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Are Changes in Worry Associated with Treatment Response in Cognitive Behavioral Therapy for Insomnia?

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Abstract. Aim: Little is known about why some patients respond to cognitive behavioral therapy for insomnia, whereas other patients do not. To understand differences in treatment response, there is a dire need to examine processes of change. The purpose was to investigate the long-term association between insomnia-related worry and outcomes following cognitive behavior therapy for insomnia. Methods: Sixty patients with early insomnia (3–12 months duration) received group cognitive behavioral therapy for insomnia. At pretreatment and at a 1-year follow-up, the patients completed questionnaires indexing two domains of insomnia-related worry (sleeplessness and health), insomnia severity, anxiety, and depression as well as sleep diaries. Results: Decreases in the two worry domains were associated with improvements in all of the outcomes, except for sleep onset latency (SOL), at a medium to large level. Reductions in insomnia-related worry were associated with improvements in insomnia severity, wake after sleep onset (WASO), total sleep time (TST), and depression, but not in SOL or anxiety. While reductions in worry for sleeplessness were related to improvements in insomnia severity and TST, decreases in worry for health were associated with enhancements in WASO and depression. Conclusion: The findings suggest that reductions in insomnia-related worry might be one process route in which cognitive behavioral therapy operates to improve insomnia symptomatology. The results are discussed in relation to theory, clinical implications, and future research. Key words: insomnia; worry; sleep; cognitive behavioral therapy

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Insomnia is one of the most prevalent health problems reported by 10% of the population and is characterized by a chronic difficulty in involving problems initiating sleep, maintaining sleep, or waking in the morning not feeling restored (Ancoli-Israel & Roth, 1999). The consequences for the sufferer are severe and include functional impairment, work absenteeism, impaired concentration and memory, increased use of medical services, and a heightened risk of subsequently developing another psychiatric disorder (Breslau, Roth, Rosenthal, & Andreski, 1996; Ford & Kamerow, 1989; Roth & Ancoli-Israel, 1999). Insomnia is therefore regarded as a serious public health problem. An associated and documented feature of insomnia is worry about the consequences of not getting enough sleep, its effects on daytime functioning and about being able to fall asleep the following night (Harvey, 2002). As a general construct, worry has been defined as a predominance of verbal thought, but also of imagery, that are characterized by negative valence and relative uncontrollability (Borkovec, William, & Stöber, 1998). The worry process represents an attempt to engage in mental problem solving on issues of uncertainty, which carries the potential of one or more negative outcomes. The function of this appears to be cognitive avoidance of future threats (Borkovec, Robinson, Pruzinsky, &
DePree, 1983; Borkovec et al., 1998). The worry process is also proposed to affect or trigger the activation of the sympathetic nervous system, through the body’s inbuilt fight or flight system with an elevated autonomic arousal as a result (Borkovec et al., 1998; Harvey, 2002).

There has been a growing interest in the importance of intrusive and worrisome thinking in the maintenance of insomnia (e.g., Borkovec, 1982; Espie, 2002; Harvey, 2002; Lundh & Broman, 2000; Morin, 1993). According to several models of insomnia, intrusive and worrisome thoughts prior to sleep and during nightly awakenings are viewed as exacerbating the sleep difficulties associated with the condition (Espie, 2002; Harvey, 2002; Lundh & Broman, 2000; Morin, 1993). For example, in a cognitive model of insomnia, it has been proposed that worry can trigger autonomic arousal and emotional distress, culminating in an anxious state under which sleep is likely to be disturbed and daytime functioning impeded (Harvey, 2002). In another model, sleep interpretive processes (i.e., cognitions functionally similar to worry) regarding the consequences about sleep loss and daytime functioning are proposed to trigger a state of autonomic arousal interfering with normal sleep (Lundh & Broman, 2000). Finally, a third model posits that the relatively involuntary psychophysiological process of normal sleep may be inhibited because of pervasive sleep preoccupation, consisting of selective attention bias to sleep, sleeplessness, and sleep consequences, leading to active intention to sleep (intentional actions designed to deliver sleep and to eliminate wakefulness) and ultimately to a sleep effort syndrome which interrupts the normal sleep cycle (Espie, 2007). A shared line of reasoning in all these three models is thus that worry (sometimes also referred to as cognitive arousal or excessive cognitive activity) is a maintaining factor for insomnia.

