. [96].

Worry Postponement Intervention

On the back of the worry log, participants in the worry postponement condition received additional instructions. They were instructed that every time they noticed they were worrying, they had to try to postpone this worrying to a special 30-min worry period at the end of the day. The same procedure has been used by Brosschot and van der Doef [88]. The following specific instruction was used:

A frequently used method to deal with worrying is to set a special half-an-hour worry period. It works like this, every time you realize that you are worrying, you need to try to stop worrying and postpone the worrying to a moment later

on in the day (i.e., the half-an-hour worry period). We ask you to start with this tomorrow and continue with the half-an-hour worry period for 6 consecutive days. [88, p. 23]

Procedure

After people registered on the site using their email address, the computer employed a simple randomization scheme to allocate participants to either the experimental or control condition. After login, all participants had to fill in several demographic questions (i.e., age, gender, level of education, type of job, living situation, duration of sporting activity, amount of weekly alcohol intake, number of cigarettes weekly smoked, and sleep quality and duration), complete three measures (Penn State Worry Questionnaire [PSWQ], SHC, and PANAS), and read about how to register their worrying. In addition, participants in the experimental condition were told to postpone their worrying to a special 30-min period in the early evening. The registration (or registration and intervention) period started the day after participants had completed the questionnaires and lasted 6 days and nights. To register worrying, participants had to print the worry log and use this for daily worry registration. Next, worry frequency and duration had to be registered online; this could be carried out daily or at the end of the registration period. Participants received daily emails to remind them of their worry registration. After the 6 days, participants filled in a second SHC, PANAS, and two questions about their sleep quality. Additionally, after completing the intervention, adherence to the registration was checked with the question 'To what extent did you succeed in registering the worrying?' Participants in the intervention group also rated how successful they had been at postponing worrying during the intervention period (i.e., 'To what extent did you succeed in postponing the worrying to the special 30-min worry period'). Both questions were rated on a 10-point scale, ranging from 'very bad' to 'very good.' Participants were then acknowledged for their participation. The entire procedure operated independently of the researchers.

Statistical Analysis

A Pearson partial correlation was used to assess the relation between trait worry and SHC at T1, controlling for negative affect at T1. To examine whether daily worry frequency and duration on the first three days was related to SHC at T2, additional Pearson correlations were performed in the control condition (i.e., amongst participants who had not been influenced by the worry postponement) [88]. To assess whether the intervention had an effect on SHC and affect, a repeated-measures ANOVA was performed with the timing of the measurement (i.e., T1 or T2) as the within-subject

variable and condition (i.e., control or experimental condition) as the between-subject variable.

To determine whether changes in worrying during the 6 days were related to condition or to changes in SHC, linear bootstrap regression analyses were carried out. In contrast to traditional regression analyses that involve a dependent variable with a single level, in linear bootstrap regression analyses, a dependent variable can consist of repeated measures (i.e., of worrying). Because the worry data consists of repeated measures, dependency amongst the measures exists and this dependency can bias the resulting standard errors. Unbiased standard errors can be obtained using a bootstrap procedure [100, 101]. This particular procedure was chosen, because this analysis was capable of handling the non-normal responses [102]. It is a procedure in which new samples of the same sample size as the original sample are formed with replacement. The variation in estimated parameters across the newly created samples is used to get an unbiased standard error [102]. To study the condition effect, bootstrap regression models were built for both worry frequency and duration including the predictor time, condition, and the interaction between these two predictors. The Time X Condition interaction was our main focus, because it shows whether the intervention was capable of reducing daily worry over time. Bootstrap regression models were also used to examine whether changes in worry were related to changes in SHC whilst controlling for changes in negative affect. Here, the interaction between time and change in SHC was our main interest, as it shows whether changes in worrying over time are related to changes in SHC. This analysis was conducted using data from the control condition only, as the worry data of this group was not influenced by the worry postponement intervention (cf. [88]).

Linear regression with bootstrap was performed using RStudio (version 0.98). The other analyses were conducted using the Statistical Package for Social Sciences, version 21.0 (IBM Corp., 2012).

