Does an online CBT program for anxiety impact upon sleep problems in anxious youth?

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Abstract

**Objective:** This study aimed to assess whether the transdiagnostic therapy elements of an online, cognitive behaviour therapy (CBT) anxiety program also impact on sleep related problems (SRPs) in anxious youth. **Method:** Participants were drawn from two previously published studies evaluating online CBT for child anxiety (BRAVE-ONLINE). The study included 63 children aged 7-12 years (M= 9.49; SD=1.37) and 71 adolescents aged 12-18 years (M=13.90; SD=1.68). SRPs, severity of anxiety diagnosis, anxiety symptoms, number of diagnoses, depressive symptoms, and global functioning were assessed at pre- post- and 6-month follow-up assessment points.

**Results:** SRPs were positively related to anxiety symptoms and severity for children and were positively related to depression for adolescents. SRPs did not differ between males and females, between children and adolescents, or between those who had generalised anxiety disorder in their profile and those who did not. Finally, children but not adolescents participating in the online program demonstrated a significantly greater reduction in SRPs from pre- to post-treatment compared to the waitlist group, and these gains were maintained at 6-month follow-up. **Conclusions:** Treatment focusing on child anxiety alone may reduce SRPs in children but not adolescents. Although further research is clearly needed, clinicians should ensure that they assess for SRPs in their teenage clients and directly target SRPs in treatment where required.

**KEYWORDS:** Anxiety, sleep, treatment, intervention research
Introduction

Anxiety in children and adolescents is common, with 12.3% of children and 11% of adolescents meeting criteria for an anxiety disorder (Costello, Egger, Copeland, Erkanli, & Angold, 2011), and 22.7% of youth suffering with an anxiety disorder by the time they reach young adulthood (Copeland, Angold, Shanahan, & Costello, 2014). Along with high prevalence comes a myriad of deleterious consequences for young people with anxiety disorders. Short and long-term problems associated with academic performance, family relationships, social interaction, substance use, and depression have been found (Ialongo, Edelsohn, Werthamer-Larsson, Crockett, & Kellam, 1994; Ialongo, Edelsohn, Werthamer-Larsson, Crockett, & Kellam, 1995; Wolitzky-Taylor, Bobova, Zinbarg, Mineka, & Craske, 2012), with childhood anxiety being associated with health, financial and interpersonal problems in adulthood (Copeland et al., 2014).

Fortunately, efficacious treatments exist for youth anxiety disorders, with the treatment of choice being Cognitive Behaviour Therapy (CBT) (Compton et al., 2004). Despite the efficacy of CBT for anxiety, up to 80% of anxious children do not seek or receive assistance for a variety of reasons including lack of appropriate services, therapy costs, stigma and the time-poor nature of busy families (Booth et al., 2004; Merikangas et al., 2011; Lawrence et al., 2015). In recent years, there has been a surge of interest into alternative modes of treatment delivery aimed at overcoming such barriers, with computer and online approaches offering unique benefits. They are extremely flexible, have the potential to reach a greater proportion of the population, offer a sense of anonymity, and have the potential to be cost-effective.

There have been relatively few studies investigating the efficacy of computer-based treatments for child anxiety. In a systematic review of 11 studies examining the
efficacy of six computerised CBT programs targeting youth anxiety, Donovan and March (2014a) concluded that programs comprising a variety of CBT anxiety management strategies and which include exposure therapy, are able to produce reductions in diagnostic status, severity and self-reported anxiety symptoms. Of those 11 studies, four were conducted on the BRAVE-ONLINE program, a therapist-mediated, internet-based, CBT program for youth anxiety disorders. There have now been four randomised controlled trials (RCTs) conducted with anxious pre-schoolers (Donovan and March, 2014b), school-aged children (March et al., 2009; Spence, Holmes, March, & Lipp, 2006) and adolescents (Spence et al., 2011), with all studies demonstrating significantly greater improvements in anxiety for treatment versus waitlist control participants from pre- to post-treatment, with treatment gains maintained at follow-up. Furthermore, in two of the studies (Spence et al., 2006; Spence et al., 2011), face-to-face CBT comparison groups were employed, with no differences being found between internet-based and face-to-face therapy approaches in terms of efficacy. Thus, it would seem that the BRAVE-ONLINE program is effective in treating child and adolescent anxiety disorders.

