ORIGINAL RESEARCH

Psychometrics of the Concise Health Risk Tracking Self-Report (CHRT-SR$_{16}$) Assessment of Suicidality in a Sample of Adults with Moderate to Severe Methamphetamine Use Disorder: Findings from the ADAPT-2 Randomized Trial

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Background: The co-occurrence of suicidality and substance use disorders has been well established, but rating scales to examine suicidal behavior and risk are sparse among participants with substance use disorders. We examined the psychometric properties of the 16-item Concise Health Risk Tracking Scale – Self Report (CHRT-SR$_{16}$) to measure suicidality among adults with moderate-to-severe methamphetamine use disorder.

Methods: Participants (n = 403) with moderate-to-severe methamphetamine use disorder completed the CHRT-SR$_{16}$ as part of a randomized, double-blind, placebo-controlled pharmacotherapy trial. The CHRT-SR$_{16}$ factor structure was assessed using confirmatory factor analysis (CFA). Internal consistency was estimated with coefficients alpha (α) and omega (ω), test-retest reliability with intraclass correlation coefficient (ICC) and standard error of measurement, and convergent validity using Spearman's ρ rank order correlation coefficient test between CHRT-SR$_{16}$ factors and the Patient Health Questionnaire (PHQ-9). The analyses utilized baseline and week 1 data (for test-retest reliability only).

Results: CFA revealed a seven-factor model of Pessimism, Helplessness, Social Support, Despair, Impulsivity, Irritability, and Suicidal Thoughts as the best-fitting model. The CHRT-SR$_{16}$ also exhibited strong internal consistency (α = 0.89; ω = 0.89), test-retest reliability (ICC = 0.78) and convergent validity with the PHQ-9 total score (ρ = 0.62).

Conclusion: The CHRT-SR$_{16}$ showed strong psychometric properties in a sample of participants with primary methamphetamine use disorder.

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Keywords: stimulant use disorder, confirmatory factor analysis, irritability, impulsivity, propensity, PHQ-9

Introduction

Substance use disorders and suicidal ideation are highly prevalent and concerning public health problems; nearly 20 million Americans aged 12 or older had a substance use disorder in 2017,[1] and in 2019, 47,511 Americans died by suicide.[2] Suicide rates have also been steadily rising from 1999 to 2018,[3] and individuals with substance use disorders are

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at increased risk for suicide.[4,5] Beyond outcomes like suicide attempts and completion, specific components of substance misuse are also associated with suicide risk factors. Despair, hopelessness/helplessness, and lack of social support may be risk factors for suicidality,[6,7] and may be more common in those with substance abuse disorders.[8] Impulsivity and substance use disorders are strongly associated,[9] and impulsivity more than doubles the odds of a suicide attempt.[10] Irritability is also associated with substance use and withdrawal,[11,12] and there is some evidence that irritability may be a risk factor for suicidality, though this relationship may vary by patient population.[13,14] Recent work found irritability to be predictive of suicidal ideation in adults in residential treatment for stimulant use disorder, and this relationship persisted when controlling for depression.[15] Thus, it is clear that studying the relationship between suicidal ideation and risk factors among those with primary substance use disorders is vital.

Given the clear public health problem represented by suicidal ideation and behaviors, several self-report and clinician-rated measures have been developed to measure suicidal ideation, behaviors, and risk factors. Perhaps the most widely used suicide assessment is the Columbia Suicide Severity Rating Scale (CSSRS),[16] a clinician rated measure that classifies possibly suicidal events into the Columbia Classification Algorithm for Suicide Assessment (C-CASA) categories. Another popular and validated measure has been the self-report Concise Health Risk Tracking Index (CHRT-SR).[17] Unlike the CSSRS, the CHRT-SR is a self-report measure and includes not only suicidal ideation and behaviors, but also other factors associated with increased risk of suicide. Prior research has validated multiple versions of the CHRT-SR for both unipolar and bipolar depression (the 7-item, 12-item, and 14-item $CHRT-SR_7$, $CHRT-SR_{12}$, and $CHRT-SR_{14}$ respectively),[18–20] for use in adolescents ($CHRT-SR_{14}$),[21] and for use in treatment studies ($CHRT-SR_{12}$).[22–24] Specifically, one paper[25] investigated the psychometrics of the $CHRT-SR_{12}$ in a sample of participants who were primarily receiving an education or exercise-based intervention to treat stimulant use disorder, and found that the psychometric properties of the $CHRT-SR_{12}$ were consistent with prior work (ie, Propensity and Suicidal Thoughts factors, and four domains within the Propensity subscale), and that the scale demonstrated strong evidence of reliability and convergent validity.