RESULTS

Descriptive Statistics

Figure 1 shows the flow chart of participants. Of the participants that registered on the website, 508 stopped during or after filling in the baseline questionnaires and 127 stopped during the intervention period, resulting in a total of 361 participants who completed the entire study. Due to a programming error, only a subsample of the participants (n = 317) received a PANAS measure at T2. Ten participants were excluded from the analyses on the basis of three different criteria. Six participants were

excluded because the number of reported worry episodes was far greater than the total duration of those episodes in minutes. To illustrate this, one participant reported a total of 240 worry episodes in one day, with total worry duration of 30 min. As these figures seem highly unlikely, participants with similar data were excluded. Two more participants were excluded, because the duration of their daily worrying was extreme, namely 840 min (i.e., 14 hr) or higher. Lastly, two participants were excluded, because the duration of nightly worrying exceeded 360 min (i.e., 6 hr). This resulted in a final sample size of 351.
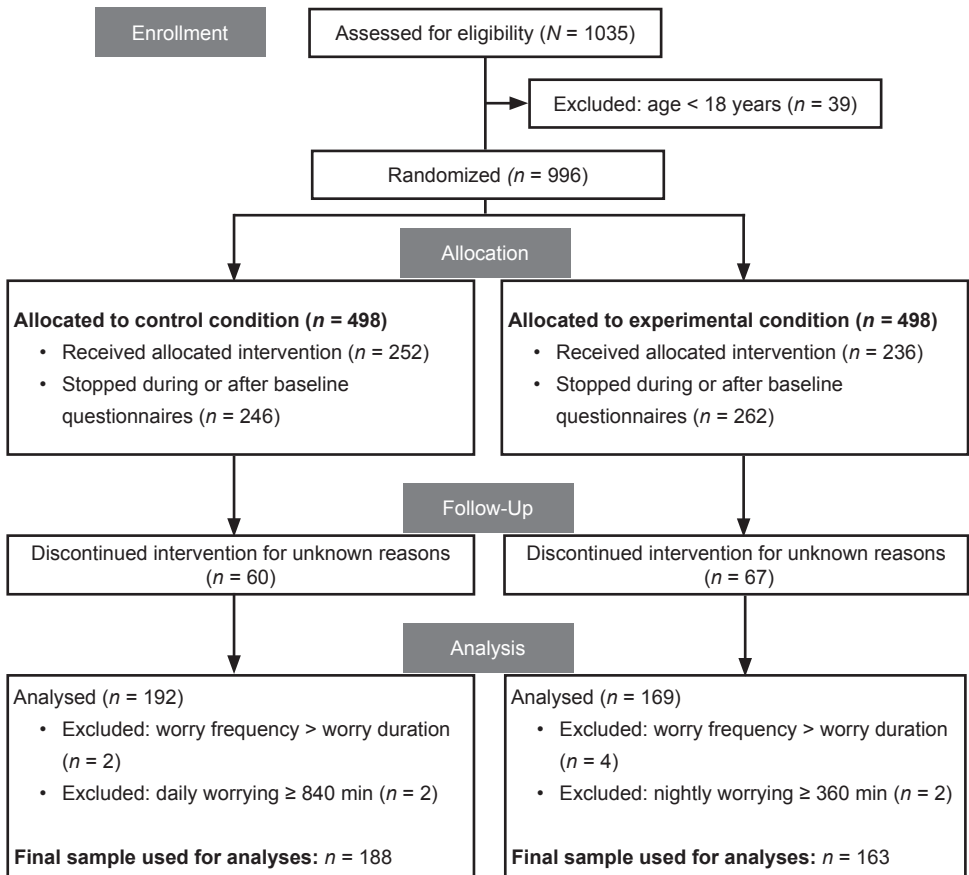

FIGURE 1 Flow diagram of participants during this trial

Table 1 displays the descriptive statistics of both the final population and of the participants who dropped out (i.e., participants who did not finish the study and participants who

were excluded). Dropout was not related to condition, with $\chi^2(1, 996) = 2.75$, $p = .097$. The dropout participants were significantly younger than the participants who finished the intervention, with $t(666.31) = -2.65$, $p = .008$. In addition, a chi-square test revealed that males were more likely to drop out compared to females, $\chi^2(1, 996) = 4.34$, $p = .037$, $\phi = .07$. Moreover, the final population had lower levels of trait worry and negative affect, and higher levels of positive affect compared to the dropout group, $t(994) = 2.12$, $p = .035$, $t(994) = 4.89$, $p < .001$, and $t(994) = -3.28$, $p = .001$, respectively. Lastly, no significant differences were found between the two groups on SHC, with $t(994) = 1.70$, $p = .090$; or the level of education, with $\chi^2(1, 996) = 1.31$, $p = .726$.