**Sleep problems in youth with anxiety disorders**

Common to youth suffering with anxiety disorders are sleep related problems (SRPs), with around 90% of clinically anxious children reporting comorbid SRPs (Chase & Pincus, 2011). There appears to be a stronger association between SRPs and anxiety than between SRPs and other psychiatric problems (Gregory, Eley, O’Connor, & Plomin, 2004), and when anxious children have a comorbid SRP, the anxiety disorder tends to be more severe (Chase & Pincus, 2011). Furthermore, it has been found that SRPs tend to pre-date the onset of child anxiety disorders (Gregory et al., 2004) and that there are bidirectional and cyclical associations between the two
disorders, with sleep issues leading to heightened anxiety and anxiety leading to greater sleep problems (Peterman, Carper, & Kendall, 2014).

SRPs themselves are extremely common in young people, with up to 40% of youth reporting issues in this domain (Alfano, Zakem, Costa, Taylor, & Weems, 2009; Gregory & Sadeh, 2012). Like anxiety, SRPs in children and adolescents are associated with numerous problems both in the short and long term, including anxiety, depression, inattention, impulsivity, poor daytime functioning, disruptive behaviour, academic problems, suicidal ideation, overweight and / or obesity status, and substance use (Do, Shin, Bautista, & Foo, 2013; Gregory & O'Connor, 2002; Morrison, McGee, & Stanton, 1992; Shanahan, Copeland, Angold, Bondy, & Costello, 2014; Short, Gradisar, Lack, & Wright, 2013; Short, Gradisar, Lack, Wright, & Dohnt, 2013; Wong & Brower, 2012). Thus, both anxiety and sleep problems are common and problematic in young people, and commonly occur together.

Underpinning the high comorbidy rates of child anxiety disorders and SRPs, appears to be a complex interplay of biological, cognitive and environmental factors (Peterman et al., 2014). In terms of biological factors, the prefrontal cortex is implicated in both sleep regulation and the integration of higher cognitive processing and emotion regulation (e.g., limbic system), with the medial prefrontal cortex in particular, being important in the regulation of the amygdala, a section of the brain specifically related to the fear response (Peterman et al., 2014). Underarousal of the prefrontal cortex has been found in those with anxiety and SRPs, lending support for a shared biological pathway (Altena et al., 2008).

With regard to cognitive factors, sleep deprivation has been shown to lead to higher levels of arousal and deficits in emotional processing (Yoo, Gujar, Hu, Jolesz, & Walker, 2007), and similarly high levels of both cognitive (worry and negative
thoughts) and somatic (physiological) arousal are associated with limbic system arousal and higher cortisol levels respectively, leading to SRPs (Peterman et al., 2014). In other words, anxious children have many negative thoughts and worries, particularly at bedtime, and are ill-equipped to self-regulate the arousal the thoughts produce. Pre-sleep arousal then activates the limbic system which might not be well-regulated due to the effects of sleep deprivation on the prefrontal cortex. Thus, young people sleep poorly, which leads to further arousal and deficits in emotional processing, and the cycle continues.

In terms of environmental factors, parental accommodation, avoidance and safety behaviours have all been shown to play a role in both SRPs and anxiety in children (Cowie et al., 2014; Peterman et al., 2014). For instance, parents may allow their anxious child to sleep in their bed and/or to avoid going to sleep by using media. Children may frequently seek reassurance by asking parents to come into their room after lights out to answer questions. Allowing the child to co-sleep, reinforces the child’s anxiety around sleep and has been shown to increase sleep problems and separation anxiety (Tikotzky & Sadeh, 2010). Furthermore, parental accommodation, avoidance and safety behaviours interfere with the child learning to reduce their own arousal and to self-soothe (Cowie et al., 2014). Thus, comorbidity between anxiety and sleep problems is high and appears to be due to a number of shared biological, cognitive and environmental factors.

