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A Psychometric Evaluation of the Panic Disorder Severity Scale for Children and Adolescents

R. Meredith Elkins,

Center for Anxiety and Related Disorders, Boston University

Donna B. Pincus, and

Center for Anxiety and Related Disorders, Boston University

Jonathan S. Comer

Center for Children and Families, Florida International University

Abstract

The Panic Disorder Severity Scale (PDSS; Shear et al., 1997) is a well-validated measure that assesses symptoms of panic disorder and agoraphobia (PDA) in adults. The Panic Disorder Severity Scale for Children (PDSS-C) is an adaptation of the PDSS for youth ages 11 to 17. The current study evaluated the psychometric properties of the PDSS-C. Participants included sixty adolescents from an RCT investigating the efficacy of an intensive cognitive behavioral treatment for adolescent PDA. Convergent and discriminant validity of PDSS-C scores were evaluated via observed associations between the PDSS-C and the Childhood Anxiety Sensitivity Index (CASI; Silverman et al., 1991), Multidimensional Anxiety Scale for Children (MASC; March et al., 1997), and Children's Depression Inventory (CDI; Kovacs, 2003). Baseline and post-treatment data afforded the opportunity to evaluate the measure's sensitivity to treatment-related change. PDSS-C scores demonstrated acceptable internal consistency ($\alpha = 0.82$) and adequate 1-day test-retest reliability ($r = 0.79$). Convergent and discriminant validity of the PDSS-C scores were supported through significant associations with the CASI and the MASC, and non-significant associations with the CDI, respectively. Linear regression analysis demonstrated sensitivity to treatment-related changes—i.e., greater PDSS-C change scores were significantly associated with assignment to CBT versus waitlist condition. Clinical utility was further established through significant associations between PDSS-C change scores and MASC and CASI change scores, and through non-significant associations with CDI change scores. Results support the use of PDSS-C scores as reliable, valid, and clinically useful for the assessment of youth panic disorder in research and clinical settings.

Keywords

panic disorder; adolescent; assessment; self-report; reliability; validity

Roughly one quarter of the general population suffers from panic attacks at some point in their life, with approximately 5% meeting formal lifetime criteria for panic disorder with or without agoraphobia (PDA) (Grant et al., 2006; Kessler et al., 2006). PDA most commonly onsets in early-adulthood (Barlow, 2002; Grant et al., 2006), with prevalence rates increasing across childhood and adolescence (Beesdo, Knappe, & Pine, 2009; Merikangas et al., 2010). Thus, adolescence is a developmental period marked by increased vulnerability to panic disorder, with prevalence rates ranging from 1-2% in community adolescent samples (e.g. Kessler et al., 2012, Merikangas et al., 2010), 2-6% in outpatient psychiatric clinic samples of adolescents (e.g. Biederman et al., 1997; Diler et al., 2004), and as high as 15% in inpatient adolescent samples (Alessi, Robbins, & Dilsaver, 1987). Adolescents with PDA suffer from debilitating physical symptoms during panic attacks, including heart palpitations, chest pains, nausea, and shaking/trembling, the repeated occurrence of which contributes to significant distress and functional impairment (Diler et al., 2004; Masi, Favilla, Mucci, & Millepiedi, 2000; Merikangas et al., 2010). Fear of future panic attacks cause many adolescents with PDA to avoid everyday settings such as restaurants, crowds, parks, elevators, or malls (Kearney, Albano, Eisen, Allan, & Barlow, 1997), and is frequently implicated in school refusal behavior (King & Bernstein, 2001). PDA onsetting before adulthood is associated with comorbid depression, additional anxiety disorders, and suicidal ideation and attempts (e.g. Beesdo et al., 2009; Biederman et al., 1997; Diler et al., 2004; Masi et al., 2000), and places youth at risk for continuing mental health concerns in adulthood (Pine, Cohen, Gurley, Brook, & Ma, 1998). When left untreated, PDA is associated with considerable disability and reduced quality of life in adulthood (Comer et al., 2011; Merikangas et al., 2007).

Given that the prevalence of PDA increases across adolescence, with earlier onset associated with a more chronic and debilitating course (Merikangas et al., 2010; Ramsawh, Weisberg, Dyck, Stout, & Keller, 2011), accurate identification and treatment of adolescent PDA is critical. Semistructured clinician-administered interviews, such as the Anxiety Disorders Interview Schedule: Child and Parent Versions (ADIS-C/P; Silverman & Albano, 1997) can be used to establish formal diagnosis of PDA in children and adolescents. However, the time demands and expertise needed to conduct such interviews can limit their broad use. Children with panic symptoms and related somatic complaints often present to primary care and specialty pediatric settings (Campo, Comer, Jansen-McWilliams, Gardner, & Kelleher, 2002; Lipsitz et al., 2004) where medical professionals may lack the sufficient training and/or time to formally assess PDA symptoms. Poorly assessed children presenting to pediatric settings and emergency departments for PDA symptoms, such as noncardiac chest pain, are often subjected to unnecessary medical testing (McDonnell, White, & Grady, 2012). Accordingly, there is a critical need for a brief standardized self-report measure that can evaluate adolescent PDA severity for the purposes of identifying PDA severity across settings, or to support diagnostic formulations when structured diagnostic interviewing of mental disorders is not available.

Although several clinically useful and psychometrically sound assessment measures are available to aid in the assessment of general child anxiety and formal anxiety disorders, currently no brief measures for the specific assessment of child PDA severity have been developed and well-evaluated. Early research in this area has relied on community samples

with low base rates of PDA (Queen, Ehrenreich-May, Hershorin, 2012). The most widely used measures of overall anxiety, such as the Revised Children's Manifest Anxiety Scale (RCMAS; Reynolds & Richmond, 1985) or the Multidimensional Anxiety Scale for Children (MASC; March, Parker, Sullivan, Stallings, & Conners, 1997), may detect general anxiety and important anxiety-related constructs, but they do not focus on panic symptomatology in particular. Brief self-report measures may assess for symptoms relevant to panic disorder (e.g. the Child Anxiety Sensitivity Index; Silverman et al., 1991), or may include sub-scales that map onto panic symptoms as part of a larger inventory of general anxiety symptoms, but these measures do not focus on the specific criteria needed to support a diagnosis of PDA.