TABLE 1 Descriptive statistics of the final population and dropout participants at baseline

	Final population (n = 351)			Dropout participants (n = 645)		
Variable	%	Mean	SD	%	Mean	SD
Gender	85% female			80% female		
Age		36.23	12.96		34.02	11.86
PSWQ		56.72	11.38		58.27	10.75
SHC		9.32	4.53		9.88	4.67
NA		23.66	8.03		26.51	8.48
PA		31.32	7.83		29.41	7.80
Registration		6.73	1.69		—	—

Note. NA= negative affect subscale of the Positive and Negative Affect Schedule; PA= positive affect subscale of the Positive and Negative Affect Schedule; PSWQ= Penn State Worry Questionnaire; Registration = the extent to which participants succeeded in registering worrying; SHC= Subjective Health Complaints inventory.

The final sample consisted of 52 men and 299 women, with a mean age of 36.23 years (SD = 12.96). The experimental condition consisted of 163 participants and the control condition of 188. There were no differences between the conditions on any of the descriptive variables. The average trait worry score as measured by the PSWQ was 56.72. Female participants scored significantly higher on trait worry compared to male participants, respectively, 57.78 (SD = 10.45) and 50.67 (SD = 14.38) with $t(60.71) = -3.41$, $p = .001$. Men and women did not differ significantly on the other descriptive variables. The average level of adherence to the registration was 6.73 (SD = 1.80; NB. on a 10-point scale, ranging from 'very bad' to 'very good') for all participants and those in the experimental group scored their ability to postpone their worrying on average 4.09 (SD = 2.53; idem). The mean number of worry episodes that participants in the control condition reported per day was 6.98 (SD = 6.30), and the mean duration of these episodes per day was 76.66 (SD = 80.66). In the final sample, the timescale in which participants finished their intervention varied highly (i.e., from 2005 to 2012).

However, the year of completion did not significantly differ between conditions with $t(349) = 1.10$, $p = .271$. There were significant positive but small correlations between year of completion and SHC and trait worry at T1, $r(351) = .20$, $p < .001$ and $r(351) = .26$, $p < .001$, respectively, but not with total worry frequency and total worry duration.

Relation between Worry and Subjective Health Complaints
There was a moderate positive correlation between trait worry and SHC at T1 with $r(349) = .34$, $p < .001$. Yet this correlation was no longer significant when controlling for negative affect at T1, $r(345) = .04$, $p = .453$. Furthermore, in the control condition there was a moderate positive correlation between worry frequency on the first three registration days and SHC at T2, $r(184) = .31$, $p < .001$. Likewise, a correlation was found between worry duration on the first three registration days and SHC at T2, $r(184) = .24$, $p = .001$. However, change in SHC was not related to change in worrying when controlling for change in negative affect, as indicated by the non-significant Time X SHC-change interaction of the bootstrap regression models for frequency (B = -0.02, CI [-0.06, 0.03]) and duration (B = -0.23, CI [-1.04, 0.57]), indicating that daily worry was prospectively related to SHC, but not related to changes in SHC.

TABLE 2   Mean (and SD) of SHC, NA, and PC at T1 and T2 for the experimental and the control condition

Variable	Time	Experimental condition	Control condition
SHC	T1	9.28 (4.72)	9.35 (4.38)
	T2	8.48 (4.76)	8.52 (4.12)
NA	T1	24.79 (8.16)	24.14 (7.90)
	T2	23.67 (8.53)	23.64 (8.15)
PA	T1	30.67 (8.45)	31.16 (7.63)
	T2	29.04 (7.94)	29.26 (7.42)

Note. NA= negative affect subscale of the Positive and Negative Affect Schedule; PA= positive affect subscale of the Positive and Negative Affect Schedule; SHC= Subjective Health Complaints inventory.

Effect of Worry Postponement on Subjective Health Complaints and Affect
Repeated measure analyses were performed to examine whether SHC, negative affect, and positive affect changed from baseline (T1) to post-intervention (T2) as a result of the intervention.