Whether the association between anxiety and sleep differs depending on type of anxiety disorder, age and gender has also been of empirical interest. With respect to diagnostic profile, it has generally been found that youth diagnosed with generalised anxiety disorder (GAD) report the highest rate of SRPs (Alfano, Beidel, Turner, & Lewin, 2006; Alfano, Ginsburg, & Kingery, 2007; Alfano, Pina, Zerr, &
In terms of age, the results are somewhat mixed. Some authors have found similar rates of SRPs across anxious children and adolescents (Alfano et al., 2006; Chase & Pincus, 2011), while others have suggested that the association between anxiety and SRPs increases as youth become older (Gregory & O'Connor, 2002; Johnson, Chilcoat, & Breslau, 2000). With respect to gender differences, it would seem that the association between anxiety and SRPs does not differ between males and females (Alfano et al., 2007; Alfano et al., 2009; Chase & Pincus, 2011; Hansen, Skirbekk, Oerbeck, Richter, & Kristensen, 2011), although Storch et al (2008) found that female OCD sufferers reported more SRPs than males. Furthermore, there may be some gender differences in terms of particular SRPs, with girls being found to demonstrate greater bedtime resistance and sleep anxiety than boys (Alfano et al., 2010).

Given the high comorbidity rates, common underlying maintaining mechanisms, and bidirectional and cyclical associations between youth anxiety disorders and SRPs, it is reasonable to suggest that treating the anxiety disorder may lead to a reduction in SRPs, even if the SRPs themselves are not directly addressed in treatment. This is particularly likely given that CBT treatments for both disorders consist of common therapy elements such as relaxation, cognitive restructuring, self-monitoring, parent management training, psychoeducation, contingency management, guided imagery and coping self-talk (Peterman et al., 2014). Indeed, a reduction in SRPs following treatment for anxiety has been found to be the case, although the majority of research in this area has been conducted with adults. A meta-analysis of 19 studies examining the effectiveness of CBT for anxiety on SRPs in adults found a moderate effect size (Belleville, Cousineau, Levrier, & St-Pierre-Delorme, 2011). However, only five studies to date have examined the effects of child anxiety treatment on sleep. Kendall
and Pimentel (2003) found that CBT for generalised anxiety disorder was effective in reducing associated ‘sleep disturbance’ in children aged 9-11 years, and Storch et al (2008) found that CBT treatment for obsessive compulsive disorder was effective in reducing secondary SRPs in youth aged 8-17 years. Similarly, Caporino et al. (2015) found that a combination of CBT and sertraline or sertraline alone evidenced the greatest reduction in SRPs, with CBT alone producing the greatest reductions in sleep dysregulation specifically. In a drug trial examining the efficacy of fluvoxamine for anxiety in youth found that those in the drug treatment condition showed a greater reduction in SRPs than those taking a placebo (Alfano et al., 2007). Finally, a very recent study by Peterman et al., (2016), found that anxiety treatment for youth aged 7-17 years resulted in a reduction in SRPs as reported by parents, with treatment responders (in terms of anxiety) demonstrating a greater reduction in SRPs than non-responders. With respect to specific SRPs, it was found that only parent-reported sleep anxiety and bedtime resistance showed significant reductions from pre- to post-treatment (Peterman et al., 2016).

From the above discussion it is evident that anxiety and sleep problems are highly prevalent in pediatric populations, are associated with numerous problematic consequences, and commonly co-occur. There is preliminary evidence to suggest that pharmocotherapy and CBT for anxiety disorders in youth may have a secondary effect of reducing SRPs in this population. However, to date, the ability of online CBT programs for youth anxiety to reduce SRPs has not been tested in this manner. The present study examined the degree to which CBT for anxious children and adolescents, delivered online, has secondary effects upon SRPs. Given that the online programs involved in this study have been shown to produce reductions in anxiety that are equivalent to those found in face-to-face versions of the same program
(Spence et al., 2006; Spence et al., 2011), it was expected that they would also produce a reduction in sleep symptoms consistent with prior studies in the area. It was therefore hypothesised that, compared to youth in the waitlist control group, youth receiving the online CBT program would demonstrate a greater reduction in SRPs at post-treatment assessment that would be maintained at 6-month follow-up. The study also examined some subsidiary issues. In particular, the question of whether or not children with GAD report greater SRPs than children with other disorders, and whether SRPs differ between gender and age groups were also examined. Consistent with previous research, it was hypothesised that children with GAD in their diagnostic profile would report more SRPs than children without GAD. Given the mixed findings for age and gender in the literature, differences in SRPs for these groups were investigated in an exploratory manner.