This research contributes to the literature by examining a 16-item version of the CHRT-SR ($CHRT-SR_{16}$), which adds four additional items that assess impulsivity and irritability to the original $CHRT-SR_{12}$. It is worth noting that prior work found that the inclusion of the two impulsivity items to the $CHRT-SR_{12}$ (creating the $CHRT-SR_{14}$) slightly worsened the psychometric properties of the scale in a sample of individuals with substance use disorder.[25] However, assessment of non-depressive risk factors, such as impulsivity and irritability, is a unique feature of the $CHRT-SR_{16}$, and there may be value in including these items to assess these factors in people with methamphetamine use disorder.

We conducted psychometric analyses of the $CHRT-SR_{16}$ in a sample of adult participants receiving an intervention for moderate-to-severe methamphetamine use disorder, with a goal to assess this measure's factor structure, reliability, and convergent validity among individuals with substance use disorders. Specifically, this study investigated the following questions:

1. What is the overall factor structure of the $CHRT-SR_{16}$ among a sample of participants receiving an intervention for a primary methamphetamine use disorder and how does this compare to the factor structure observed in other samples?
2. What is the test-retest reliability (from baseline to week 1) and internal consistency/coefficient alpha values for the domains of the $CHRT-SR_{16}$?
3. What is the convergent validity as measured by correlations between the $CHRT-SR_{16}$ total score (and domains) and the nine-item Patient Health Questionnaire (PHQ-9)[26] total score and the score on the PHQ-9 suicidal ideation item?

Materials and Methods
Design
This study utilized data from a previously published Accelerated Development of Additive Treatment for Methamphetamine Disorder (ADAPT-2) clinical trial, a 12-week randomized, double-blind, sequential parallel comparison design trial evaluating the efficacy of combination injectable naltrexone and oral bupropion versus placebo in outpatient adults with moderate-to-severe methamphetamine use disorder.[27] The analyses utilized baseline ADAPT-2 data to evaluate the psychometric properties of the

CHRT-SR$_{16}$, including internal consistency and convergent validity. Baseline and week 1 data (average 6.5 days between visits) were used to assess test-retest reliability of the scale.

Participants

The detailed inclusion and exclusion criteria for the ADAPT-2 study are described elsewhere.[27] The baseline sample consisted of 403 adults between 18 and 65 years of age who used methamphetamine, while complete baseline and week 1 data (for test-retest reliability) were available for 277 participants. Randomized participants met criteria for moderate-to-severe methamphetamine use disorder based on the 5th edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5),[12] and reported methamphetamine use on at least 18 out of the last 30 days before the consent. Participants undergoing substance use treatment, needing opioid medications during the study, or having other contra-indicated medical conditions were excluded from the study. In addition, those with suicidal or homicidal ideation requiring immediate attention at baseline were excluded and referred to appropriate psychiatric care. The ADAPT-2 trial was carried out in accordance with the Declaration of Helsinki. All participants provided written informed consent approved by a central institutional review board and each site's local institutional review board prior to initiating any study procedures.

Measures

The CHRT-SR$_{16}$ is a Likert-type ordinal scale with item-level responses ranging from 0 ("Strongly Disagree") to 4 ("Strongly Agree") to each item/statement when considering the past week. Total score ranges from 0 to 64, with higher CHRT scores indicative of greater suicidality risk and higher frequency of suicidal thoughts. Baseline and Week 1 CHRT-SR$_{16}$ data were utilized in the analysis.

The self-report Patient Health Questionnaire (PHQ-9) consists of nine items corresponding to the degree of frequency of being bothered by the nine symptoms of major depressive disorder over the last two weeks, where item-level responses are measured on a scale from 0 ("not at all") to 3 ("nearly every day") and the total score ranges from 0 to 27. Higher scores on the PHQ-9 are indicative of greater depressive symptom severity. Item 9 of the scale assesses suicidal ideation.