Subjective health complaints. There was a significant decrease in SHC from T1 to T2 with $F(1, 347) = 31.62$, $p < .001$, $\eta_p^2 = .08$, CI (0.04, 0.14). However, contrary to our expectation there was no difference between the two conditions, $F(1, 347) = -0.02$, $p = .885$, $\eta_p^2 = .00$, CI (0.000, 0.003). Descriptives of SHC are displayed in Table 2.

Affect. Furthermore, negative affect also significantly decreased from T1 to T2, $F(1, 306) = 4.66$, $p = .032$, $\eta_p^2 = .02$, CI (0.00, 0.05). Contrary to our hypothesis, no significant difference in this decrease in negative affect was found between the two conditions, $F(1, 306) = 0.70$, $p = .405$, $\eta_p^2 = .002$, CI (0.00, 0.03). A similar pattern was found for positive affect. Thus, a significant decrease in positive affect over time was found, $F(1, 306) = 18.34$, $p < .001$, $\eta_p^2 = .06$, CI (0.02, 0.11), and this change was not significantly different between the conditions, $F(1, 306) = 0.11$, $p = .739$, CI (0.00, 0.02). Descriptives of negative and positive affects are shown in Table 2.

Effect of Worry Postponement on Daily Worry Frequency and Duration

To determine whether the online worry postponement intervention lowered worrying over time in daily life (both frequency and duration), linear regression analyses with clustered bootstrapping of the standard errors were conducted. The results of the regression models are depicted in Table 3. Furthermore, Figures 2 and 3 display the mean number of worry episodes and the mean duration of those episodes per day for the two conditions.

Worry frequency. The main effect of time was significant, indicating an overall decline in the number of worry episodes over time, B = -0.31, CI (-0.46, -0.15). However, contrary to our expectation, the Time X Condition interaction was not significant (B = 0.20, CI [-0.03, 0.43]), implying that the average change trajectory for worry frequency was not different for the two conditions. Furthermore, the main effect of condition was also significant, B = -1.68, CI (-3.08, -0.28; see Figure 2). Specifically, individuals in the experimental group reported, on average, less worry episodes during the 6 days, compared to individuals in the control condition (respectively, 6.27 and 7.75 episodes on day 1). The overall model was fit with an $R^2 = .01$. To examine whether the effect of condition on the frequency of worry episodes was dependent on the presence of the nonsignificant interaction effect in the model, the interaction term was removed. Results showed that the effect of condition was no longer significant, with B = 0.98, CI (-2.17, 0.20).

Worry duration. For worry duration, neither time, nor condition, nor the interaction between time and condition significantly predicted worry duration (respectively, B = -2.44, CI [-5.52, 0.64], B = -10.67, CI [-33.87, 12.52], and B = 0.58, CI [-3.22, 4.39]), indicating that the average change trajectory of worry duration had a slope of zero, that there was no difference in the average worry duration between the conditions, and most importantly, that the average change trajectory for worry duration was not different for the two conditions. The explained variance of the overall fitted model was $R^2 = .003$.

TABLE 3 Results of the bootstrap regression models predicting the frequency and duration of worry ($n = 351$)

Model	R^2	B	SE B	d	95% CI LL	UL
Worry frequency	.01					
Constant		8.06	0.55		6.97	9.14
Time		-0.31*	0.08	-0.12	-0.46	-0.15
Condition		-1.68*	0.71	-0.14	-3.08	-0.28
Time x Condition		0.20	0.12	0.05	-0.03	0.43
Worry duration	.003					
Constant		85.20	8.33		68.87	101.54
Time		-2.44	1.57	-0.06	-5.52	0.64
Condition		-10.67	11.83	-0.05	-33.87	12.52
Time x Condition		0.58	1.94	0.01	-3.22	4.39