The evidence for the role of worry in insomnia has accrued (see Harvey, 2004 for a review). For example, experiments have shown that an increase in worry result in an increase in the subjective estimation of time taken to fall asleep (Gross & Borkovec, 1982; Hall, Buysse, Reynolds, Kupfer, & Baum, 1996; Lichstein & Fanning, 1990), and experimental manipulations that decrease worry result in a decrease in sleep onset latency (SOL; Harvey & Payne, 2002; Hayney, Adams, & Franzen, 1981; Levey, Aldaz, Watts, & Coyle, 1991). Also, an intervention designed to learn patients with insomnia to cope with worry in a constructive way resulted in significant reductions in insomnia severity and sleep-related worry (Jansson-Frojmark, Lind, & Sunnhed, 2011). There is also empirical evidence (Carney, Harris, Moss, & Edinger, 2010) suggesting that, among those with insomnia, worry is cognitively a distinct phenomenon from rumination, a cognitive process with a focus on making attributions for disturbed mood and symptoms (Nolen-Hoeksema, 1991). Further, high worriers, relative to low worriers, has been shown to display less total sleep time (TST) measured with actigraphy, indicating that worry may increase the risk for sleeplessness (Omvik, Pallesen, Bjorvatn, Thayer, & Nordhus, 2007). Finally, one study has also demonstrated that it is likely that, among those with insomnia, worries about sleep become tied to perceived poor sleep over time (Jansson & Linton, 2006).

Given the theoretical models and extant research underscoring intrusive and worrisome thinking as a maintaining factor in insomnia, one may hypothesize that reductions in worry is associated with changes in therapeutic outcome and hence could be an important process route of change during cognitive behavioral therapy (CBT-I) for insomnia. A process variable is a construct targeted by treatment, which correlate with treatment outcome and through that might identify some proportion of the common or shared variance, and may be used to predict treatment response. A process variable is also usually considered to be the first step before moving further with more extensive research and identifying mediators and mechanisms of change (Kazdin, 2007). Earlier research on process variables in CBT-I has recently been summarized in a review article (Schwartz & Carney, 2012). The review authors concluded that the reviewed investigations provided some evidence that individuals following CBT-I demonstrated reductions in several process variables, including time in bed, napping, bedtime and rise time variability, and hyperarousal. Improvements in maladaptive beliefs and attitudes about sleep, sleep-related self-efficacy, and sleep locus of control were also
reported. For many of these variables, significant interactions with outcomes were demonstrated, which indicate that they explain some variance of the outcome due to greater improvements in these processes for those being administered CBT-I, relative to the comparison groups. The findings were consistent with theoretical models of insomnia suggesting that CBT-I appears to be leading to changes in the proposed processes perpetuating the condition. The review authors also underscore that, in spite of the extensive literature citing cognitive arousal as a key maintenance factor in insomnia, only a small proportion of the reviewed studies examined changes in arousal over the course of treatment, with no process analysis conducted to date.

Studying worry as a process variable in the treatment of insomnia could be important for several reasons. First, the role of worry as a maintaining factor has been emphasized in several models of insomnia (Borkovec, 1982; Espie, 2002; Harvey, 2002; Lundh & Broman, 2000; Morin, 1993), and studies on worry during the course of CBT-I could thus provide valuable theoretical information. Second, interventions designed to target cognitive processes are often already included in the CBT-I treatment package, which further highlights the need for a more detailed insight about the role of worry in CBT-I. With this background, the overall purpose of this study was to examine the long-term link between insomnia-related worry and outcomes following cognitive behavior therapy for insomnia. More specifically, the analyses focused on examining whether reductions in insomnia-related worry were associated with improvements at follow-up. In this study, insomnia-related worry was indexed with a previously validated scale (Jansson & Linton, 2006) consisting of two subscales, one assessing worry for sleeplessness and one worry for health. These two worry domains were chosen as worrisome thoughts concerning sleeplessness and sleep consequences (health) are believed to be critical in insomnia (Harvey, 2002). As outcomes, insomnia severity was used as the primary outcome, and SOL, wake after sleep onset (WASO), TST, anxiety, and depression as the secondary outcomes. The aim of this study was examined using data from a randomized controlled trial in which 64 patients with early insomnia, i.e., 3–12 months duration, were administered group cognitive behavioral therapy for insomnia or self-help information (Jansson & Linton, 2005); the group that received the self-help information was not the focus for this paper and the data for that group were therefore not used. In the trial, two measurement points, one at pretreatment and one at a 1-year follow-up, were used. The Örebro Hospital’s Board on Research Ethics approved this study.