Method

Participants

Participants included 134 Australian youth from two previously published studies that evaluated internet delivery of CBT for youth anxiety (March et al., 2009; Spence et al., 2011). The present study included 63 child participants aged 7-12 years (M= 9.49; SD=1.37) from the evaluation conducted by March et al. (2009) and 71 adolescent participants aged 12-18 years (M=13.90; SD=1.68) from the study conducted by Spence et al (2011). Those from the March et al. (2009) study included 34 who received the internet condition (NET) and 29 who were allocated to waitlist (WLC). Those from the Spence et al. (2011) study included the 44 NET and 27 WLC participants. Figures 1 and 2 outline the number of participants for whom SRP data was available at each time point for children and adolescents respectively. The flow of participants through each of the respective studies, together with the recruitment
procedures employed are outlined in the March et al (2009) and Spence et al (2011) studies and therefore will not be reported again here.

Table 1 outlines the demographic characteristics of the two samples. Child participants had a mean age of 9.49 years (SD=1.37) whilst adolescent participants had a mean age of 13.90 years (SD=1.68). Comorbidity was high in both samples, with children holding between 1-6 diagnoses (M=3.05, SD=1.40) and adolescents holding between 1-9 diagnoses (M=2.54, SD=1.34) prior to treatment. All youth held a primary anxiety diagnosis of social phobia, specific phobia, GAD or separation anxiety disorder according to the Anxiety Disorders Interview Schedule for DSM-IV – Child and Parent Versions (ADIS-C/P: Silverman & Albano, 1996: see below). As is evident from Table 1, the majority of participants were born in Australia, lived with both biological parents, had relatively educated parents, and came from a range of socioeconomic backgrounds.

Measures

All measures were taken prior to treatment (pre-treatment), following treatment (post-treatment) and at 6-month follow-up.

**Diagnosis and diagnostic severity.** Diagnosis and diagnostic severity was determined by a telephone administration of the Anxiety Disorders Interview Schedule for DSM-IV – Child and Parent versions (ADIS-C/P; Silverman & Albano, 1996). The ADIS-C/P comprises both child and parent interviews, each of which take approximately one hour to complete. Interviewers assign a clinical severity rating (CSR) for each diagnosis, ranging from 0 (absent) to 8 (severely disabling / disturbing), with a CSR of 4 indicating clinical-level severity. The combined parent/child diagnosis and CSR was used in accordance with the ADIS-C/P manual. Telephone administration of the ADIS-C/P has shown comparable reliability to face-
to-face administration (Cobham, Dadds, & Spence, 1998; Lyneham & Rapee, 2005). A random sample of 15% of interview was chosen for inter-rater reliability analyses in both the March et al (2009) and Spence et al (2011) studies. The inter-rater reliability for the child sample was high, with a kappa of 1 for the primary diagnosis and a correlation between assessors of .98 for the CSR. Similarly, the inter-rater reliability for the adolescent sample was high, with a kappa of .94 for the primary diagnosis and a correlation of .92 between the assessors for the CSR.

**Global functioning.** Overall level of functioning was measured using the Child’s Global Assessment Scale (CGAS; Shaffer et al., 1983) and was determined by the interviewer administering the ADIS-C/P. The CGAS provides a rating from 0 to 100, where scores of 81-100 indicate normal levels of functioning, scores between 61 and 80 indicate slight disability, scores of 41-60 are indicative of moderate disability, and scores between 1 and 40 suggest serious disability (Shaffer et al., 1983). The psychometric properties of the CGAS have been found to be strong, with good inter-rater reliability (r=.84) and test-retest reliability (r=.85) (Dyrborg et al., 2000; Rey, Starling, Wever, Dossetor, & Plapp, 1995; Shaffer et al., 1983). An inter-rater reliability of .91 was found for the CGAS in both the March et al (2009) and Spence et al (2011) studies.