Note. B = coefficient; CI = confidence interval; d = standardized mean-difference effect size; LL = lower limit; SE B = bootstrap standard error of the coefficient; UL = upper limit.
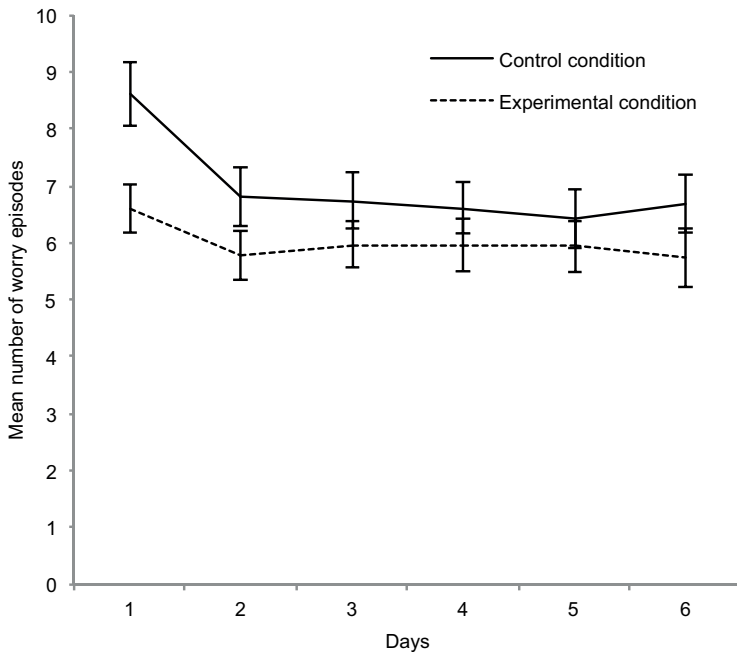* = $p < .05$.

FIGURE 2 Line graph representing the mean frequency of worry episodes over time per condition. Error bars represent ± 2 SE.
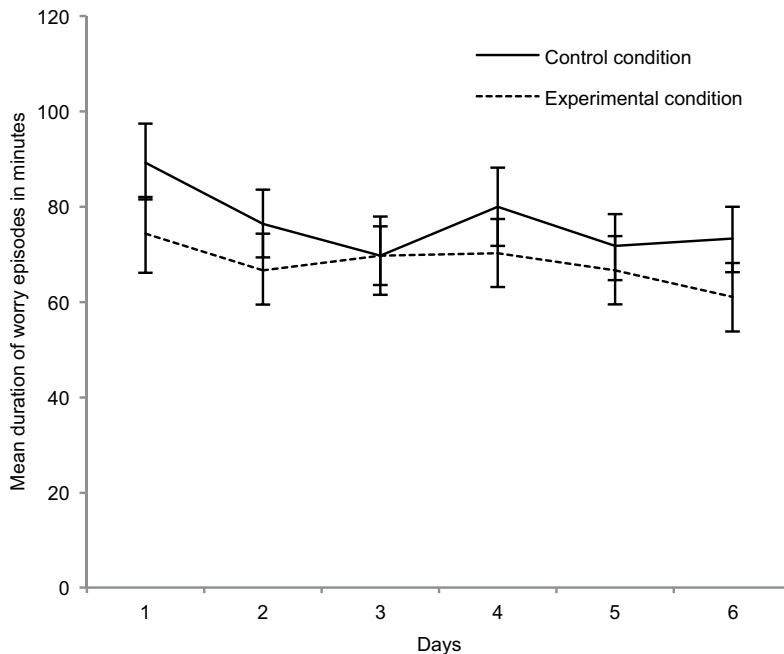
FIGURE 3 Line graph representing the mean duration of worry episodes in minutes over time per condition. Error bars represent ± 2 SE.

DISCUSSION

The current study was conducted to examine the association between worry and SHC, and to test the effectiveness of a worry postponement intervention in reducing SHC, daily worry, and negative affect. Findings indicated that trait worry was positively associated with SHC at baseline; however, daily worry was not associated with changes in SHC. Moreover, a decrease was found in SHC, negative affect, and positive affect. However, contrary to our expectation, participants who received the intervention did not demonstrate a greater reduction in the number of SHC, compared to participants who merely registered their worries. In addition, no robust significant differences between conditions were found in daily worry, negative affect, and positive affect. In short, the main finding is that no evidence was found that the worry postponement intervention reduced the number of SHC as was previously found [86, 88].

We did find that all participants showed a decrease over time in SHC, negative affect, and positive affect. Although it could be argued that merely registering worries had a beneficial effect on SHC and negative affect, the decrease in these complaints was small and a reduction in positive affect was also found which is inconsistent with

a beneficial effect of registering. Therefore, the overall decline in these scores remains somewhat puzzling, but could be explained using the literature on measurement reactivity [103]. That is, it has been repeatedly found that when people are asked to fill in questionnaires about emotions at two occasions, a decline in emotions is found from pre- to post-intervention.