Measures of PDA do exist for adults; in fact, a brief self-report form of the clinician-administered Panic Disorder Severity Scale (PDSS; Shear et al., 1997) was developed for adults to assess the severity of the disorder and to serve as a screening measure (Houck, Spiegel, Shear, & Rucci, 2002). The clinician-administered PDSS assesses several core features of PDA, including panic frequency, distress associated with panic attacks, severity of anticipatory anxiety, agoraphobia and avoidance, fear associated with the physical symptoms that accompany panic attacks, and occupational and social impairment related to the disorder. Psychometric evaluations conducted with adult panic disorder patients have shown that scores on a clinician-administered version of the PDSS demonstrate high inter-rater reliability ($r = 0.71 - 0.87$), moderate to high internal consistency ($\alpha = 0.65 - 0.92$; Houck et al., 2002; Shear et al., 1997; Shear et al., 2001; Wuyek, Antony, & McCabe, 2011), and sensitivity to change, capturing decreases in panic disorder symptomatology between baseline and post-treatment for patients participating in CBT for panic disorder (Barlow, Gorman, Shear, & Woods, 2000; Shear et al., 1997). Moreover, the clinician-administered version of the PDSS also has demonstrated convergent validity by significant correlations with several measures of panic symptomatology and general anxiety, including the clinical severity rating of the Anxiety Disorders Interview Schedule ($r = 0.55$; Shear et al., 1997) and the Anxiety Sensitivity Index ($r = 0.21 - 0.54$; Shear et al., 1997, 2001; Wuyek et al., 2011), among others. A 7-item self-report form (PDSS-SR) has also shown excellent psychometric properties in adults, demonstrating strong test-retest reliability ($r = 0.83$; Houck et al., 2002), acceptable internal consistency ($\alpha = 0.80 - 0.92$; Houck et al., 2002; Wuyek et al., 2011) and sensitivity to change (Farchione et al., 2012). Intraclass correlation coefficients support agreement between the clinician and self-report formats of the adult PDSS ($r = 0.81$; Houck et al., 2002), and both versions of the PDSS have been used as outcome measures in clinical trials evaluating treatment for adult PDA (e.g. Barlow et al., 2000; Farchione et al., 2012).

Although there is precedence for the use of the adult version of the PDSS to assess symptoms of panic disorder in children (e.g. Renaud, Birmaher, Wassick, & Bridge, 1999), the psychometric properties of the PDSS in youth samples have not been evaluated. Importantly, several items from the adult PDSS may not be relevant to child populations (e.g., items about work or sexual activity), and key life domains of adolescence, such as school, are not assessed. To afford a developmentally sensitive, brief assessment of panic severity for use with adolescent populations, Pincus and colleagues adapted the traditional

PDSS-SR for youth ages 11 to 17 (PDSS-Child Version; PDSS-C; Pincus, Spiegel, & Mattis, 2004) and used the measure as a self-administered primary outcome measure of panic severity at baseline, post-treatment, and follow-up evaluations in several adolescent PDA clinical trials (Pincus, May, Whitton, Mattis, & Barlow, 2010; Pincus et al., 2013). Items on the PDSS-C are functionally parallel to the PDSS, with the exception of item word changes to maximize appropriateness for the target youth audience. For example, the degree of work and social impairment was modified to assess interference in school and social activities. Whereas the clinician-administered version of the PDSS for adults inquires about panic within the past month, and the self-report version on the PDSS does not specify a time during which the respondent should anchor their report of symptoms, the PDSS-C asks about adolescent panic symptoms within the past week to afford a more time-limited evaluation of recent symptoms. The PDSS-C also includes explicit instructions to aid adolescents in their report of panic, in which a panic attack and a limited symptom attack are defined, and a list of associated physical symptoms is provided. The face validity of the PDSS-C was evaluated by an expert panel, which included noted experts in the field of pediatric anxiety disorders and the psychopathology of panic disorder. The PDSS-C can be administered as a self-report measure or may be used as a guide for the clinician follow during a semi-structured assessment of panic symptoms. The PDSS-C utilizes the same 5-point ordinal scale (0 to 4) to assess each of the 7 items as the PDSS-SR, yielding a total score between 0 and 28. Despite the usage of the PDSS-C as a primary outcome measure across multiple clinical trials, the psychometric properties of this adaptation have not yet been evaluated. See Appendix A for a copy of the measure.

In the present study we evaluated the psychometric properties of the PDSS-C in a sample of treatment-seeking adolescents with PDA. As in PDSS validation studies with adult samples (Shear et al., 1997, 2001), we hypothesized that the PDSS-C scores would demonstrate acceptable internal consistency (i.e., $\alpha > .70$, in accordance with precedence and general consensus for minimum acceptable internal consistency coefficients; see Cortina, 1993) and adequate 1-day test-retest reliability (i.e., $r \geq .80$, in accordance with Aiken's (1994) guideline for interpreting the adequacy of test-retest reliability). We further hypothesized that convergent validity would be evidenced by significant correlations between PDSS-C scores and established measures of anxiety and anxiety symptomatology, and that discriminant validity would be established by non-significant correlation between the PDSS-C and depression symptoms. Finally, we expected the PDSS-C to demonstrate sensitivity to treatment-related changes between baseline and post-treatment.