**Anxiety symptoms.** The Spence Children’s Anxiety Scale - Parent (Nauta et al., 2004) and Child (Spence, 1998) versions were used to assess anxiety symptoms. The SCAS-P consists of 38 items and the SCAS-C consists of 44 items (of which 6 are filler items) in response to which participants are required to rate from 0 (never) to 3 (always) the frequency with which each item applies to themselves (SCAS-C) or their child (SCAS-P). Total scores may range from 0-114, with higher scores indicating greater anxiety symptoms. The psychometric properties of the SCAS-C and
SCAS-P are strong, with internal reliability estimates of .89 for the SCAS-P and .92 for the SCAS-C (Muris, Schmidt, & Merckelbach, 2000; Nauta et al., 2004; Spence, 1998). The Cronbach’s coefficient alphas for the SCAS-C and SCAS-P in the present study were .92 and .88 respectively.

**Depression symptoms.** Depression symptoms were measured using the Centre for Epidemiological Studies for Depression Scale (CES-D; Radloff, 1977) for the adolescents and the Centre for Epidemiological Studies Depression Scale for Children (CES-DC; Faulstich et al., 1986) for the children. The CES-D consists of 20 items for which youth are required to respond from 0 (rarely or none of the time, less than one day) to 3 (most or all of the time, 5-7 days), the frequency with which they experience each symptom. The CES-D has been shown to be acceptable and to have strong psychometric properties with an adolescent population, with reliabilities of .85 and .86 for junior high school and high school students respectively (Radloff, 1991). The CES-DC requires children to respond on a 4-point scale from 0 (not at all) to 3 (a lot), the degree to which they felt the item applied to them during the past week. Total scores for each questionnaire may range from 0-60, with higher scores indicating higher levels of depressive symptoms. The Cronbach’s coefficient alphas for the CES-DC and the CES-D in the present study were .84 and .91 respectively.

**Sleep related problems.** Sleep related problems (SRPs) were measured using a composite of the seven sleep-related items of the Child Behaviour Checklist (CBCL; Achenbach & Rescorla, 2001). The CBCL requires parents to rate from 0 (never) through 1 (sometimes) to 2 (often) the frequency with which each item occurs for their child. The seven sleep items include: nightmares (item 47), overtired without good reason (item 54), sleeps less than most kids (item 76), sleeps more than most kids during the day and / or night (item 77), talks or walks in sleep (item 92), trouble
sleeping (item 100), and wets the bed (item 108). For the purposes of this study, the seven sleep items were summed to produce a composite sleep score that could vary from 0-14, with higher scores indicating more SRPs. Recently, a study by Becker, Ramsay & Byars (2015) tested this composite and found it to be significantly correlated with the Children’s Sleep Habits Questionnaire (CSHQ; Owens, Spirito, & McGuinn, 2000), the Sleep Disorders Inventory for Students (SDIS; Luginbuehl, Bradley-Klug, Ferron, Anderson, & Benbadis, 2008), and the Adolescent Sleep Wake Scale (ASWS; LeBourgeois, Giannotti, Cortesi, Wolfson, & Harsh, 2005). The authors concluded that the composite, although not providing a comprehensive measure of sleep, was adequate in determining overall sleep function (Becker et al., 2015). The reliability of the SRP composite of the CBCL was low (.50) in the current study.

**Procedure**

The procedures for the March et al (2009) and Spence et al (2011) study are outlined in the respective publications and will not be repeated here. However, it should be noted here that the recruitment for both studies was identical and involved sending information packages to schools, placing advertisements in school newsletters, sending information to general practitioners, and media exposure in the form of newspaper articles, television and radio interviews. Similarly, the BRAVE-ONLINE programs have been described in detail elsewhere (see March et al., 2009; Spence et al., 2008; Spence et al., 2011; Spence et al., 2006) and therefore only a short description will be provided below.

