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Validation of the Insomnia Severity Index as a Web-Based Measure

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Although the Insomnia Severity Index (ISI) is already administered online, this frequently used instrument has not been validated for Web delivery. This study compares online and paper-and-pencil ISI versions completed by participants in a randomized controlled trial testing an Internet-delivered intervention for insomnia. Forty-three adults with insomnia completed both ISI versions during pre- (Assessment 1) and post-intervention (Assessment 2). Correlations between total scores of both versions were significant ($r_s \geq .98$, $p_s < .001$). For both ISI versions, internal consistency was acceptable (Assessment 1, $\alpha = .61$; Assessment 2, $\alpha \geq .88$). Among participants not receiving the parent study intervention, correlations between 1 format at Assessment 1 and the alternative format at Assessment 2 were generally significant ($r_s = .26-.82$). Together, findings suggest the ISI can be delivered online.

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The Internet is increasingly used to collect assessment and outcome data (Kuchenbecker, Dick, Schmitz, & Behrens-Baumann, 2001), including within the sleep medicine field. There are many advantages to administering measures online, including remote administration, greater recruitment opportunities, reduced cost, improved user convenience and privacy, and increased efficiency (Barak & English, 2002). However, the psychometric properties of a Web-based measure cannot be assumed to be similar to those of its corresponding paper version.

The emerging literature comparing the psychometric properties of paper and Web-based measures indicates that, in some cases, there is little or no difference between paper-and-pencil and Web-based measures (Carlbring et al., 2007; Fouladi, McCarthy, & Moller, 2002), but online and offline versions of the same instrument are not always psychometrically identical (Buchanan, 2002). Given that there is no consensus regarding the correspondence between online and offline measures, there is an ongoing need to evaluate Web-based measures. In fact, there has been a call to establish the reliability and validity of each measure used on the Internet (Buchanan, 2003).

Obtaining validated online measures of insomnia is of particular importance because research targeting this highly prevalent disorder (Ohayon, 2002) has already expanded to the Internet for assessing and treating adults with insomnia (Ritterband et al., 2009; Vincent & Lewycky, 2009). The Insomnia Severity Index (ISI) (Bastien, Vallières, & Morin, 2001) is frequently used (Moul, Hall, Pilkonis, & Buysse, 2004), has well-documented psychometric properties as a paper-and-pencil measure (Bastien et al., 2001), and has been used for more than 20 years (Savard, Savard, Simard, & Ivers, 2005). It is a suitable tool to evaluate sleep-related treatment outcomes as it is brief, easy to administer and score, and provides important information about insomnia severity. Given that it is already being used online (Ström, Pettersson, & Andersson, 2004; Vincent & Lewycky, 2009), it needs to be evaluated for Web use. We are not aware of any published studies testing the correspondence between offline and online versions of sleep-related instruments, including the ISI.

This study expands the validation of online measures by comparing the paper-and-pencil ISI to an online ISI version in a sample of treatment-seeking adults with primary insomnia. Demonstrating that the online version of the ISI has adequate psychometric properties and yields similar results to the paper-and-pencil administration would provide empirical support for using the ISI as an online measure.

METHOD

Participants

Forty-five participants with primary insomnia were enrolled in the parent randomized controlled trial (RCT) to assess the effectiveness of an Internet intervention called Sleep Healthy Using the Internet (SHUTi), designed to deliver cognitive behavioral therapy for insomnia (for the main results from the trial, see Ritterband et al., 2009). Participants were recruited for the parent trial through radio and printed advertisements, newsletters, Internet postings, referrals, and flyers. Eligibility criteria consisted of age between 18 and 65 years, diagnosis of primary insomnia as defined by the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; American Psychiatric Association, 2000), self-report of sleep complaints for at least

6 months, presence of sleep difficulties 3 or more nights per week, endorsement of significant daytime impairments due to the sleep disturbance, and regular Internet access. Participants were excluded from the parent study if they met criteria for other sleep disorders (e.g., sleep apnea) or major medical or psychiatric disorders that could account for the sleep disruption. Exclusion criteria consisted of current psychological treatment, unstable medication regimens, shift work preventing establishment of regular sleep patterns, and pregnancy during the study.