Method

Participants

Participating youth who completed the PDSS-C were drawn from a larger sample of adolescents enrolled in a randomized clinical trial investigating the feasibility and efficacy of an intensive 8-day cognitive behavioral treatment for PDA. Outcomes for the trial are reported elsewhere (Pincus et al., 2013). Treatment was conducted at a university-based outpatient clinic specializing in the treatment of anxiety and related disorders in New England. In the larger trial, adolescents who met criteria for a principal diagnosis of panic

disorder with or without agoraphobia were assigned to one of three study conditions: an immediate 8-day intensive CBT for adolescent panic with parental involvement, an immediate 8-day intensive CBT for adolescent panic without parental involvement, or to a 6 week waitlist condition. For the purposes of the present study analyses, the two active treatment conditions in the RCT were combined, as no differences in response were found between both active CBT conditions (Pincus et al., 2013). Thus, sixty adolescents ages 11-17 ($M = 15.17$; $SD = 1.71$) were assigned to either an immediate intensive CBT for adolescent panic condition (CBT; $N = 42$) or to a 6-week waitlist condition (WL; $N = 18$). Participants in the present study were predominantly female (58%, $N = 35$) and Caucasian (85%, $N = 51$). Annual family income for participants in this study ranged from \$25,000 to \$500,000, with the modal annual income at \$100,000 and a mean annual income of \$112,000. Eight participants (13%) were assigned a co-principal diagnosis in addition to PDA, including specific phobia ($N = 4$), social anxiety disorder ($N = 2$), anxiety disorder not-otherwise-specified ($N = 1$), and major depressive disorder ($N = 1$). We did not exclude participants based on psychotropic medication use in order to maximize the representativeness of our sample, given recent estimates indicating that adolescents with panic disorder are over five times more likely to be treated with antidepressants than adolescents without panic disorder, and are also more likely than non-anxious youth to be taking anxiolytic, mood stabilizing, or stimulant medication (Olfson, He, & Merikangas, 2012). Prior to initial baseline diagnostic assessment, however, individuals treated with psychotropic medications were required to be stabilized on steady doses of their medication for at least one month for benzodiazepines and three-months for SSRIs or tricyclic medications. At baseline, 6.6% ($N = 3$) of participants reported taking antianxiety medications (sedatives and/or hypnotic medications), 21.7% of participants ($N = 13$) reported taking antidepressant medications (SSRIs, SARIs, or atypical antidepressants), and 18.3% of participants ($N = 11$) reported taking multiple psychotropic medications.

Diagnoses were assigned based on the results of a semi-structured diagnostic interview, the Anxiety Disorders Interview Schedule for Diagnostic and Statistical Manual of Mental Disorders IV: Child and Parent Versions (ADIS-C/P; Silverman & Albano, 1997). A total of 103 adolescents were assessed for eligibility based on information obtained during an initial phone screen. Following the baseline diagnostic assessment, 43 participants were excluded from participation, because they did not meet diagnostic criteria for primary diagnosis of PD or PDA ($N = 40$) or due to unwillingness to participate in the study ($N = 3$). The majority of eligible participants received a diagnosis of panic disorder with agoraphobia ($N = 59$), and one participant was assigned a diagnosis of panic disorder without agoraphobia. Exclusion criteria for the trial included the following: (a) positive diagnosis of schizophrenia, pervasive developmental disorder, organic brain syndrome, mental retardation, or current suicidal ideation; (b) unavailability of at least one parent or caregiver with whom the adolescent was living to bring the adolescent to treatment; (c) refusal of parent(s) to accept random assignment to treatment conditions; and (d) refusal of the parent(s) or adolescent to accept stabilization of medication of one month prior to their initial diagnostic assessment for any benzodiazepines and three-months for SSRIs or tricyclic medication. Finally, as the treatment and assessment procedures were delivered in English, only English-speaking participants were enrolled in the study.

Measures

Child Diagnoses—The Anxiety Disorders Interview Schedule: Child and Parent Versions (ADIS-C/P; Silverman & Albano, 1997) is a semi-structured diagnostic interview that assesses child mood, anxiety, and disruptive behavior disorders in accordance with DSM-IV criteria. The ADIS-C (child version) and the ADIS-P (parent version) collect data on child and parent reports of child symptoms, respectively. Child and parent diagnostic profiles are integrated into a composite diagnostic profile. The ADIS-C/P is the most widely used diagnostic interview in clinical research evaluating child anxiety disorders, likely due to the strong reliability, validity, and sensitivity to change of its scores and interpretation (Silverman & Ollendick, 2005). In age ranges comparable to the present sample, the ADIS-C/P has demonstrated good reliability for parent (κ range from 0.65 – 0.88) and child diagnostic profiles (κ range from 0.63 – 0.88) (Silverman & Ollendick, 2005; Silverman, Saavedra, & Pina, 2001). Acceptable interrater reliability has been established for scores on both child and parent versions of the ADIS ($\kappa = 0.71$ and 0.77 ; Grills & Ollendick, 2003), and the test-retest reliability estimates of the child ($\kappa = 0.61$ – 0.80), parent ($\kappa = 0.65$ – 1.00), and combined ($\kappa = 0.62$ – 1.00) diagnoses yield acceptable to excellent reliability (Silverman et al., 2001). The convergent validity of interpretations based on the anxiety disorders sections of the ADIS-C/P has also been established through large associations between social phobia, separation anxiety disorder, and panic disorder diagnoses and corresponding factor scales of the MASC (Wood, Piacentini, Berman, McCracken, & Barrios, 2002).