Statistical Analyses

A series of confirmatory factor analyses (CFA) were performed to evaluate the factor structure of the CHRT-SR$_{16}$. The following four models were tested with factors identified a priori based on prior literature:[16] (1) a single-factor model with 16 items loading on one factor of Suicidal Risk (CHRT-SR$_{16}$ total); (2) a two-correlated-factor model with items 1–13 loading on the Propensity factor and items 14–16 loading on the Suicidal Thoughts factor; (3) a seven-correlated-factor model with items 1–13 loading on the Pessimism, Helplessness, Social Support, Despair, Impulsivity, and Irritability factors and items 14–16 loading on the Suicidal Thoughts factor; and (4) we tested the hypothesis that the 16-items on the CHRT-SR would load on seven first-order factors (Pessimism, Helplessness, Social Support, Despair, Impulsivity, Irritability, and Suicidal Thoughts), with six factors (Pessimism through Irritability) loading on a second-order latent factor of Propensity.

All CFA models were fitted using diagonally weighted least squares mean and variance adjusted (WLSMV) estimators with robust standard errors. WLSMV does not assume multivariate normality among observed indicators, resulting in less biased estimates of factor loadings compared to maximum and robust maximum likelihood estimators, particularly among large sample sizes and ordinal-level responses.[28,29] The following fit indices and cutoffs were used as indicators of satisfactory model fit: root mean square error of approximation (RMSEA) ≤ 0.06 (90% CI ≤ 0.08), standardized root mean square residual (SRMR) ≤ 0.08, comparative fit index (CFI) ≥ 0.95, Tucker-Lewis Index (TLI) ≥ 0.95,[30,31] and the weighted root mean square residual (WRMR) ≤ 1.00.[32]

The internal consistency reliability of the CHRT-SR$_{16}$ was examined for the entire scale, two main factors (Propensity and Suicidal Thoughts), and six Propensity subscales (Pessimism, Helplessness, Social Support, Despair, Impulsivity, and Irritability) using coefficients alpha (α) and omega (ω). Acceptable internal consistency was indicated by coefficient values ≥ 0.70.[33] Coefficient ω does not assume equal factor loadings (essential tau equivalence), making it a more general estimator of reliability.[34]

The test-retest reliability was assessed between baseline and week 1 (mean 6.5 days apart) using the intraclass correlation coefficient (ICC) as a relative measure of reliability and the standard error of measurement (SEM) as an absolute reliability index. Specifically, we used a two-way mixed effects ICC measurement, with subjects as random effects and visits as fixed effects.[35,36] The SEM formula was computed as follows: $SEM = \sqrt{MeanSquare_{Error}} \times \sqrt{(1 - ICC)}$.[36] ICC and SEM scores were obtained for CHRT-SR$_{16}$ overall scale, the second-order Propensity factor and each of the first-order factors. Convergent validity was evaluated by assessing the Spearman ρ correlation coefficient between PHQ-9 total score and the CHRT-SR$_{16}$ total score, including the first- and second-order factors.

All statistical analyses were conducted using *R* statistical software (version 4.1.1), with CFA models fitted using package lavaan,[37] and reliability and validity estimates obtained using package psych.[38]

Results

The baseline sample consisted of 403 participants randomized into the study. Full descriptive and demographic information, including substance use history, is presented in Table 1, and has also been previously published.[27] The participants were primarily male (68.7%), middle-aged (*M* = 41.0 years; SD = 10.1), and White (71.2%), with 55 (13.6%) and 48 (11.9%) participants of Hispanic or Latino ethnicity and identifying as Black, respectively. All participants met DSM-5 criteria for moderate-to-severe methamphetamine use disorder, with an average of 26.7 days (SD = 4.1) of methamphetamine use in the 30 days prior to consent.