There are both child and adolescent versions of the BRAVE-ONLINE program. The child version comprises 10 child sessions and 6 parent sessions, while the adolescent version includes 10 teen sessions and 5 parent sessions. Both child and
teen versions also include two youth and parent booster sessions conducted one month and three months following the initial 10 sessions. The child and adolescent programs are developmentally appropriate versions of the same content and share identical CBT principles and format. Both programs are highly interactive, incorporating games, graphics, and quizzes to ensure youth engagement and interest.

BRAVE is an acronym for the strategies taught throughout the program. B stands for body signs (identification of the physiological signs of anxiety), R stand for relax (including deep breathing, progressive muscle relaxation and guided imagery), A stands for activating helpful thoughts (cognitive restructuring), V stands for victory over fears (exposure and problem solving) and E stands for enjoy, reward yourself (positive reinforcement for effort and brave behaviour). The programs are therapist mediated in that each participant is assigned a virtual therapist, who peruses the answers to questions and homework activities provided by the participant, and responds with a weekly email to provide encouragement and / or redirection. A telephone call with the therapist is also provided half-way through the program, to assist the young person and parent in exposure hierarchy development.

**Data Analytic Procedure**

Separate analyses were conducted for child and adolescent participants to ensure that any age-related differences were captured. The analyses were divided into two sections. The first section was concerned with examining the association between SRPs and anxiety, and thus for each of the two age groups, SRPs were correlated with CSR of the primary diagnosis, number of diagnoses, CGAS rating, parent and child SCAS, and the CES-D. In addition, for each of the two age groups, an ANOVA was conducted to compare participants who had a diagnosis of GAD anywhere in their diagnostic profile with those participants who did not. In order to determine whether
there were any gender differences in SRPs, two between groups ANOVAs (one for children and one for adolescents) were conducted with gender as the between groups variable. Finally, a between groups ANOVA was conducted to determine whether children and adolescents differed with respect to SRPs.

The second section of the analyses was concerned with determining whether participation in the BRAVE-ONLINE programs resulted in a reduction in SRPs. First, two between groups ANOVAs (one for children and one for adolescents) were conducted with condition (NET versus WLC) as the between subjects variable and SRPs as the outcome variable, to ensure that there were no pre-existing differences in SRPs between the two conditions prior to treatment. Subsequently, for both child and teenage participants, linear mixed model analyses were conducted was conducted to determine whether SRPs were reduced as a result of participating in the BRAVE-ONLINE program. Finally, to test for effects on SRPs at 6-month follow-up, only NET participants were available as the WLC participants ceased to be part of the studies after the post-assessment time point. Thus, for each age group, linear mixed model analyses were conducted to assess for changes in SRPs over time.

**Results**

**Association between anxiety and SRPs**

The correlations between SRPs and anxiety, depression and overall functioning are provided in Table 2 (for children) and Table 3 (for adolescents). As is evident from Table 2, sleep issues were correlated with both severity of primary diagnosis and parent-reported, but not child-reported anxiety symptoms for children. In contrast, Table 3 suggests that sleep issues were strongly related to adolescent-reported depression symptoms, and were unrelated to anxiety severity and symptoms.
With respect to the ANOVA comparing SRPs for those participants with a diagnosis of GAD anywhere in their diagnostic profile with those who did not, the results were not significant for either children, F(1,61)=.024, p=.877, or adolescents, F(1,61)=.045, p=.832. It should be noted however, than only 19 of the 63 children, and 10 of the 71 adolescents, were without a diagnosis of GAD somewhere in their profile. In addition, males and females were not found to differ on SRPs in either the child sample, F(1,61)=.197, p=.659, or the adolescent sample, F(1,69)=2.77, p=.101, and teenagers and children were not found to differ in terms of SRPs either, F (1,132) = .321, p=.572,

**Changes in SRPs following the BRAVE-ONLINE program**

At pre-assessment, there were no significant differences between the NET and WLC conditions for either the child sample, F(1, 61)=.285, p=.595, d=.13, or the adolescent sample, F(1, 69)=.303, p=.584, d=.13, on SRPs, suggesting that there were no pre-existing differences in sleep between NET and WLC participants prior to treatment. The estimated marginal means for SRPs for both children and adolescents are presented in Table 4 (pre- to post-assessment for NET and WLC groups) and Table 5 (pre- to post-assessment and 6-month follow-up for the NET group). The fixed effects for intercept and slopes and effect sizes are presented in Table 6 (pre- to post-assessment for NET and WLC groups) and Table 7 (pre- to post-assessment and follow-up for the NET group).