Measures

ISI. The ISI is a seven-item self-report questionnaire that measures individuals' perceptions of their insomnia by asking them to rate their sleep difficulties over the past 2 weeks on a Likert scale ranging from 0 to 4. The seven items assess the severity of problems with delayed sleep onset, sleep maintenance, and early morning awakenings, as well as the level of satisfaction with current sleep pattern, interference with daily functioning, others noticing impairment from the sleep problem, and worry or distress related to the sleep problem. A previous validation study comparing the paper-and-pencil ISI to sleep diaries showed that the internal consistency of the ISI was .74, with item-total correlations varying from a low of .36 (initial item) to a high of .67 (interference item; Bastien et al., 2001). In a treatment-seeking sample, a comparison between paper-and-pencil ISI scores and polysomnography data indicated that the ISI is valid and sensitive to changes in perceived sleep difficulties (Bastien et al., 2001). The measure also provides cutoff values for clinically significant insomnia: <8 represents no insomnia, 8 to 14 denotes sub-threshold insomnia, 15 to 21 indicates clinical insomnia (moderate severity), and 22 to 28 represents severe clinical insomnia.

Procedure

Interested individuals were screened sequentially through an online Interest Form, a 15-min phone screen, and an in-person interview as part of the parent RCT. Completion of the pre-intervention assessment (Assessment 1) occurred before participants were randomized to condition, and only eligible participants completed the assessment. The intervention period lasted 9 weeks. The post-intervention assessment (Assessment 2) occurred approximately 3 months after Assessment 1 (range = 87–108 days between assessments).

During each 2-hr assessment, participants completed both versions of the ISI, but the time between the two administrations varied based on the predetermined randomized order of all measures. The online and paper versions of the ISI were counterbalanced within the battery to ensure that one half of the participants in the study received the paper version before receiving the Web version. Informed consent was obtained from all participants in this institution review board-approved study, and participants were compensated \$100 for completion of both assessments.

Data Analysis

Participants were collapsed across conditions from the parent study for purposes of the primary data analyses, as participant assignment was unrelated to the goal of comparing paper-and-pencil and online administration of the ISI at the two assessment periods. A 2 (Format: paper

vs. online) \times 2 (Time: Assessment 1 vs. Assessment 2) repeated-measures ANOVA was used to examine differences between the two formats over the course of the two time points. Both format and time were within-subjects variables. Mean differences were also examined for individual items between the two formats. Correlations were calculated among these items. This approach followed similar methods favored by much of the existing Internet assessment literature to establish associations between two versions of a measure (Carlbring et al., 2007; Vallejo, Jordan, Diaz, Comeche, & Ortego, 2007).

As a check to assess whether memory inflated the correlation between the online and paper-and-pencil versions completed within 2 hr of each other, the correlations between one format (paper or online) at Assessment 1 and the alternate format at Assessment 2 were also examined in the group who did not receive the intervention, as their ISI scores were not expected to change across time. Of the participants who did not receive the intervention, one half were randomly elected to use their paper-and-pencil scores at Assessment 1 ($n = 11$), and one half were elected to use their online scores at Assessment 1 ($n = 11$). These scores were then correlated with the score from the alternate format at Assessment 2. Participants who received the intervention were not included in these analyses because correlations across assessments in that group would likely bias correlations downward (i.e., a participant with the highest score on an item at pre-intervention might respond well to treatment and have a much lower score at post-intervention, reducing that item's correlation between time points).

RESULTS

Participants were randomized to receive the Internet intervention (SHUTi) immediately ($n = 22$) or to serve as a waitlist control group ($n = 23$). Following the intervention period, two participants (one in the SHUTi group and one in the control group) did not complete Assessment 2. Thus, the analyses used to assess the associations between the Web and paper versions of the ISI were based on the 43 individuals (33 women and 10 men) who completed the ISI at both time points (mean age of 45.02 years \pm 11.10 [$M \pm SD$]). Participants were frequent Internet users, with 86% (37 out of 43) reporting Internet use at least daily and 100% reporting Internet use at least once or twice weekly. Most (95%; 41 out of 43) indicated that they were at least "comfortable" with using the Internet, and 100% indicated that they were at least "somewhat comfortable."