Panic severity—As previously noted, the 7-item self-report Panic Disorder Severity Scale for Children (PDSS-C) was adapted for youth ages 11-17 by Pincus and colleagues (Pincus et al., 2004) from the 7-item adult self-report PDSS-SR (Houck et al., 2002) which itself was a self-report adaptation of the clinician-administered adult PDSS (Shear et al., 1997). As in the adult PDSS, the seven items of the PDSS-C were designed to assess: (1) panic frequency, (2) distress associated with panic attacks, (3) severity of anticipatory anxiety, (4) agoraphobia and avoidance, (5) fear associated with the physical symptoms that accompany panic attacks, and (6) work and (7) social impairments related to the disorder. In addition, the sum of these seven items yields an overall PDA severity score. Items on the PDSS-C are functionally parallel to the PDSS, with the exception of item word changes to maximize appropriateness for the target youth audience. The PDSS-C utilized the same 5-point ordinal scale (0 to 4) to assess each of the 7 items as the PDSS-SR, yielding a total score between 0 and 28.

Child anxiety—The Multidimensional Anxiety Scale for Children (MASC; March et al., 1997) is one of the most commonly used and well-validated brief measures of general anxiety in children and adolescents (Beesdo et al., 2009; Silverman & Ollendick, 2005). The MASC is a 39-item self-report questionnaire designed to assess various anxiety dimensions in children and adolescents, which provides youth with a list of anxiety-related statements (e.g., “I feel tense or uptight”, “I get nervous if I have to perform in public”). The child or adolescent responds to each statement by specifying how often the statement is true for him or her on a scale from 0 to 3, where 0 indicates “never true about me,” 1 indicates “rarely true about me,” 2 indicates “sometimes true about me,” and 3 indicates “often true about

me.” The sum of all items is the MASC Total Score, which provides a measure of the overall level of anxiety. Total scores on the MASC range from 0 to 117, with scores over 60 indicating above-average levels of anxiety (March et al., 1997). The MASC yields four factor scales: Physical Symptoms, Harm Avoidance, Social Anxiety, and Separation/Panic. Scores on the MASC have shown robust psychometric properties, demonstrating good internal consistency ($\alpha = 0.90$), test-retest reliability ($r = 0.93$ at three-month follow-up), and construct validity supported by significant associations with the RCMAS ($r = 0.63$; March et al., 1997). MASC factor scores have also demonstrated convergent and discriminant validity with ADIS-C/P diagnostic profiles (Wood et al, 2002).

Anxiety Sensitivity—Anxiety sensitivity refers to the fear of anxiety and anxiety-related bodily sensations, and has been linked to the psychopathology of panic across the lifespan (e.g. Weems, Hayward, Killen, & Taylor, 2002). Given the strength of the association between panic disorder and anxiety sensitivity, the Childhood Anxiety Sensitivity Index (CASI; Silverman, Fleisig, Rabian & Peterson, 1991) was administered in the present study. The CASI is a modified version of the Anxiety Sensitivity Index (Peterson & Reiss, 1987), a widely used instrument for the assessment of anxiety sensitivity in adults. The CASI is an 18-item self-report measure and is the standard measure of child anxiety sensitivity throughout the literature (Beesdo et al., 2009; Weems, 2011). The CASI lists a number of statements tapping into anxiety sensitivity (e.g. “When I notice that my heart is beating fast, I worry that there might be something wrong with me”) and asks children and adolescents to indicate how well the statement describes them, where 1 indicates “not at all,” 2 indicates “some,” and 3 indicates “a lot.” The CASI Total Score is the sum of the child’s endorsements and ranges from 18 to 54. CASI scores have demonstrated good reliability ($\alpha = 0.87$) and test-retest reliability ($r = 0.82$; Silverman et al., 1991). The validity of the CASI scores has been supported through numerous studies (see Weems, 2011, for review). The incremental validity of the CASI scores has been established, accounting for 9-16% of unique variance in the prediction of fearfulness (Weems, Hammond-Laurence, Silverman, & Ginsburg, 1998). Importantly, the CASI successfully differentiates between adolescents with PDA versus those with other anxiety disorders (Kearney et al., 1997), and was shown to correlate with the number of panic attacks within the last year and distress associated with panic attacks (Lau, Calamari, & Waraczynski, 1996).

Child depression symptoms—The Children’s Depression Inventory (CDI; Kovacs, 2003) is an extensively used self-report measure of depressive symptoms for youth ages 7-17. The CDI consists of 27 items, each including three related statements that are graded in severity (e.g. “I have fun in many things,” “I have fun in some things,” “Nothing is fun at all”). The patient indicates which statement best describes his/her thoughts and feelings over the past 2 weeks. The sum of all endorsed statements generates a CDI Total score ranging from 0 to 54. The psychometric properties of the CDI scores are well established, with over 500 clinical and experimental studies supporting the internal consistency, test-retest reliability, and discriminant validity of the measure across clinical and community samples (see Kovacs, 2003, for review). For example, in a clinical sample of depressed adolescents, Weiss and colleagues (1991) found that the CDI scores had excellent internal consistency ($\alpha = 0.88$), with test-retest reliability at 3-month follow-up at $r = 0.56$. The construct validity of

the CDI score interpretations is well-supported; for example, in a sample of psychiatric inpatients, Kazdin and colleagues (1983) found significant associations between the CDI and the Hopelessness Scale ($r = 0.51$, $p > .001$) and the Self-Esteem Inventory ($r = -0.49$, $p < .001$).

Procedures

All study procedures were approved by the Internal Review Board of _____. Participants completed major assessments at baseline and 6-week post-waitlist/post-treatment by independent evaluators (IEs) who were blind to the participants' study condition. These major assessments entailed administration of the ADIS-C/P and all self-report forms. IEs were postdoctoral fellows and doctoral candidates in clinical psychology specializing in the assessment and treatment of pediatric anxiety disorders. All IEs met internal certification and reliability procedures in structured diagnostic interviewing, developed in collaboration with one of the ADIS-C/P authors: observing 3 complete interviews, collaboratively administering 3 interviews with a trained diagnostician, and conducting supervised interviews until achieving the reliability criterion (i.e., full diagnostic profile agreement on 3 of 5 consecutive supervised assessments). Demographic information was obtained from parent report.