**Children.** The analyses conducted on child SRPs revealed a significant effect for time, F(1, 51.51)=26.457, p<.001, and a significant condition by time interaction, F(1, 51.51)=6.69, p=.013. Inspection of Tables 4 and 6 suggests that children in the NET condition demonstrated a greater reduction in SRPs from pre- to post-assessment compared to children in the WLC condition. Analyses across pre-assessment, post-
assessment and 6-month follow-up revealed a significant effect for time, F(2,31.716)=23.88, p<.001. Inspection of Tables 5 and 7 suggest that the reduction in SRPs evident at post-assessment was maintained at 6-month follow-up.

**Adolescents.** The analyses conducted on SRPs revealed only a significant effect for time, F(1, 64.86)=14.94, p<.001, suggesting that both WLC and NET participants demonstrated a reduction in SRPs from pre- to post-assessment. The condition by time effect was not significant, F(1, 64.86)=0.147, p=.685. Analyses across pre-assessment, post-assessment and 6-month follow-up revealed a significant effect for time, F(2,47.78)=6.68, p=.003. Inspection of Tables 5 and 7 suggests that the reduction in SRPs evident at post-assessment was maintained at 6-month follow-up.

**Discussion**

This study examined the relationship between sleep related problems (SRPs) and anxiety in children and adolescents, and assessed whether participation in an online, CBT intervention for anxiety disorders led to a subsequent decrease in SRPs despite the program not targeting SRPs per se. It was found that parent-reported SRPs were related to parent-reported anxiety symptoms and severity for children, whilst being related to teen-reported depression for adolescents. It was also found that parent-reported SRPs did not differ between males and females, between children and adolescents, or between those who had a diagnosis of GAD in their profile and those who did not. Finally, it was found that for the child sample, those participating in the online program demonstrated a significantly greater reduction in parent-reported SRPs from pre- to post-treatment compared to the waitlist group, and that these gains were maintained at 6-month follow-up. With respect to adolescents, parent-reported
SRPs were found to reduce equally from pre- to post-assessment for the treatment and waitlist participants. Each of these findings will now be discussed.

The finding that SRPs were related to anxiety severity and symptoms in children but not adolescents is contrary to previous research where it has generally been found that the association becomes stronger with age (Gregory and O’Connor, 2002; Johnson et al., 2000). Furthermore, the finding cannot be attributed to higher levels of SRPs in children versus adolescents, because consistent with previous research (e.g., Alfano et al., 2006; Chase & Pincus), frequency of SRPs was not found to differ between the two age groups in this study. The stronger association between SRPs and anxiety in children may be due to the higher rates of bedtime related anxiety (e.g., separation anxiety, fear of the dark, etc) experienced by a younger age group. Alternatively, the discrepant results may be due to the use of the CBCL as a measure of sleep. Remembering that the CBCL is parent-rated, it may be that although parents are extremely aware of sleep issues in school age children, they may be less aware of sleep problems in their adolescent offspring. Indeed, there is considerable evidence to suggest that child and parent reports of child sleep do not always align even in school-age children (e.g., Owens, Spirito, McGuinn and Nobile, 2000). Reliance on parent report of SRPs is a limitation of the present study and future research should ensure that youth-rated sleep measures are employed to counteract this potential confound.