Comparison of Change From Assessment 1 to Assessment 2 in ISI Total Scores

Across total ISI scores for all participants, the paper-and-pencil and Web formats did not differ, $F(1, 42) = 0.00$, $p = .95$ ($\eta_p^2 < .001$). In addition, there was no interaction between format and time, $F(1, 42) = 1.56$, $p = .22$ ($\eta_p^2 = .04$), indicating that the paper-and-pencil and online formats showed similar changes in mean score from Assessment 1 to Assessment 2. For the paper-and-pencil version, the mean total score changed from 15.86 ± 3.80 at Assessment 1 to 11.03 ± 6.40 at Assessment 2. Using the online format, the mean total score changed from 16.00 ± 3.87 to 10.91 ± 6.20 . When ISI scores were examined separately by condition,

the experimental group showed significant reductions in insomnia severity scores, whereas ISI scores for the control group did not change between assessment (for detailed results of ISI changes by condition, see Ritterband et al., 2009).

Individual Item Comparisons and Correlations

Internal consistency was $\alpha = .61$ for both paper-and-pencil and Web versions at Assessment 1, and $\alpha = .89$ for the paper-and-pencil format and $\alpha = .88$ for the Web version at Assessment 2. For each individual item, means between the two formats were nearly identical, with an average difference of .05 ($\pm .06$; range = .00–.12) between item means of the two versions at Assessment 1 and .07 ($\pm .07$; range = .05–.14) at Assessment 2 (see Table 1). Item correlations between the paper-and-pencil and online formats were significant at both assessments (see Table 1). In addition, the correlations between total scores in the two formats at both assessments were large, with a correlation coefficient of .98 ($p < .001$) at Assessment 1 and .99 ($p < .001$) at Assessment 2.

Correlations Between One Format at Assessment 1 and the Alternate Format at Assessment 2

Cross-format correlations between one format at Assessment 1 and the alternate format at Assessment 2 were expected to be reduced compared to item correlations in Table 1 due to measurement error. Correlations between measures at two more distant time points are generally reduced by the imperfect reliability of a measure, independent of the true correspondence between the two formats of administration (paper-and-pencil and online). The range of correlations between items across the two formats and the two assessment periods for ISI are shown in Table 2. Five of the seven items for each group pairing were significant at $p < .05$. The two nonsignificant correlations for the Assessment 1 paper/Assessment 2 online correlations (Items 4 and 6) and the Assessment 1 online/Assessment 2 paper correlations (Items 6 and 7) are still small to medium and large correlations, respectively (per Cohen's, 1992, parameters).

DISCUSSION

The psychometric properties of the ISI appear similar between the paper-and-pencil and Web formats based on total scores and individual item responses. The associations suggest that a change in ISI from paper-and-pencil to online format does not have a significant effect on participant response. Both types of administrations were also sufficiently sensitive to detect changes with treatment. In short, the results show that the ISI is a reliable and valid tool to quantify perceived insomnia severity when delivered online.

While considering the similarities between the two ISI formats, it is important to note several study limitations. The sample was relatively comfortable using the Internet, and it is possible that these findings may not generalize to less technologically adept individuals. Previous studies have suggested that sampling bias due to differences in familiarity with technology can be a

TABLE 1
Correlations Between Paper-and-Pencil and Online ISI Formats at Assessment 1 and Assessment 2