Participants in the RCT were randomized to receive either immediate CBT with family involvement, immediate CBT without family involvement, or a 6-week waitlist (WL). Those in either of the immediate CBT conditions completed the baseline assessment one week prior to the start of treatment. As previously noted, as there were no group differences at baseline or post-treatment between participants receiving treatment with or without parental involvement (Pincus et al., 2013), the two immediate treatment conditions were collapsed into one "immediate CBT" condition for the present analyses. The intensive treatment in CBT occurred over eight consecutive days, including five days in the clinic, two days over the weekend, and the final day in the clinic. The PDSS-C was administered daily during CBT treatment, whereas WL participants did not complete daily assessments. Post-treatment assessment was conducted six weeks following the initial baseline assessment to allow for anticipated improvement, continued practice, and consolidation of treatment gains once participants returned home. WL participants were also assessed six weeks following their initial assessment.

Participants in the CBT condition received an 8-day intensive-format of the manual-based cognitive-behavioral protocol, *Mastery of your Anxiety and Panic for Adolescents: Riding the Wave* (Pincus, Ehrenreich, & Mattis, 2008; Pincus, Ehrenreich, & Spiegel, 2008). Treatment was delivered over eight consecutive days and included psychoeducation about panic disorder, cognitive restructuring, and interoceptive and situational exposure exercises. Participants were also expected to continue practicing skills learned during treatment once they returned home, and thus continued improvement was expected between the last day of treatment and the 6-week post-treatment assessment (see Angelosante, Pincus, Whitton, Cheron & Pian, 2009, for more details about the treatment protocol).

Participants in the WL condition were randomly assigned to one of the two treatment conditions following the 6-week post-waitlist assessment. No contact was made with waitlist

participants between the baseline and post-waitlist assessment time points. Full details on the participant flow for the RCT can be found elsewhere (Pincus et al., 2013). For the purposes of this study, post-treatment data refers to data collected after participants received a full course of treatment, regardless of whether participants received treatment immediately or following the 6-week waitlist.

Analytic Strategy

The internal consistency of the PDSS-C was evaluated by computing Cronbach's alpha coefficients. Cronbach's alphas of .70 to .80 or greater are generally interpreted as indicating adequate internal consistency (Clark & Watson, 1995; Cortina, 1993). Test-retest reliability of the PDSS-C was examined by computing correlations between PDSS-C scores gathered on two consecutive days (Day 1 and Day 2) of treatment, consistent with test-retest investigations of the adult PDSS (Houck et al., 2002). Importantly, previous research has shown that treatment-related improvements do not occur between Day 1 and Day 2 of intensive treatment of adolescent panic disorder (e.g., Gallo et al., in press), and thus comparison of Day 1 and Day 2 PDSS-C scores affords a sound opportunity for evaluating test-retest reliability. Test-retest reliability correlations were computed for the total PDSS-C scores as well as for each individual subscale score. To evaluate the convergent validity of the PDSS-C, correlations were computed between baseline PDSS-C scores and baseline MASC and CASI total scores. Discriminant validity was examined by computing correlations between baseline PDSS-C and CDI total scores. Linear regression analysis examined PDSS-C sensitivity to treatment-related change by evaluating the contribution of participant condition (CBT vs. WL) in the prediction of 6-week post PDSS-C scores, after accounting for the predictive contribution of baseline PDSS-C scores. To further investigate the sensitivity of the PDSS-C to treatment-related PDA change, we computed correlations between PDSS-C residual change scores (i.e., 6-week post minus baseline scores) and MASC, CASI, and CDI change scores. This methodology of computing change scores is consistent with recent psychometric investigations (e.g. Gielissen, Prins, Knoop, Verhagen, & Bliegenberg, 2013; Last, Miles, Wills, Brownhill, & Ford, 2012). The magnitude of the correlations were interpreted using conventions outlined by Cohen (1988), whereby correlations from ± 0.1 to ± 0.3 were considered small, ± 0.3 to ± 0.5 were considered medium, and ± 0.5 to ± 1.0 were considered large.

We hypothesized that the PDSS-C scores would demonstrate adequate test-retest reliability and internal consistency. We hypothesized that the convergent and discriminant validity of the PDSS-C would also be established. More specifically, we expected that the PDSS-C would correlate significantly with anxiety sensitivity as measured by the CASI total score and with overall anxiety as measured by the MASC total score, but would show non-significant correlation with the CDI total score. Judgments regarding the presence or absence of convergent and discriminant validity were made in comparison with documented correlations with associated constructs when establishing the validity of the adult PDSS-SR. However, given limited work comparing the PDSS with other measures for which developmental adaptations are available to assess similar constructs in youth, only the Anxiety Sensitivity Index (ASI; Peterson & Reiss, 1987), from which the CASI was developed, allowed for adequate comparison with measures used in the present study.

Specifically, previous work with adults has found a significant correlation of $r = 0.29$ between the Anxiety Sensitivity Index (ASI) and the adult PDSS-SR (Wuyek et al., 2011), and so judgments about the presence of PDSS-C convergent validity were made when associations between PDSS-C scores and measures of related constructs were significant and exceeded $r \equiv 0.3$. We hypothesized that the PDSS-C would be sensitive to changes in symptomatology occurring between baseline and post-treatment time points, as evidenced by significant correlations between PDSS-C change scores and MASC and CASI change scores, as well as a weaker or non-significant correlation between PDSS-C and CDI change scores. Finally, to further confirm the ability of the PDSS-C to capture treatment-related change, we hypothesized that PDSS-C post scores would significantly differ between participants receiving immediate treatment and those in the waitlist control group.