CHRT-SR$_{16}$ descriptive statistics, including means and SDs at baseline, are included in Table 1. Most participants scored 0 ("strongly disagree") or 1 ("disagree") to items related to Suicidal Thoughts and the subfactors of pessimism, helplessness, and despair. Particularly for item 16, an item regarding having a suicide plan, 382 individuals (94.8%) reported that they "strongly disagree[d]" (79.2%) or "disagree[d]" (15.6%) with the statement. The median Suicidal Thoughts factor total score was 0, with 59.8% of participants having a total score of 0 (out of a possible 12) across three suicidality items. Items of impulsivity (M = 4.4, SD = 2.2) and irritability (M = 4.0, SD = 2.4) were more frequently endorsed.

Table 1 Baseline Characteristics of the Sample (*N* = 403)

	Mean	SD
Age (years)	40.8	10.1
Males (%)	277 (68.7%)	
Hispanic/Latino (%)	55 (13.6%)	
Race		
White (%)	287 (71.2%)	
Black (%)	48 (11.9%)	
Other (%)	68 (16.9%)	
CHRT-SR$_{16}$ Total	22.8	11.6
Propensity Latent Factor	21.4	10.4
Pessimism	2.9	2.2
Helplessness	3.2	2.3
Social Support	3.3	2.3
Despair	3.6	3.0
Impulsivity	4.4	2.2
Irritability	4.0	2.4
Suicidal Thoughts Factor	1.4	2.2
PHQ-9 Total	10.9	6.5
Days methamphetamine used (30 days before consent)	26.7	4.1

Abbreviations: CHRT-SR$_{16}$, 16-item Concise Health Risk Tracking Self-Report; PHQ-9, Patient Health Questionnaire-9.

Table 2 Goodness-of-Fit Indicators (*N* = 403)

	Factors	χ2/df	RMSEA [90% CI]	CFI	TLI	SRMR	WRMR
Model 1	CHRT-SR16	6.37	0.116 [0.107–0.124]	0.707	0.662	0.113	1.797
Model 2	Propensity and Suicidal Thoughts	5.52	0.106 [0.098–0.115]	0.756	0.715	0.088	1.625
Model 3	Pessimism, Helplessness, Social Support, Despair, Impulsivity, Irritability, Suicidal Thoughts	1.84	0.046 [0.034–0.057]	0.964	0.947	0.033	0.614
Model 4	Propensity (2nd Order) and Suicidal Thoughts	3.23	0.074 [0.065–0.084]	0.887	0.860	0.064	1.155

**Abbreviations**: χ2, Chi Square; df, Degrees of Freedom; RMSEA, Root Mean Square of Approximation; CI, Confidence Interval; CFI, Comparative Fit Index; TLI, Tucker-Lewis Index; SRMR, Standardized Root Mean Square Residual; WRMR, Weighted Root Mean Square Residual; CHRT-SR16, 16-item Concise Health Risk Tracking Self-Report.

CHRT-SR$_{16}$ Fit Indices

The one-factor (Model 1; CHRT-SR$_{16}$) model, the two-factor (Model 2; Propensity latent factor and Suicidal Thoughts factor) model, and model 4 (Propensity latent factor as a second-order factor determined from the correlation among the factors) did not adequately fit the observed data. Only model 3 (7-factor structure) exhibited acceptable model fit. Table 2 shows fit indices across all models, and Figure 1 shows Model 3 factor structure.