Methods

The participants

Participants were recruited via advertisements in local newspapers. The inclusion criteria required that the participants fulfilled the criteria for insomnia (DSM-IV-TR), would be of a working age according to Swedish standards (18–65 years), and were willing to participate in the project. In this study, insomnia was defined as reporting (a) 30 min or more to initiate or maintain sleep, (b) 3 days or more with difficulties in initiating or maintaining sleep per week, (c) duration of insomnia of 3–12 months, and (d) daytime symptomatology due to poor sleep. Each participant was interviewed via telephone by the second author using the Insomnia Interview Schedule (Morin, 1993), which includes questions on insomnia symptoms, sleep–wake rhythm, insomnia management, sleep history, contextual parameters, symptoms of other common sleep disorders (e.g., restless legs syndrome, periodic limb movement disorder, sleep apnea, narcolepsy, parasomnia, and circadian rhythm disorder), and symptoms of psychiatric disorders. Exclusion criteria were (a) evidence that the insomnia symptoms could be explained exclusively by another primary sleep disorder or psychiatric disorder or (b) reporting a major obstacle for participating in the intervention.

In sum, 81 participants were randomized to the CBT intervention. After inclusion, the CBT participants were mailed the pretreatment questionnaire (including a sleep diary) and asked to return it. Of the 81 participants, 10 did not start the assigned CBT intervention (did not want to participate in group therapy: \( n = 1 \), perceived his own insomnia symptoms as too small: \( n = 1 \), lack of time to participate: \( n = 1 \), lack of interest: \( n = 1 \), medical reasons: \( n = 1 \), other reasons: \( n = 1 \)).
n = 8). Relative to the participants who started their assigned intervention, the dropouts in the study as a whole did not significantly differ on demographic or clinical parameters (Jansson & Linton, 2005). Of the 71 participants who started the CBT intervention, 64 returned the 1-year follow-up questionnaire; thus, seven participants failed to complete the follow-up material. Relative to those who returned the follow-up questionnaire, the dropouts in the study as a whole did not significantly differ on demographic or clinical variables (Jansson & Linton, 2005). For the purpose of this study, 60 participants were included (four participants had incomplete data on one or several study variables and were therefore removed).

The mean age among the 60 participants was 50 years (SD = 10.3) and 85% were women. While 80% were fully employed, the remaining participants included students, unemployed individuals, or individuals on sick leave or pension. Concerning the level of education, 43% reported high school to be their highest level and 57% university. The participants’ mean duration of insomnia was 7.8 months (SD = 3.4), which, in comparison with previous treatment research (11 years), is of a short duration (Morin, Culbert, & Schwartz, 1994; Murtagh & Greenwood, 1995).

Procedure
Participants were asked to complete postal questionnaires that used items from standardized instruments at pretreatment and 12 months post-treatment. Along with the questionnaire, a letter of introduction, information about the project, and a stamped return-envelope were also included. Participants completed the questionnaires at home and returned them in the envelope provided. If a response had not been received within 2 weeks, a reminder was sent. If the questionnaire was not received within an additional 2 weeks, a second reminder was sent. At follow-up, the person was contacted by telephone if a response was not received within an additional 2 weeks.