Results

Table 1 presents the means and standard deviations of all study variables at baseline. Independent-samples t -tests were computed to evaluate the baseline equivalency of CBT and WL youth. Groups did not differ at baseline on any observed variables, including age ($t[58] = -1.51, p = 0.14$), gender ($\chi^2[1] = 0.08, p = 0.78$), or medication status ($\chi^2[1] = 0.003, p = 0.96$). There were no gender differences on baseline PDSS-C total scores ($t[53] = 1.18, p = 0.25$), consistent with previous adult studies using the PDSS (e.g. Barlow et al., 2000).

Internal Consistency

Across the full PDSS-C scale, internal consistency was adequate ($\alpha = 0.82$). Pairwise inter-item correlations between PDSS-C items ranged from small to large ($r = 0.20 - 0.70$). Despite this variability in pairwise inter-item correlations, removal of any individual item did not yield improved overall internal consistency (α if single items were deleted ranged from $0.79 - 0.80$).

Test-Retest Reliability

Among CBT youth, test-retest reliability estimates for PDSS-C total score gathered on consecutive days were adequate ($r = 0.79, p < .01$). Zero-order correlations between Treatment Session 1 and 2 PDSS-C subscale scores yielded significant associations, with test-retest reliability correlations ranging from 0.55 to 0.77 . Specifically, test-retest reliability estimates were found for distress caused by panic ($r = .70$), panic frequency ($r = 0.55, p < .01$), anticipatory anxiety about panic ($r = 0.76, p < .01$), agoraphobic fear/avoidance ($r = 0.77, p < .01$), interoceptive fear/avoidance ($r = 0.64, p < .01$), interference of panic in school and home responsibilities ($r = 0.71, p < .01$), and interference of panic in social life ($r = 0.77; p < .01$).

Convergent and Discriminant Validity

Table 2 presents the zero-order correlations among baseline total scores on the PDSS-C, MASC, CASI, and CDI. As hypothesized, significant correlations suggesting convergent validity were found between the PDSS-C total score and the MASC total score and the CASI total score, both of which exceeded the defined “cut-off” point of $r = 0.3$ while also

attaining statistical significance. Evidence of discriminant validity is reflected in the absence of a significant baseline correlation between the PDSS-C and the CDI.

Sensitivity to Change

Change scores (i.e., 6-week post minus baseline scores) were calculated across study variables. As hypothesized, PDSS-C change scores correlated significantly with both MASC total change scores and CASI total change scores, whereas there was not a significant association between PDSS-C change scores and CDI change scores (see Table 3).

Multiple linear regression analyses further evaluated the ability of the PDSS-C to capture treatment-related changes in PDA symptoms by evaluating the contribution of participant condition (CBT vs. WL) in the prediction of 6-week post PDSS-C scores, after accounting for the predictive contribution of baseline PDSS-C scores. As expected, there was a moderate within-subjects association between baseline and 6-week post PDSS-C total scores total score ($r = .36, p = .01$). There was also a large correlation between participant condition and 6-week post PDSS-C total scores ($r = .52, p < .01$), with CBT youth showing significantly lower post PDSS-C scores than WL youth ($t = -3.33, p < 0.01$).

In order to evaluate the link between participant condition and post PDSS-C scores after accounting for the effect of baseline PDSS-C scores, baseline PDSS-C total scores were entered into the first step of the regression model predicting 6-week post PDSS-C total scores. Participant condition was then entered into the second step of the model. Baseline PDSS-C scores significantly predicted post PDSS-C scores, $F(1, 37) = 5.50, p = .02$ (see Table 4 for regression details). Adding participant condition to the prediction of post PDSS-C scores added a significant contribution to the model, $F(1, 36) = 14.74, p = .00$, indicating that participant condition predicted 6-week post PDSS-C scores over and above the variance accounted for by baseline PDSS-C scores.

Discussion

The present study found robust psychometric support for a child version of the Panic Disorder Severity Scale (i.e., the PDSS-C) in a treatment-seeking sample of anxious adolescents presenting with a principal diagnosis of PDA. Whereas previous measurement advances support the utility of adult measures of PDA symptom frequency, severity, and impairment (e.g., Houck et al., 2002; Wuyek et al., 2011), the present study provides the first psychometric evaluation of a panic severity measure for youth among a sample of youth with PDA. The present report offers preliminary support for the reliability, validity, and clinical utility of the PDSS-C scores, which have already been used in clinical trials (e.g., Pincus et al., 2010, 2013).

Specifically, the PDSS-C total score demonstrated adequate internal consistency ($\alpha = 0.82$), suggesting overall consistency within the measure itself. The low to moderate pairwise inter-item correlation of the items on the PDSS-C may reflect the polythetic nature of panic disorder symptoms. Importantly, each item of the PDSS assesses a conceptually distinct element of the diagnostic criteria for panic disorder (see Shear et al., 1997), and research demonstrates the partial independence of symptom domains assessed by the adult version of

the PDSS (see Craske & Barlow, 1988). Follow-up analyses indicated that removal of any individual item did not yield improved overall internal consistency (α if single items were deleted ranged from 0.79 – 0.80), lending support to the understanding of the individual PDSS-C items as evaluating distinct but related domains. Given weak inter-item correlations for some pairs of items, future factor analytic work is needed to reveal the broad structure of panic disorder symptoms, and the extent to which some items should not be retained for subsequent iterations of the PDSS-C. It is notable that the overall internal consistency identified in the present sample is similar to that found in recent research by Wuyek and colleagues (2011) documenting the internal consistency of the adult version of the PDSS-SR ($\alpha = 0.80$), although it is somewhat lower than the value found by Houck and colleagues (2002; $\alpha = 0.92$).