CHRT-SR$_{16}$ Standardized Factor Loadings

In Model 3, the majority of items loaded strongly on their underlying factors and exhibited strong inter-item correlation. Items 7 and 16 had the weakest loading on their respective factors of Despair (0.61) and Suicidal Thoughts (0.57). Item 7
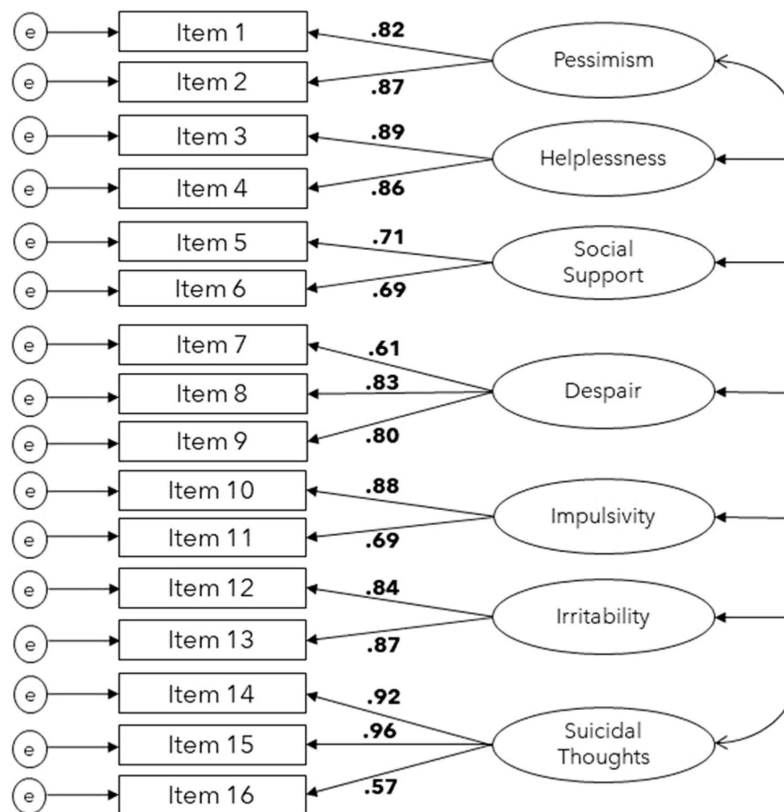
Figure 1 CHRT-SR16 Confirmatory Factor Analysis of Model 3 where a seven-correlated-factor model with items 1–13 loading on the Pessimism, Helplessness, Social Support, Despair, Impulsivity, and Irritability factors and items 14–16 loading on the Suicidal Thoughts factor.
Notes: Fitted using diagonally weighted least squares mean and variance adjusted (WLSMV) estimators with robust standard errors. The figure shows standardized factor loadings. Covariance coefficients are not shown, all coefficients were statistically significant at *p* < 0.001.

Table 3 Standardized Factor Loadings for Model 3 (N = 403)

Model 3 (Standardized Factor Loadings)	Pessimism	Helplessness	Social Support	Despair	Impulsivity	Irritability	Suicidal Thoughts
Item 1	0.82						
Item 2	0.87						
Item 3		0.89					
Item 4		0.86					
Item 5			0.71				
Item 6			0.70				
Item 7				0.61			
Item 8				0.83			
Item 9				0.80			
Item 10					0.88		
Item 11					0.69		
Item 12						0.84	
Item 13						0.87	
Item 14							0.92
Item 15							0.96
Item 16							0.57

Notes: All standardized coefficients are statistically significant at $p < 0.001$.

also showed a moderate correlation with Items 8 ($\rho = 0.44$) and 9 ($\rho = 0.46$) – the other items in the Despair factor. In comparison, Items 8 and 9 correlated strongly with each other at $\rho = 0.77$. For the Suicidal Thoughts factor, Items 14 and 15 had excellent factor loadings of 0.92 and 0.96, respectively, while Item 16 had a weak factor loading of 0.57. Item 16 also showed lower correlation with other items on the Suicidal Thoughts factor ($\rho = 0.63$ and $\rho = 0.67$ with Items 14 and 15) compared to the correlation between Items 14 and 15 ($\rho = 0.84$). In general, Item 16 correlated weekly with most other items on CHRT-SR$_{16}$, with inter-item correlations ranging between 0.10 (Item 5) to 0.46 (Item 8). The standardized factor loadings for Model 3 are presented in Table 3.

CHRT-SR$_{16}$ Internal Consistency

The internal consistency for CHRT-SR$_{16}$ was 0.89 for both coefficients α and ω, suggesting acceptable internal consistency. The internal consistency for individual factors was also acceptable, with the exception of the Social Support factor (both α and ω = 0.66), which was slightly lower than the rest of the factors. Both Propensity and Suicidal Thoughts demonstrated excellent internal consistency at Baseline, with α = 0.89 and ω = 0.89 for Propensity, and α = 0.86 and ω = 0.90 for Suicidal Thoughts. The correlations between six first-order factors (Pessimism, Helplessness, Social Support, Despair, Impulsivity, and Irritability) loading on a second-order latent Propensity factor ranged from 0.63 (Impulsivity) to 0.80 (Helplessness) and were all statistically significant at $p < 0.001$. The lowest first-order inter-correlations were observed between the Impulsivity factor and the other first-order factors (correlation coefficients ranging between 0.29 and 0.42). Additionally, the individual items showed strong and statistically significant correlations with underlying factors, with all item-factor correlations greater than 0.70. Table 4 and Table 5 provide a summary of inter-factor and inter-item correlations for the CHRT-SR$_{16}$.