Cognitive behavioral group therapy for insomnia
The participants randomized to the CBT group intervention received a six-session structured program, in which participants met in groups of 6–10 people for 2 h once a week for 6 weeks. A booster session followed 2 months after the sixth group session. The attendance at the sessions was good (M = 5.1, SD = 1.3): 83.3% of the participants attended five or more sessions, 11.7% three or four sessions, and 5% one session. To standardize the intervention, the intervention followed a written manual, and the four therapists were certified cognitive behavior therapists that had received training and guidance in administering this group treatment. Each therapist had previous experience of working with CBT for insomnia and also received supervision (~2 h per group) from the second author of this paper, a certified psychologist specializing in behavioral sleep medicine. Each session had several parts and began with a short review and introduction, in which homework was covered. Subsequently, the therapist introduced the topic for the session and provided relevant facts to pave the way for the specific methods. Further, training on methods was provided to give participants the opportunity to learn or improve upon their skills in a particular area. To enhance implementation, individualized homework assignments were designed so that every participant had the opportunity to test each technique. Finally, the session was evaluated during the end of the session. Each session involved specific methods. Session I covered basic problem solving and applied relaxation (Lichstein, 2000) in addition to framing sleep as a physiological phenomenon. Session II consisted of outlining insomnia as a psychological condition and specifying cognitive and behavioral maintaining mechanisms, and treatment components were worry time, distraction, an observation exercise (Lundh & Hindmarsh, 2002), and paradoxical intention (Ascher & Efran, 1978). Session III consisted of the following components: sleep hygiene practices (Hauri, 2004), sleep restriction, and stimulus control (Bootzin & Engle-Friedman, 1981; Spielman, Saskin, & Thorpy, 1987). During Session IV, participants were instructed how to identify unhelpful sleep-related cognitions as well as how to learn basic stress management techniques. Session V consisted of formulating helpful and functional sleep-related cognitions, a program covering how the participants could limit or cease their sleep medication use (Morin, 1993), and
learning how to cope with daytime symptoms. During Session VI, participants were asked to construct their own sleep management program consisting of CBT components in the intervention and how to apply relapse prevention. Session VII was mainly a repetition of Session VI in terms of content but the focus was more on solving problems regarding the participants’ sleep management program.

**Self-report inventories**
Self-report instruments with adequate psychometric properties and sleep diaries were administered to the patients at pretreatment and follow-up.

**Insomnia-related worry.** As no scale specifically measuring sleep-related worry in patients with insomnia could be located at the time of this study, six new items were developed to form a brief instrument to index worry. The items were constructed based on clinical experiences working with patients with insomnia. The participants were asked to rate each item on a 5-point scale with the end points “totally disagree” (1) to “totally agree” (5).

A factor analysis, described in more detail in Jansson and Linton (2006), showed that a two-factor solution was the most appropriate for the items, accounting for 68% of the variance. One of these factors, termed **worry for sleeplessness** (α = .79), consisted of three items: “I worry about my sleep when I go to bed,” “I worry about my sleep when I cannot fall asleep,” and “I worry about my sleep when I am awake at night.” The correlations between the three items and the total factor score were large (item 1: \( r = .83 \); item 2: \( r = .88 \); item 3: \( r = .77 \)). The other factor, labeled **worry for health** (α = .71), also consisted of three items: “I worry that my body will be harmed if I sleep poorly,” “Because of my poor sleep, I worry that I will get sick more easily,” and “Because of my poor sleep I worry that there is something wrong in my body.” The correlations between the three items and the total factor score were large (item 1: \( r = .86 \); item 2: \( r = .82 \); item 3: \( r = .69 \)). The correlation between the two worry domains was small to moderate at \( r = .28 \) (\( p = .029 \)). In the analyses of the present study, the items of each factor were summed.

**Insomnia severity.** To index insomnia severity, the insomnia severity index (ISI) was used (Bastien, Vallieres, & Morin, 2001). The ISI is a 7-item scale assessing four insomnia domains: severity of initial, middle, and late insomnia, sleep satisfaction, interference of insomnia with daytime functioning, noticeability of sleep problems by others, and distress about sleep difficulties. The participant was asked to respond to the seven items by marking one out of five categories [low score (0) and high score (4)]. The total score ranges from 0 to 28, and a higher score indicates more severe insomnia.

**Nighttime symptoms.** To assess sleep a diary was used (Morin, 1993). The sleep diary was completed once a day during 1 week at pretreatment and once again during 1 week at follow-up. The diary questions assessed hours of sleep, hours in bed, SOL (min), TST (h), sleep quality (1–5; 1 = very low, 5 = very high), and sleep efficiency (TST divided by total time in bed). The outcome variables in this study were weekly mean scores for three of the outcome measures: SOL, WASO, and TST. The reliability for SOL was \( \alpha = .95 \), for WASO \( \alpha = .96 \), and for TST \( \alpha = .70 \). In terms of reliability, all the sleep diary measures used as outcomes thus appear to be acceptable to high. This type of diary has been used in both clinical and research settings (Morin, 1993).