PDSS-C scores also evidenced adequate overall 1-day test-retest reliability ($r = 0.79$), further supporting the reliability of the measure in the assessment of adolescent PDA symptoms. Notably, despite the adequacy of 1-day test-retest reliability observed in the present study, there is evidence that the magnitude of PDSS-C test-retest reliability attenuates with increased latency between assessment points. For example, in the present dataset, test-retest reliability observed between initial baseline assessment and the first day of treatment (with a delay of at least one week) was lower than correlations computed from values obtained on consecutive days ($r = 0.67$), and the magnitude of PDSS-C test-retest reliability was inversely associated with the length of interval between baseline assessment and session one (data not shown). These somewhat weaker correlations between PDSS-C scores with greater time between assessment points is consistent with previous research on the relative instability of scores on other well-established measures such as the Beck Depression Inventory (e.g. Ahava, Ianonne, Grebstien, & Schirling, 1998). In addition, psychometric evaluations of the adult PDSS suggest somewhat weaker test-retest reliability with longer delays between assessment points (3-17 days, $r = 0.71$, compared with $r = 0.81$ for consecutive days; see Shear et al., 2001 compared with Houck et al., 2002). At this point it remains unclear whether attenuation of PDSS-C test-retest values with increased retest intervals reflect true changes in panic disorder symptomatology over time, or relative PDSS-C imprecision.

Associations among study variables supported the convergent and discriminant validity of the PDSS-C, with the adapted measure significantly correlating with measures of overall anxiety and anxiety sensitivity. Given that anxious youth with PDA tend to endorse higher levels of anxiety sensitivity than anxious youth without PDA (Noel & Francis, 2011), the significant correlation between the PDSS-C and the CASI in particular is not surprising. Moreover, despite the association between panic disorder and depression in youth (e.g. Diler et al., 2004), the PDSS-C does not appear to be assessing depressive symptomatology, per se, as demonstrated by the absence of a significant association between the PDSS-C and the CDI. Although the present study did not find a significant link between the PDSS-C and the CDI, significant associations were found between the CDI and the MASC and CASI. This finding may initially appear surprising, given the significant moderate associations between the PDSS-C and the MASC and CASI. These findings are consistent with previous research supporting links between childhood depression, anxiety sensitivity, and general anxiety.

More specifically, research indicates that anxiety sensitivity is significantly associated with depression in adolescents (Weems, Hammond-Lawrence, Silverman, & Ferguson, 1997), and Kovacs (1985) found significant correlations between the CDI and the Children's Manifest Anxiety Scale, a measure of generalized anxiety similar to the MASC ($r = 0.65$, $p < .001$). In light of these findings, it may be that observed links between adolescent panic and depression are concentrated mostly among their shared relationships with general anxiety and anxiety sensitivity, rather than being dependent upon the severity of their panic symptoms. Additional research is needed to elaborate upon these overlapping relationships.

The moderate associations observed between PDSS-C scores and scores of general anxiety and anxiety sensitivity are particularly compelling in the context of the present, relatively homogeneous, sample. Given that all participants met diagnostic criteria for panic disorder, and the relatively restricted range of scores that accompanies such a homogeneous sample (i.e., fewer participants have low scores), the present analysis offers a conservative test of convergent validity. It is presumed that similar analyses in a more heterogeneous general clinical sample with a broader range of scores on measures would have yielded associations of larger magnitude than those identified in the present report.

The present findings support the clinical utility of the PDSS-C as sensitive to treatment-related changes. Multiple linear regression analysis demonstrated that after accounting for baseline PDSS-C scores, the variability in follow-up PDSS-C scores is significantly linked to whether a child participated in evidence-based treatment, supporting the measure's continued use in the formal evaluation of clinical methods for the treatment of adolescent PDA (Pincus et al., 2010; 2013). Sensitivity to treatment-related change was further established through significant correlations between PDSS-C change scores and change scores in established measures of anxiety and anxiety sensitivity.

The present analysis has several limitations that warrant comment. First, the study took place in a university-based outpatient clinic specializing in the treatment of anxiety disorders in a major metropolitan city. As a result, the findings may not be representative of youth presenting for treatment in other settings, or in the general population. Second, many children in the sample were being managed on psychotropic medications, which may have impacted observed symptom and diagnostic presentations. However, recent epidemiological work indicates that adolescents with panic disorder are over five times more likely to be treated with antidepressants than adolescents without panic disorder, and are also more likely than non-anxious youth to be taking anxiolytic, mood stabilizing, or stimulant medication (Olfson et al., 2012). Therefore excluding participants based on medication use would have limited the generalizability of the present work. Findings may have been influenced by the sample size of the present study and it is possible that a larger sample may have yielded different results; although given the relationship between sample size and power, it is likely that a larger sample would have demonstrated only stronger results in support of the PDSS-C. It should also be noted that sample sizes were not consistent across study conditions ($N = 42$ in the CBT condition versus $N = 18$ in the WL condition). Although the analyses reported are robust against differential sample sizes across conditions, it is nonetheless possible that estimates for the WL condition are less stable and precise than estimates for the larger CBT condition. Study selection procedures, particularly the inclusion

and exclusion criteria, may limit the generalizability of the present results. Specifically, non-English-speaking participants were not eligible to participate in the study, as all assessments and treatment procedures were delivered in English. The sample was predominantly Caucasian and of relatively high economic means, which is consistent with findings in the adult literature that minority and lower-income participants are consistently underrepresented in randomized controlled trials of treatments for PDA (Mendoza, Williams, Chapman, & Powers, 2012). As ethnic minority patients may show differences in the way in which they report experiencing, understanding, and coping with symptoms of panic (Mendoza et al., 2012), cultural variations in PDSS-C responses and the psychometric properties associated with the measure merit additional study. Moreover, in the present study the PDSS-C was not administered to youth with primary diagnoses other than PD or PDA. Accordingly, in the absence of diagnostic variability, the present study did not permit evaluation of the diagnostic utility of the PDSS-C (i.e., how well the measure can identify PDA versus non-PDA youth).