ISI Item	A1: Paper		A1: Online		A1		A2: Paper		A2: Online		A2	
	M (SD)	Range	M (SD)	Range	r	Range	M (SD)	Range	M (SD)	Range	r	Range
1. Difficulty falling asleep	1.65 (1.27)	0-4	1.74 (1.29)	0-4	.93	0-4	1.07 (1.12)	0-4	1.02 (1.08)	0-4	.94	0-4
2. Difficulty staying asleep	2.72 (1.01)	0-4	2.70 (1.04)	0-4	.99	0-4	1.93 (1.16)	0-4	1.88 (1.09)	0-4	.91	0-4
3. Problem with waking too early	1.63 (1.23)	0-4	1.65 (1.23)	0-4	.99	0-4	1.00 (1.15)	0-4	1.05 (1.21)	0-4	.97	0-4
4. Satisfied/dissatisfied with sleep pattern	3.44 (0.55)	2-4	3.56 (0.55)	2-4	.83	2-4	2.63 (1.18)	0-4	2.58 (1.18)	0-4	.98	0-4
5. Sleep problem interference with daily functioning	2.35 (0.92)	0-4	2.33 (0.94)	0-4	.88	0-4	1.72 (1.20)	0-4	1.77 (1.11)	0-4	.93	0-4
6. Sleep problem noticeable to others	1.53 (0.80)	0-4	1.53 (0.85)	0-4	.93	0-4	1.02 (1.01)	0-4	1.09 (1.02)	0-4	.90	0-4
7. Worried/distressed about sleep pattern	2.53 (0.96)	1-4	2.49 (0.98)	1-4	.93	1-4	1.72 (1.37)	0-4	1.58 (1.43)	0-4	.92	0-4
Total	15.86 (3.80)	8-27	16.00 (3.87)	8-28	.98	8-28	11.03 (6.40)	0-23	10.91 (6.20)	0-22	.99	0-22

Note. $N = 43$. All correlations (r_s) between paper and online versions are significant at the $p < .001$ level. ISI = Insomnia Severity Index; A1 = Assessment 1; A2 = Assessment 2.

TABLE 2
Cross-Format Item Correlations Between Paper-and-Pencil and
Online ISI Formats for Control Participants

<i>ISI Item</i>	<i>A1: Paper</i>	<i>A1: Online</i>
	<i>A2: Online</i>	<i>A2: Paper</i>
1. Difficulty falling asleep	.77*	.69*
2. Difficulty staying asleep	.77*	.81**
3. Problem with waking too early	.66*	.82**
4. Satisfied/dissatisfied with sleep pattern	.26	.67*
5. Sleep problem interference with daily functioning	.76*	.66*
6. Sleep problem noticeable to others	.29	.54
7. Worried/distressed about sleep pattern	.62*	.55

Note. $N = 22$ ($n = 11$ in each group). ISI = Insomnia Severity Index; A1 = Assessment 1; A2 = Assessment 2.

* $p < .05$. ** $p < .01$.

potential source of non-equivalence between paper-and-pencil and online formats (Buchanan, 2002). This sample was also comprised of adults seeking treatment as part of an RCT for primary insomnia; thus, ISI scores do not represent the full range of possible scores (e.g., lowest total ISI score was 8 at Assessment 1). It will be important to replicate these findings with samples in other settings (e.g., primary care) that may not be seeking insomnia treatment. Individuals were also excluded from the larger trial if they had other sleep disorders or medical or psychiatric illnesses that could account for their sleep problems. Future studies should include comorbid samples to determine whether this would impact findings.

Although internal consistency of the ISI in this study was lower at Assessment 1 for both the Web and paper-and-pencil versions than that reported in the initial ISI validation study (Bastien et al., 2001), this difference is not surprising due to the discrepant sample sizes between studies (i.e., this study had fewer participants). The greater internal consistency for both formats in this study at Assessment 2 could also potentially be explained by the number of participants who received the intervention and improved after the intervention, resulting in less heterogeneity among the items.

In sum, a sample of treatment-seeking adults with insomnia responded similarly to both the paper-and-pencil and online versions of the ISI. These findings provide empirical support for the online use of the ISI as a measure of perceived insomnia severity, and more generally extend the emerging literature on comparing paper-and-pencil and online measures to the field of behavioral sleep medicine.

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