CHRT-SR$_{16}$ Test-Retest Reliability

The CHRT-SR$_{16}$ total score and the Propensity factor had acceptable test-retest reliability between Baseline and week 1 (ICC = 0.78 for both). Among the first-order factors, the ICC ranged from 0.64 (Helplessness) to 0.74 (Despair). The lowest ICC was observed for the Suicidal Thoughts factor (ICC = 0.49). Table 6 presents the ICC and SEM scores for the scale's total score and individual factors.

Table 4 Inter-Subscale Correlations for CHRT-SR$_{16}$ Total and Subscale Scores (ρ, Spearman's Rho Rank Order Coefficient Test)

	Pessimism	Helplessness	Social Support	Despair	Impulsivity	Irritability	Suicidal Thoughts	Propensity
Hopelessness	0.63							
Social Support	0.46	0.47						
Despair	0.55	0.54	0.46					
Impulsivity	0.29	0.42	0.28	0.36				
Irritability	0.43	0.43	0.31	0.41	0.53			
Suicidal Thoughts	0.33	0.34	0.25	0.55	0.23	0.22		
Propensity	0.76	0.80	0.67	0.77	0.63	0.70	0.45	
Total	0.74	0.78	0.65	0.80	0.61	0.68	0.57	0.99

Notes: All correlation coefficients are statistically significant at $p < 0.001$. CHRT-SR$_{16}$ = 16-item Concise Health Risk Tracking Self-Report.

Table 5 Item-Subscale Correlations for CHRT-SR$_{16}$ (ρ, Spearman's Rho Rank Order Coefficient Test)

	Total	Propensity	Pessimism	Helplessness	Social Support	Despair	Impulsivity	Irritability	Suicidal Thoughts
Item 1	0.67	0.70	0.94						
Item 2	0.71	0.72	0.92						
Item 3	0.73	0.75		0.94					
Item 4	0.73	0.74		0.93					
Item 5	0.58	0.60			0.85				
Item 6	0.56	0.56			0.87				
Item 7	0.60	0.60				0.84			
Item 8	0.73	0.68				0.80			
Item 9	0.71	0.67				0.84			
Item 10	0.61	0.62					0.90		
Item 11	0.49	0.51					0.86		
Item 12	0.62	0.64						0.92	
Item 13	0.64	0.67						0.93	
Item 14	0.56								0.94
Item 15	0.57								0.94
Item 16	0.40								0.74

Notes: All correlation coefficients are statistically significant at $p < 0.001$.
Abbreviation: CHRT-SR$_{16}$, 16-item Concise Health Risk Tracking Self-Report.

CHRT-SR$_{16}$ Convergent Validity

The association between the CHRT-SR$_{16}$ total score and PHQ-9 total score was moderate-to-high ($\rho = 0.62$, $p < 0.001$), as was the association between the Propensity factor and the PHQ-9 total score ($\rho = 0.63$, $p < 0.001$). The Suicidal Thoughts factor had the weakest correlation with the PHQ-9 total score, but the relationship was still statistically significant ($\rho = 0.31$, $p < 0.001$). Among the first-order factors that load on Propensity, the correlation coefficients (ρ) with PHQ-9 total score ranged from 0.32 (Social Support) to 0.53 (Despair) and all were statistically significant at $p < 0.001$. Similar to the CHRT-SR$_{16}$ Suicidal Thoughts factor (items 14–16), the distribution of the suicidality item (#9) on the PHQ-9 was positively skewed, with 80.9% of participants endorsing "not at all" (no thoughts that they would be better off dead or hurting themselves) over the past week. The suicidality item on the PHQ-9 exhibited the strongest correlation with the Suicidal Thoughts factor on the CHRT-SR$_{16}$ ($\rho = 0.51$, $p < 0.001$). Table 7 shows the CHRT-SR$_{16}$ factor correlations with the PHQ-9 total score and the suicidality item (item 9).