**Anxiety and depression.** To assess anxiety and depression, the hospital anxiety and depression scale (HADS) was used (Zigmond & Snaith, 1983). HADS is a self-rating scale in which the severity of anxiety and depression is rated on a 4-point scale. Seven questions are related to anxiety (e.g., “I feel tense or wound up”) and seven to depression (e.g., “I still enjoy the things I used to enjoy”), both with a score range of 0–21. The instrument is widely used in clinical practice and research (Herrmann, 1997). Investigations have shown that the HADS is a psychometrically sound instrument (Bjelland, Dahl, Haug, & Neckelmann, 2002; Herrmann, 1997).

**Statistical analysis**
The data from the pretreatment and the 1-year follow-up questionnaire were first summarized and examined using descriptive statistics. \( t \)-Tests were used to examine the change from pretreatment to follow-up on the process variables and the outcomes. Raw change scores were then calculated in the process variables (worry for sleeplessness and worry for health)
and the outcome variables (insomnia severity, sleep diary parameters, anxiety, and depression) in order to descriptively examine change patterns. Thereafter, changes in the process variables and the outcomes were calculated in terms of standardized residual change from pre-treatment to the 12-month follow-up. The standardized residual is a way of expressing the score at time two as larger or as smaller than the score predicted linearly by time one score (Cronbach & Furby, 1970). This procedure is recommended rather than using raw change scores, as standardized residuals take into account the score at time one, at the same time adjusting for possible random errors of measurement (Stekette & Chambless, 1992).

The standardized residual gain score was computed by converting the raw scores to $Z$ scores and were further computed as follows:

$$Z_2 - (Z_1 \times r_{12})$$

in which $Z_2$ is the follow-up score, $Z_1$ the pre-treatment score and $r_{12}$ the correlation between both ratings. Simple correlations between the process variables using standardized residual change scores were then calculated. Next, analyses were performed to examine whether changes in the process variables were correlated with changes in the outcomes using standardized residual change scores. To assess the strength of the correlations, Cohen’s guidelines were used (Cohen, 1988): .10 – .29 small correlation, .30 – .49 medium correlation, and >.50 large correlation. Thereafter, in separate stepwise regression analyses, standardized residual change scores were used as predictors of improvement in the outcomes.

results

CBT-I treatment response: insomnia-related worry and outcomes

The descriptive and inferential statistics for the process and outcome variables at pretreatment and at 1-year follow-up are displayed in Table 1. As can be seen in the table, both process variables (worry for sleeplessness and worry for health) improved significantly over time; the two parameters were reduced from pretreatment to follow-up. Further, all the six outcome variables improved significantly over time; while insomnia severity, SOL, WASO, anxiety, and depression were decreased, and the TST was increased.

Prediction of improvement in outcomes

Simple correlations between the process variables (standardized residual change scores) were first calculated. Changes in worry for sleeplessness were positively related to changes in worry for health at a significant level ($r = .34$, $p < .05$). Based on standardized residual change scores, simple correlations between the process and the outcome variables were then analyzed. As can be seen in Table 2, there were significant relationships, at a small-to-medium level, between changes in process variables and changes in outcome variables. Changes in worry for sleeplessness were significantly related to changes in insomnia severity, TST, anxiety, and depression. Also, changes in worry for health were significantly associated with changes in insomnia severity, WASO, TST, anxiety, and depression.

The last analyses target the relative contribution of changes in process variables in

<table>
<thead>
<tr>
<th>Pretreatment $M$ (SD)</th>
<th>Follow-up $M$ (SD)</th>
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<tbody>
<tr>
<td><strong>Processes</strong></td>
<td></td>
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<tr>
<td>Worry: sleeplessness</td>
<td>8.2 (3.0)</td>
<td>6.2 (2.5)</td>
</tr>
<tr>
<td>Worry: health</td>
<td>7.3 (2.7)</td>
<td>5.7 (2.6)</td>
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<td><strong>Outcomes</strong></td>
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<td></td>
</tr>
<tr>
<td>ISI (0–28)</td>
<td>20.9 (3.3)</td>
<td>11.7 (4.2)</td>
</tr>
<tr>
<td>SOL (min)</td>
<td>57.5 (53.0)</td>
<td>34.0 (31.7)</td>
</tr>
<tr>
<td>WASO (min)</td>
<td>132.6 (74.8)</td>
<td>66.1 (58.3)</td>
</tr>
<tr>
<td>TST (h)</td>
<td>4.9 (1.1)</td>
<td>5.8 (1.1)</td>
</tr>
<tr>
<td>Anxiety (HADS; 0–21)</td>
<td>9.1 (4.0)</td>
<td>6.5 (3.4)</td>
</tr>
<tr>
<td>Depression (HADS; 0–21)</td>
<td>6.8 (3.5)</td>
<td>4.8 (3.3)</td>
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Note. HADS, Hospital anxiety and depression scale. **$p < .01$. The last analyses target the relative contribution of changes in process variables in