Moreover, the present analysis relied exclusively on self-report data. Future work would benefit from examination of the measure's correspondence with structured diagnostic interviews, psychophysiological data, and measurements drawn from ecological momentary assessment designs. In particular, readability analysis indicated that the grade level of the PDSS-C is appropriate for students in the latter part of the 9th grade (Flesch-Kincaid Grade Level = 9.8), or approximately 14 to 15 years old. As the mean age of the sample was 15.17, it is possible that the language of the PDSS-C may have been too advanced for some of participants in the study. Accordingly, we conducted a post hoc analysis to evaluate whether the reliability of the PDSS-C varied as a function of age by dividing the sample into a younger group (i.e., youth below the mean sample age of 15.17) and an older group (i.e., youth above the mean sample age of 15.17). A Fisher's Z-Test revealed the test-retest reliability of the younger group ($r = 0.89$) and the older group ($r = 0.72$) did not significantly differ from one another ($z = 0.51$, $p = 0.61$). Although age did not significantly affect the test-retest reliability of the PDSS-C, future iterations of the PDSS-C might consider whether alterations in the language of the measure may improve the assessment panic disorder symptoms for younger populations.

Of enormous concern, only one-third of individuals affected by PDA obtain mental health services within the first year of PDA onset, and among affected individuals who do eventually obtain mental health care, the median delay between PDA onset and first mental health treatment contact is 10 years (Wang et al., 2005). Accurate assessment of PDA symptoms is the critical first step in appropriate and timely care. Despite the above noted study limitations, the favorable psychometric properties demonstrated in this analysis provide strong preliminary support for the utility of PDSS-C scores as reliable and valid measurements that can both complement diagnostic interviewing procedures and may have clinical utility as a stand-alone measure. Given that youth with panic symptoms and related somatic complaints often present to primary care and specialty pediatric settings (Campo et al., 2002; Lipsitz et al., 2004) where medical professionals may lack the sufficient training and/or time to formally assess PDA symptoms, the PDSS-C may be a promising measure with which to assess PDA symptoms in non-mental health settings. Moreover, the ability of

the PDSS-C to detect treatment-related changes supports its continued use as an outcome measure in research and clinical settings. As good clinical care necessitates the ongoing assessment of symptoms throughout treatment, the brief self-report nature of the measure should facilitate repeated administrations in clinical practice. Indeed, in other research, repeated administration of the PDSS-C has been used to evaluate typical and individual growth trajectories associated with CBT for adolescent PDA (Gallo, Cooper-Vince, Hardway, Pincus, & Comer, 2012). Such ongoing assessments throughout treatment can afford clinicians timely insight into the progress or deterioration of adolescent patients and can inform the course of treatment, improving overall treatment efficacy and reducing the burden of lengthy, costly, and unnecessary treatments. Future research is needed to identify how the PDSS-C can be incorporated into clinical practice in order to accelerate the flow of affected individuals into appropriate mental health care, and to optimally inform evidence-based intervention efforts.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Means and Standard Deviations of Study Variables at Baseline

Measure	CBT Group (n = 40)	WL Group (n = 18)	Full Sample (n = 60)
PDSS-C Total Score	13.46 (5.42)	13.39 (5.38)	13.44 (5.36)
MASC Total Score	62.08 (17.60)	55.67 (13.06)	60.02 (16.44)
CASI Total Score	36.34 (4.90)	34.94 (5.35)	35.93 (5.03)
CDI Total Score	12.60 (7.95)	13.22 (7.12)	12.80 (7.81)

Note: CBT Group = Cognitive-behavioral therapy group (i.e., randomized to receive immediate intensive CBT for adolescent panic disorder); WL Group = Waitlist group (i.e., Group randomized to a 6-week waitlist control condition); PDSS-C = Panic Disorder Severity Scale for Children; MASC = Multidimensional Anxiety Scale for Children; CASI = Child Anxiety Sensitivity Index; CDI = Children's Depression Inventory.

Table 2

Baseline Correlations among Study Variables

Measure	PDSS-C total score	MASC total score	CASI total score
MASC total score	0.41**	—	—
CASI total score	0.40**	0.52**	—
CDI total score	0.17	0.38**	0.48**

Note: PDSS-C = Panic Disorder Severity Scale for Children; MASC = Multidimensional Anxiety Scale for Children; CASI = Child Anxiety Sensitivity Index; CDI = Children's Depression Inventory

**
 $p < 0.01$, two-tailed.

Table 3

Correlations among Study Variable Change Scores ()

Measure	PDSS-C	MASC	CASI
MASC	0.44 [*]	—	—
CASI	0.37 [*]	0.65 ^{**}	—
CDI	0.21	0.64 ^{**}	0.67 ^{**}

Note: Change score () = 6-week post score minus baseline score; PDSS-C = Panic Disorder Severity Scale for Children; MASC = Multidimensional Anxiety Scale for Children; CASI = Child Anxiety Sensitivity Index; CDI = Children's Depression Inventory. All scores represent change in total scores.

^{*}
 $p < 0.05$, two-tailed.

^{**}
 $p < 0.01$, two-tailed.

Multiple Regression Analysis Using Treatment Condition to Predict PDSS-C Outcome at Post-Treatment, Controlling for Baseline PDSS-C Total Score

Table 4

Variable Entered	B	SE(B)	β	t	Sig.
Step 1.					
Baseline PDSS Total Score	0.46	0.20	0.36	2.35	0.02
Step 2					
Baseline PDSS Total Score	0.54	0.16	0.42	3.41	<0.01
Treatment Condition	7.71	1.68	0.57	4.58	<0.01

Note: $R^2 = .13$ for Step 1., $R^2 = .45$ for Step 2; Change in $R^2 = .32$ for Step 2.