Table 6 CHRT-SR$_{16}$ Internal Consistency and Test-Retest Reliability Between Baseline and Visit 1 for CHRT-SR$_{16}$

	Baseline M (SD)	Baseline Coefficient α	Baseline Coefficient ω	Time 2 M (SD)	Time 2 Coefficient α	Time 2 Coefficient ω	ICC	SEM
Total Score	22.83 (11.56)	0.893	0.894	19.30 (12.52)	0.924	0.928	0.78	5.16
Propensity	21.42 (10.46)	0.888	0.888	18.12 (11.39)	0.922	0.924	0.78	4.63
Pessimism	2.85 (2.17)	0.831	0.831	2.24 (2.00)	0.816	0.817	0.67	0.64
Helplessness	3.22 (2.30)	0.866	0.867	2.71 (2.37)	0.945	0.946	0.64	0.79
Social Support	3.27 (2.30)	0.663	0.663	2.81 (2.30)	0.756	0.756	0.72	0.69
Despair	3.64 (2.95)	0.776	0.772	2.92 (2.77)	0.767	0.778	0.74	0.96
Impulsivity	4.40 (2.21)	0.756	0.776	3.87 (2.40)	0.833	0.836	0.67	0.74
Irritability	4.04 (2.36)	0.843	0.844	3.57 (2.54)	0.900	0.902	0.66	0.83
Suicidal Thoughts	1.42 (2.18)	0.855	0.903	1.18 (1.93)	0.824	0.880	0.49	0.76

Abbreviations: CHRT-SR$_{16}$, 16-item Concise Health Risk Tracking Self-Report; α, Coefficient Alpha; ω, Coefficient Omega; ICC, Intraclass Correlation Coefficient; SEM, Standard Error of Measurement.

Table 7 Convergent Validity (Spearman ρ Coefficients)

	PHQ-9 Total	PHQ-9 Item 9
Propensity	0.625	0.445
Pessimism	0.483	0.326
Helplessness	0.506	0.318
Social Support	0.322	0.241
Despair	0.531	0.489
Impulsivity	0.429	0.217
Irritability	0.454	0.290
Suicidal Thoughts	0.311	0.513
CHRT-SR$_{16}$ Total	0.623	0.498

Notes: All values are statistically significant at $p < 0.001$.
Abbreviations: CHRT-SR$_{16}$, 16-item Concise Health Risk Tracking Self-Report; PHQ-9, Patient Health Questionnaire-9.

Discussion

With a goal of examining a more comprehensive, 16-item version of the self-report Concise Health Risk Tracking Scale, we validated this measure's psychometric properties and suitability for use in people seeking treatment for moderate-to-severe methamphetamine use disorder. Specifically, confirmatory factor analysis determined that all 16 items loaded onto a series of factors and subfactors encapsulating the propensity for suicide risk as well as a second factor of Suicidal Thoughts. Test-retest reliability and internal consistency for the factors and subfactors were generally highly acceptable. Convergent validity between the CHRT-SR$_{16}$ and the suicidal ideation item from the PHQ-9 was also established.

Testing four potential models of factor structure, one model was deemed acceptable which established six first-order factors loading on a second-order latent factor of Propensity, along with a separate Suicidal Thoughts factor. This model aligns with prior CHRT-SR psychometric research and theory on how the factors of pessimism, helplessness, social support, despair, impulsivity, and irritability are described as suicide propensity.[17] Although the current study tested four models based upon theory and prior research, other models may exist that fit the data just as well. Thus, the good model fit demonstrated by one of our models does not indicate that it is "correct or true", only plausible and well supported.

Across several metrics in our sample, the three-item Suicidal Thoughts factor and its individual items did not perform as well as other CHRT items in this sample. Low base-rate prevalence may mostly explain these findings, as nearly 60% of participants responded "strongly disagree" to all three items on the Suicidal Thoughts factor, and only 19.6% responded in the affirmative on all three items, with the majority endorsing 0 or 1 responses. In addition, the final item of this factor regarding a current suicidal plan was especially infrequently endorsed, as 95% of participants reported "strongly disagree" or "disagree" to this item at baseline, and only 0.2% and 0.7% reported "agree" or "strongly agree" respectively. These low base rates are to

be expected given study eligibility criteria that excluded severe current suicidality at screening. It is therefore not surprising that this item performed relatively poorly in intercorrelation with all other items. In addition, variability across time on all three suicide thoughts items and overall factor was relatively low, with very infrequent endorsement. Low variability among items and a small number of time points can contribute to low ICC,[39] and both issues are present in our current study.