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</tr>
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</table>

Note. HADS, Hospital anxiety and depression scale. **$p < .01$. The last analyses target the relative contribution of changes in process variables in
explaining variance in the variability of outcome variables. Employing regression analyses, this was executed by entering both worry domains simultaneously as a block.

Table 3 shows the results of regression analyses aimed at predicting improvement in the primary (insomnia severity) and secondary outcomes (SOL, WASO, TST, anxiety, and depression) when both worry domains were entered simultaneously. As is shown in Table 3, a total of 23.4% of the variance in improvements in insomnia severity was associated with reduction in worry for sleeplessness over time ($F = 8.70$, $p < .01$). Thus, participants with larger improvements in worry for sleeplessness had a better outcome on insomnia severity.

As is displayed at Table 3, a total of 4.5% of the variance in improvements in SOL was explained by changes in the two worry domains ($F = 1.34$, $p = .27$). Changes in the process variables were not significantly associated with improvements in SOL. As is shown in Table 3, a total of 13.3% of the variance in improvements in WASO at follow-up was related to reductions in worry for health ($F = 4.36$, $p < .05$). In clinical terms, this indicates that participants with larger improvements in worry for health had a better outcome on WASO. As is displayed at Table 3,

Table 2. Simple correlations between changes in the process and the outcome variables

<table>
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<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tbody>
<tr>
<td>1</td>
<td>Worry: sleeplessness</td>
<td>0.34**</td>
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<tr>
<td>2</td>
<td>Worry: health</td>
<td>0.44**</td>
<td>0.34**</td>
<td></td>
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<tr>
<td>3</td>
<td>ISI</td>
<td>0.06</td>
<td>0.21</td>
<td>0.20</td>
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<tr>
<td>4</td>
<td>SOL</td>
<td>0.22</td>
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<td>0.43**</td>
<td>0.44**</td>
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<tr>
<td>5</td>
<td>WASO</td>
<td>-0.37**</td>
<td>-0.28*</td>
<td>-0.46**</td>
<td>-0.27*</td>
<td>-0.46**</td>
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<tr>
<td>6</td>
<td>TST</td>
<td>0.27**</td>
<td>0.28**</td>
<td>0.40**</td>
<td>0.08</td>
<td>0.29*</td>
<td>-0.37**</td>
</tr>
<tr>
<td>7</td>
<td>Anxiety (HADS)</td>
<td>0.34**</td>
<td>0.40**</td>
<td>0.51**</td>
<td>0.16</td>
<td>0.28*</td>
<td>-0.32**</td>
</tr>
</tbody>
</table>

Notes. All correlations are based on standardized residual change scores. HADS, hospital anxiety and depression scale; ISI, insomnia severity index; SOL, sleep onset latency; TST, total sleep time; WASO, wake after sleep onset. *$p < 0.05$ and **$p < 0.01$.