The finding that depression symptoms were related to SRPs for adolescents and not children is consistent with previous research (Alfano et al., 2009), and not surprising giving the higher prevalence rates of depression in adolescents versus children generally. Similarly, the finding that SRPs did not differ between males and females is also consistent with previous research (Alfano et al, 2009; Alfano et al,
However, the finding that youth diagnosed with GAD were no more likely to experience SRPs than youth not diagnosed with GAD, is inconsistent with previous research where it has frequently been shown that youth with GAD report the most SRPs (Alfano et al., 2007; Alfano et al., 2006; Alfano et al., 2010). However, there was high comorbidity in the current sample, with very few youth being without a diagnosis of GAD somewhere in their profile. Thus, the high rates of GAD in this study may have been responsible for the inconsistent result.

With respect to the assessment of whether BRAVE-ONLINE was able to bring about changes in SRPs despite not directly targeting them, the results were different for children versus adolescents. There was no change in SRPs as a result of engaging in the program for teenagers. However, it would appear that children engaging in treatment were significantly more likely to show a reduction in SRPs following treatment compared to waitlist children. As noted above, a reduction in SRPs following treatment for anxiety is common in adults (Belleville et al., 2011) and there is emerging evidence that this may also be the case for youth engaged in face-to-face CBT (Caporino, 2015; Kendall and Pimentel, 2003; Peterman et al., 2016; Storch et al., 2008) and pharmacotherapy (Alfano et al., 2007) for anxiety. Although children and teens are equally likely to have anxiety related sleep issues that may be reduced by treatment for anxiety, teenagers may require additional sleep-specific strategies due to the developmental period they find themselves in. Circadian rhythms are thought to slowly change towards an evening phase preference and later circadian phase during adolescence and there is a slow accumulation of homeostatic sleep pressure during puberty that delays the sleep / wake cycle (Crowley, Acebo & Carskadon, 2007). In addition, adolescence is a time of increased independence and
responsibility coupled with reduced parental control (Moran & Everhard, 2012). Thus, environmental factors such as early school starts, jobs, extracurricular activities, social activities (Woflson & Carskadon, 1998), more homework, increasing time spent with friends, stress, TV (Noland et al., 2009), video games, instant messaging, surfing the web and talking on the phone before bed (Moseley & Gradisar, 2009), have all been found to be associated with reduced adolescent sleep. Furthermore, over 70% of adolescents have been found to have set bedtimes that are later than 10pm, disallowing them the 9-10 hours sleep they require prior to getting up early for school the next day (Moran & Everhart, 2012). Thus, it may well be necessary to incorporate strategies directly targeting sleep within teenage as opposed to child anxiety programs.

Strengths, limitations, and suggestions for future research

This study had a number of strengths. It employed large sample sizes, psychometrically sound measures, and was the first of its kind to examine the potential of an online CBT program for youth anxiety to bring about changes in SRPs. However, the study was not without its limitations. Foremost, the measure of sleep employed was really only a proxy for SRPs. This study was conducted in an ad hoc manner, with the CBCL being the only measure of sleep available in studies that were not designed with sleep issues in mind. Thus, although recently found by Becker et al (2015) to be a reasonable indicator of sleep problems, the CBCL is unlikely to be the most sensitive and informative assessment tool for SRPs, and future research should endeavour to use more targeted, psychometrically sound and sensitive sleep measures.

In addition to the suggestions for future research alluded to above, there are a number of other avenues worthy of investigation. Clearly research examining the capacity of CBT for youth anxiety to reduce SRPs is in its infancy, and more studies
are required to shed light on this important topic. In addition however, the high comorbidity rates generally found between anxiety and SRPs may warrant investigation of programs designed to address both disorders. To date, only a case series analyses conducted by Clementi and Alfano (2014) examining a CBT treatment for comorbid anxiety and sleep disorders has been conducted with promising results. However, RCTs are required to better test this idea with youth across the developmental range.

Conclusions

This study suggested that online CBT for youth anxiety disorders may produce changes in SRPs for children but not adolescents. Given the high comorbidity of anxiety and sleep issues, it is suggested that a) therapists assess for sleep issues as a matter of course in their child and adolescent clients and that b) strategies directly targeting sleep issues are included in the treatment of adolescents. Given the bidirectional and cyclical associations between the two disorders, targeting both disorders in treatment may well bring about enhanced outcomes for both issues.
References


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