Study strengths include a large sample size and the inclusion of individuals with a primary stimulant use disorder – a relatively understudied population (compared to participants with a primary mood disorder) with respect to suicidality, but a critical one from a public health perspective, given the association between substance use disorders and suicide mortality.[4]

Study limitations include low endorsement of several items and factors, particularly those regarding Suicidal Thoughts and planning. The sample also had a relatively low proportion of women, who are more likely to experience suicidal thoughts and plans as compared to men.[40–42] Inclusion of a greater proportion of women may have permitted a more robust and accurate test of the performance of the Suicidal Thoughts factor in individuals with substance use disorders. This work also did not assess for this scale's predictive validity for future suicide attempts or suicidal behaviors among those with a primary stimulant use disorder, although this predictive validity has been established with another version of the CHRT-SR among adolescents treated for suicidality in an intensive outpatient program.[43]

Nonetheless, our research adds to prior literature by confirming the psychometric factor structure, reliability, and convergent validity of the CHRT-SR$_{16}$ among a sample of participants receiving treatment for a primary stimulant use disorder. To improve our understanding of the Suicidal Thoughts factor, future research should examine the reliability, validity, and psychometrics of the Suicidal Thoughts factor and its constituent items among a sample of participants where suicidal thoughts are more frequent, and where data are obtained at more than two timepoints. In addition, determining the CHRT's predictive validity of suicidal events (ie, suicide attempts, hospitalizations, and deaths by suicide) among a sample of participants with a substance use disorder is an important future direction which will require larger sample sizes. Finally, investigating the extent to which suicidal ideation as assessed by the CHRT-SR$_{16}$ predicts substance use overdoses is especially important given substance users' frequent reports of suicidal intent before overdosing.[44]

Conclusion

The results of this study offer evidence for strong reliability and convergent validity of the CHRT-SR$_{16}$, among the first validated instruments to measure Suicidal Thoughts and behavior in a population that is disproportionately experiencing overdose and death due to methamphetamine use.[45] The CHRT-SR$_{16}$ builds upon prior work with the CHRT-SR,[17,25] and allows for the novel assessment of impulsivity and irritability as possible risk factors for suicidal behavior.

Abbreviations

CHRT-SR, Concise Health Risk Tracking Self Report; CSSRS, Columbia Suicide Severity Rating Scale; PHQ-9, Patient Health Questionnaire; ADAPT-2, Accelerated Development of Additive Treatment for Methamphetamine Disorder; DSM-5, Diagnostic and Statistical Manual of Mental Disorders, 5th Edition; CFA, Confirmatory Factor Analyses; WLSMV, Weighted Least Squares Mean and Variance Adjusted; RMSEA, Root Mean Square Error of Approximation; SRMR, Standardized Root Mean Square Residual; CFI, Comparative Fit Index; TLI, Tucker-Lewis Index; WRMR, Weighted Root Mean Square Residual; ICC, Intraclass Correlation Coefficient; SEM, Standard Error of Measurement.

Data Sharing Statement

The complete de-identified patient data set, study protocols, and case report forms are available at https://datashare.nida.nih.gov/study/nidactn0068, with no end date set for availability. Data are available for anyone requesting access, and website users will have to register a name and valid e-mail address in order to download data and to accept their responsibility for using data in accordance with the NIDA Data Share Agreement.

Ethics Statement

The ADAPT-2 trial was carried out in accordance with the Declaration of Helsinki. All participants provided written informed consent approved by a central institutional review board (The University of Texas Southwestern Medical Center institutional review board) and each site's local institutional review board prior to initiating any study procedures.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

Dr. Trombello reports owning stock in Merck and has served as a paid consultant for Alto Neuroscience LLC. He is currently a Clinical Assistant Professor of Psychiatry at UT Southwestern Medicine and was employed as an Assistant Professor of Psychiatry when the study was conducted. He is now employed by Janssen Research and Development.

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