Table 3. Regression analyses predicting the primary and secondary outcomes

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<th>B</th>
<th>SE B</th>
<th>$\beta$</th>
<th>t</th>
<th>$R^2_{\text{change}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Insomnia severity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Worry: sleeplessness</td>
<td>0.602</td>
<td>0.202</td>
<td>0.368</td>
<td>3.00**</td>
<td>0.234</td>
</tr>
<tr>
<td>Worry: health</td>
<td>0.427</td>
<td>0.249</td>
<td>0.212</td>
<td>1.72</td>
<td></td>
</tr>
<tr>
<td><strong>SOL</strong></td>
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<td></td>
</tr>
<tr>
<td>Worry: sleeplessness</td>
<td>-0.022</td>
<td>0.200</td>
<td>-0.015</td>
<td>-0.11</td>
<td>0.045</td>
</tr>
<tr>
<td>Worry: health</td>
<td>0.387</td>
<td>0.247</td>
<td>0.216</td>
<td>1.57</td>
<td></td>
</tr>
<tr>
<td><strong>WASO</strong></td>
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<td></td>
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</tr>
<tr>
<td>Worry: sleeplessness</td>
<td>0.191</td>
<td>0.215</td>
<td>0.117</td>
<td>0.89</td>
<td>0.133</td>
</tr>
<tr>
<td>Worry: health</td>
<td>0.621</td>
<td>0.265</td>
<td>0.307</td>
<td>2.34*</td>
<td></td>
</tr>
<tr>
<td><strong>TST</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Worry: sleeplessness</td>
<td>-0.447</td>
<td>0.188</td>
<td>-0.307</td>
<td>-2.38*</td>
<td>0.163</td>
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<tr>
<td>Worry: health</td>
<td>-0.321</td>
<td>0.232</td>
<td>-0.178</td>
<td>-1.38</td>
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<tr>
<td><strong>Anxiety (HADS)</strong></td>
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<tr>
<td>Worry: sleeplessness</td>
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<td>0.196</td>
<td>0.195</td>
<td>1.47</td>
<td>0.110</td>
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<tr>
<td>Worry: health</td>
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<td>0.242</td>
<td>0.210</td>
<td>1.58</td>
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<tr>
<td><strong>Depression (HADS)</strong></td>
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</tr>
<tr>
<td>Worry: sleeplessness</td>
<td>0.297</td>
<td>0.159</td>
<td>0.234</td>
<td>1.86</td>
<td>0.206</td>
</tr>
<tr>
<td>Worry: health</td>
<td>0.496</td>
<td>0.197</td>
<td>0.317</td>
<td>2.52*</td>
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</tr>
</tbody>
</table>

Notes. All change scores are standardized residuals. Adjusted $R^2$—ISI, 0.207; SOL, 0.011; WASO, 0.102; TST, 0.134; anxiety, 0.079; depression, 0.178. *$p < 0.05$ and **$p < 0.01$. 

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a total of 16.3% of the variance in improvements in TST was associated with decreases in worry for sleeplessness over time ($F = 5.57$, $p < .01$). Thus, participants with larger improvements in worry for sleeplessness had a better outcome on TST.

As is shown in Table 3, a total of 11.0% of the variance in improvements in anxiety was related to changes in the two worry domains ($F = 3.53$, $p < .05$). Changes in the process variables were not significantly associated with improvements in anxiety. As is displayed at Table 3, a total of 20.6% of variance in improvements in depression was associated with reductions in worry for health over time ($F = 7.38$, $p < .01$). Thus, participants with larger improvements in worry for health had a better outcome on depression.

**Discussion**

The aim of this study was to examine whether changes in insomnia-related worry was associated with improvements following CBT-I. The results indicated that CBT-I produced improvements in both insomnia-related worry and in all the outcomes. Further, decreases in the two worry domains were associated with improvements in all of the outcomes, except for SOL, at a small-to-medium level. Reductions in insomnia-related worry were related to improvements in insomnia severity, TST, WASO, and depression, but not in SOL or anxiety.

One main finding was thus that decreases in insomnia-related worry were associated with improvements in several of the outcomes. While decreases in worry for sleeplessness were associated with improvements in insomnia severity and TST, reductions in worry for health were related to enhancements in WASO and depression. This finding suggests that reductions in insomnia-related worry might be one process route in which CBT-I operates to improve outcomes. Overall, this result has both theoretical and clinical implications, and it might pave way for future research. In terms of theory, this finding supports insomnia theories that underscore worry as a maintaining mechanism in insomnia (e.g., Borkovec, 1982; Espie, 2002; Harvey, 2002; Lundh & Broman, 2000; Morin, 1993). Concerning clinical implications, the results imply that interventions aimed at decreasing insomnia-related worry should be incorporated in CBT-I. Despite theoretical models emphasizing worry as a mechanism, it is still rare that research studies on CBT-I have incorporated a worry intervention (for an exception, see Jansson-Fröjmark et al., 2011). It is also important to emphasize that the current findings do not necessarily imply that reductions in worry precede or cause improvements in insomnia symptomatology; the results might also be interpreted as indications of the notion that improved nighttime and daytime symptoms precede or cause decreases in worry. Despite indications in this study of worry as associated with treatment improvements, future research on insomnia-related worry as a process in CBT-I is still warranted, for example by using a mediational approach (Kraemer, Wilson, Fairburn, & Agras, 2002) or by studying differences between standard CBT-I singly and combined with interventions targeting worry.