With the current findings, no unequivocal conclusion can be drawn regarding the PC hypothesis, which hypothesizes that PC or worry influences SHC and acts as a mediator between stress and SHC and other health indicators [25, 31]. Given that the worry postponement intervention did not cause a change in worrying over time, we were not able to test this fundamental assumption of the PC hypothesis. However, we did replicate the finding that trait and daily worry were moderately associated with SHC, with high worriers reporting more SHC [31, 88]

A couple of explanations can be offered for why no effect of worry postponement was found [88]. First of all, the difference could be due to the characteristics of the sample, which had relatively high levels of trait and daily worrying. Specifically, the average trait worry was above a cut-off score that is used to screen for GAD [104] and the average daily worrying was fairly high when compared to other non-clinical samples [33, 96]. It is possible that for people with enhanced levels of worry, the postponement intervention was too simple, too brief, or both in its current format. However, this seems unlikely, given that the intervention has been successfully implemented in individuals experiencing work stress [87].

A second explanation for the null results pertains to the procedure that was used. In addition to the registration and postponement instructions (which were similar to the previous studies), participants were now also asked to record their worry frequency and duration online, and daily reminders were send that participants were required to do so. This additional procedural demand could have increased two kinds of worries: (a) worries about partaking in the study and (b) these daily reminders could have served as a reminder about their other worries. Still, it seems unlikely that these procedural changes could account for the null findings. That is, reminders were sent to people in both conditions, and the hypothesized increase in worry would have been observed in both groups.

There are also reasons to assume that the paper-and-pencil design that was used in previous studies cannot be readily translated into an online format. In this study, we choose to replicate the findings obtained with a simple and short worry intervention, with little additional information about the intervention, and for example, about the need to practice it daily. It is possible that the intervention will be effective when delivered online, but maybe only when certain transformations are incorporated

into the design. Indeed, Ritterband et al. [105] stated that actions need to be taken when changing an intervention to an Internet format. These actions, for example, highlight the importance of using multimedia elements (e.g., video or audio) to make the intervention more appealing, to use strategies to personalize the intervention to the individual, and to provide feedback during the intervention. However, in this study these strategies were not incorporated—because the aim was to replicate previous findings with this simple and short intervention—which could explain why the worry postponement did not result in a significant decrease in worries. Moreover, an online format is considered non-committal and more informal for participants. This may lead to a less active participation and ultimately result in a diminished effect. In the future, instead of delivering the intervention via the Internet, it might be worthwhile to use smartphones, as this offer the potential to collect a large amount of ecological valid data in an easy and unobtrusive way, thereby ensuring commitment [71, 106].

The null findings could also be explained by the difficulty in postponing worries. After the intervention, participants rated their ability to postpone worrying quite low (i.e., 4.1 on a 10-point scale); only 39 individuals scored their success a six or higher. So, although individuals were able to register their worrying (i.e., scoring a 6.7), they were less able to postpone worrying to a later moment. In other words, it is possible that worry postponement was too difficult to master in 6 days, at least for this group. Unfortunately, no comparable data from previous studies was available. Also, the ability to register and postpone worrying was only measured once; however, it is conceivable that the fidelity with the intervention fluctuates over different days. Future studies are recommended to daily assess whether participants practiced with the intervention. Moreover, studies might focus on strategies that could improve the applicability of the worry postponement intervention. One option would be to send daily emails to participants to remind them that they should postpone their worrying (instead of only reminding them about the worry registration as done in the current study). An even better option would be to send multiple

reminders during the day (e.g., using smartphones). This repetition may help to increase the automaticity of the target behavior, that is, postponing worrying [67].