On two of the outcomes, the results did not indicate that insomnia-related worry was related to improvements in those parameters (SOL and anxiety). Despite nonsignificant findings for those two outcomes, it should be emphasized that reductions in insomnia-related worry was associated with improvements in the expected direction, but they all failed to reach significance. The nonsignificant results for the two outcomes should also be considered in light of the $\beta$ coefficients; they suggest tentatively that reductions in insomnia-related worry were associated with improvements. One unexpected finding was nevertheless that worry was not associated with SOL and anxiety; SOL because previous research shows that decreased worry result in a decrease in SOL (Harvey & Payne, 2002; Haynes et al., 1981; Levey et al., 1991) and anxiety because worry is often viewed as producing an anxious experience (Borkovec et al., 1998). A possible explanation of the nonsignificant findings on SOL is that the indexation of worry used in this study, focusing on only two dimensions of insomnia-related worry, might not fully capture the complete experience of what worry is like for those with insomnia. This notion is supported by the nonsignificant correlations between the two worry dimensions and SOL at baseline ($r \approx .06$). Explaining the nonsignificant findings on anxiety is difficult, but it is possible that the indexation of worry was not complete
and that associations between the two worry dimensions and anxiety were not as high as expected, confirmed by the modest baseline correlations ($r = 0.25–0.52$). One recent finding, with potentially important links to the current study's results, shows that rumination but not worry was associated with sleep diary parameters (Carney et al., 2010), possibly indicating that rumination might be a more central process than previously envisioned in insomnia.

The pattern of differential findings concerning the two worry domains that emerged from this study is difficult to interpret and can only be speculative. From a clinical point of view, the pattern of results that emerged is perhaps not surprising; often patients with insomnia complain of a “racing mind” consisting of catastrophic thoughts concerning sleeplessness prior to and when turning lights off in the evening, and this nighttime-dependent feature of this worry domain might explain why decreases in worry for sleeplessness had a closer association with insomnia severity and TST. It is also, in our experience, common in insomnia patients that worries focused on health are more prevalent and disabling at daytime, thereby possibly explaining the association with decreased depression. Despite these notions suggesting that worries drive insomnia symptomatology, it is also possible that improved insomnia symptomatology precedes or causes reductions in insomnia-related worry. Viewed from that perspective with the current study's findings at hand, it could be argued that improvements in SOL or anxiety are not sufficient for reductions in insomnia-related worry.

The current study has some methodological and statistical issues that should be kept in mind when interpreting the results. First, the sample size in this study was relatively small. Future studies, preferably using a larger sample size are needed to generalize the findings and clarify whether the relationships found in this study are indeed valid. Second, the inclusion of interrelated variables, all measured through self-report may cause methodological difficulties such as common method variance (Richardson, Simmering, & Sturman, 2009). Future studies may put effort into selecting hypothesized process variables that are more clearly distinct from one another and assess with a variation of methods. Third, a potential threat to external validity in this study is generalizability, based on that participants recruited via advertisements might differ from patients seeking care at sleep clinics (Davidson, Aime, Ivers, & Morin, 2009). Two additional characteristics of the sample—the large majority were women and all of the participants had a relatively short duration of insomnia—might have influenced the findings and might also hamper the generalizability. Hence, it is difficult to generalize the current findings to a broader patient group with insomnia. Fourth, polysomnographic recordings were not used during screening, thereby opening up the possibility that patients with other sleep disorders (e.g., sleep apnea) were included in the sample. Fifth, although another statistical approach, such as latent different score modeling, would have provided more information about whether changes in worry precede changes in the outcomes, this was not deemed possible in the current study due to the limited sample size and the few measurement occasions. Future studies may put effort into selecting a larger sample and including repeated measurement occasions, thereby enabling more sophisticated statistical analyses.

To conclude, the current study showed that sleep-related worry was associated with improvements following CBT-I. The findings might have heuristic value for models of insomnia as well as implications for clinical settings and future research.

References