Several other limitations need to be discussed, foremost the high dropout percentage (i.e., 64%). Specifically, individuals with high levels of complaints were more likely to drop out. This is in line with a review by Davis and Addis [107],who showed that people with high levels of emotional distress are quicker to drop out. Although the reason for their dropout is unknown, it may be that these individuals are quicker to label an intervention as taxing and thus drop out. High dropout tends to make research less credible; however, high dropout rates are commonly seen in Internet

interventions, especially when online interventions are open to the entire community [93, 108]. Eysenbach [108] suggests making a distinction between initial dropouts/ nonusers and trial dropouts. Using this criterion, the dropout percentage declines to 26%, which is considerably less dramatic compared to 64%. Nevertheless, it would be interesting to determine which predictors determine dropout rate (e.g., duration of intervention, disease severity), in order to learn how interventions can best be used to help individuals.

A second limitation is the overrepresentation of women in this study, but this is not unusual as women are known to have a higher worry level than men [109]. Considering that there are no differences in the gender distribution across conditions, gender could not bias the findings. Lastly, the duration of data collection was 4 years, which means that the participants could have been exposed to different kinds of worries caused by, for instance, the changes in the economy. It could be that some worries are harder to postpone than others. Yet, no empirical study has addressed this. Furthermore, a small to moderate positive correlation between the year of completing the study and trait worry was found. In other words, those who completed the study at a later point had higher trait worry levels. However, year of completing the study did not differ significantly between the conditions and cannot explain the current null findings. The long time frame of the study and the fact that participants started on different days of the week with the intervention can actually be considered as positive characteristics of the study. That is, an intervention aimed at worrying should be effective in reducing this detrimental style of coping with stressful situations, regardless of— for instance— the economic stressors that the participant is experiencing. By conducting a large long-running randomized controlled trial, whereby these factors are assumed to be randomly distributed between conditions, it is possible to study the effectiveness of an intervention under several global circumstances.

As the current results do not support a large-scale online implementation of this particular worry intervention in the general population, alternative ways to reduce worries and SHC are still warranted. Currently, a few other promising strategies have been tested. One of these interventions is expressive writing, in which participants are instructed to regularly write about emotional events. A review, including 146 studies, established that this has a positive effect on both psychological and physiological functioning [110]. The narrative that is formed in expressive writing is argued to help organize complex emotional experiences and this in turn decreases PC [111]. Recent studies investigating expressive writing have indeed shown that it can reduce worry, especially in high worrying individuals [112, 113]. Another promising
intervention is mindfulness-based techniques, in which mindfulness can be defined as

a present focused awareness [114]. Mindfulness has been shown to reduce psychological stress in clinical populations [115] and to reduce stress, ruminative thinking, and trait anxiety in healthy people [116, 117].

To conclude, no evidence was found for the effectiveness of the online version of the worry postponement intervention to lower SHC in the general population. Compared to merely registering worries, no beneficial effects of the postponement intervention were observed in terms of a decline in SHC, negative affect, nor the frequency and duration of worrying. All in all, the online worry postponement instruction cannot be recommended as an effective preventive intervention in the general population to decrease SHC. Considering the burden of SHC, it remains important to find effective interventions that can be easily administered in the general population.

APPENDIX 1 Worry registration form

Fill in during day: Fill in during the evening:

Number of worry episodes (one tally for every episode) ⟶

Day 1:
(if none, register: 0) ⟶ ....
(if none, register: 0) ⟶ .... min
Nightly worrying? *Estimate* number ⟶ [.........] (if none, register: 0), and duration ⟶ [..........]

Day 2:
(if none, register: 0) ⟶ ....
(if none, register: 0) ⟶ .... min
Nightly worrying? *Estimate* number ⟶ [.........] (if none, register: 0), and duration ⟶ [..........]

Day 3:
(if none, register: 0) ⟶ ....
(if none, register: 0) ⟶ .... min
Nightly worrying? *Estimate* number ⟶ [.........] (if none, register: 0), and duration ⟶ [..........]

Day 4:
(if none, register: 0) ⟶ ....
(if none, register: 0) ⟶ .... min
Nightly worrying? *Estimate* number ⟶ [.........] (if none, register: 0), and duration ⟶ [..........]

Day 5:
(if none, register: 0) ⟶ ....
(if none, register: 0) ⟶ .... min
Nightly worrying? *Estimate* number ⟶ [.........] (if none, register: 0), and duration ⟶ [..........]

Day 6:
(if none, register: 0) ⟶ ....
(if none, register: 0) ⟶ .... min
Nightly worrying? *Estimate* number ⟶ [.........] (if none, register: 0), and duration ⟶ [..........]