

## ORIGINAL RESEARCH ARTICLE

## Validation and normalization of the youth risk-taking behavior assessment scale in an Iranian sample of substance abusers undergoing methadone maintenance treatment

 Sajjad Rezaei<sup>1\*</sup>, Iraj Shakerinia<sup>1</sup>, Yasaman Larijani<sup>1</sup>, and Khadijeh Rezaei<sup>2</sup>
<sup>1</sup>Department of Psychology, University of Guilan, Rasht, Iran

<sup>2</sup>Department of Psychology, Rasht Branch, Islamic Azad University, Rasht, Iran

### Abstract

Risk-taking (RT) behaviors play a key role in addiction and drug-related disorders. It is necessary to assess RT among young people, as they represent a key demographic vulnerable to drug and alcohol abuse. The aim of the present study was to validate and normalize the 18-item scale assessing youth RT behavior (RT-18) in a sample of substance abusers undergoing methadone maintenance treatment (MMT). In the present study, we employed a descriptive design and aimed to validate the RT-18 scale. The statistical population of the research included all substance-abusing (dependent) patients under MMT in Rasht, northern Iran. Using consecutive sampling, 220 patients were selected from three addiction treatment clinics and provided informed and voluntary consent to answer the RT-18 scale and the brief substance craving scale (BSCS). The test-retest reliability of the RT-18 scale was 0.74. Cronbach's alpha coefficient of RT-18, RT, and risk assessment (RA) subscales were 0.70, 0.88, and 0.55, respectively. Confirmatory factor analysis indicated that the modified two-factor structure for abusers under MMT provided a good model fit ( $\beta^2/\text{degree of freedom} = 2.74$ ; weighted root mean square residual = 0.897; Tucker-Lewis index = 0.915; comparative fit index = 0.91; root mean square error of approximation = 0.061). The total RT-18 score was significantly correlated with BSCS scores ( $r = 0.26$ ;  $p < 0.01$ ), but explained only a small proportion of variance ( $F_{[1,218]} = 6.34$ ;  $p = 0.013$ ). The results of the present study indicate that the Persian version of the RT-18 scale has acceptable reliability coefficients and may be used reliably in outpatient addiction treatment settings to assess RT behavior. However, the reliability coefficient of the RA subscale was low, and the total RT-18 score displayed limited predictive value for substance craving scores.

#### \*Corresponding author:

 Sajjad Rezaei  
 (Sajjad.Rezaei@guilan.ac.ir)

**Citation:** Rezaei S, Shakerinia I, Larijani Y, Rezaei K. Validation and normalization of the youth risk-taking behavior assessment scale in an Iranian sample of substance abusers undergoing methadone maintenance treatment. *J Clin Basic Psychosom.* 2026;4(1):89-99. doi: 10.36922/JCBP025220043

**Received:** May 27, 2025

**1st revised:** July 30, 2025

**2nd revised:** August 9, 2025

**Accepted:** August 18, 2025

**Published online:** September 4, 2025

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**Keywords:** Substance abuse; Risk-taking behavior; Validation; Normalization

### 1. Introduction

Substance addiction is a behavior affected by various factors, such as curiosity, psychological processes, and peer pressure.<sup>1</sup> The latest edition of the diagnostic and statistical manual of mental disorders, fifth edition, text revision (DSM-5-TR), identifies a significant feature of substance use disorder (SUD) as the presence of one or more

cognitive, behavioral, and physiological symptoms, which are characterized by frequent relapses, impaired control over consumption, and persistent drug-seeking behavior.<sup>2</sup> In addition to increasing the risk of physical and psychological disorders,<sup>3,4</sup> substance addiction imposes substantial harm on the affected individual, healthcare systems, and communities.<sup>5</sup> Research indicates that individuals with SUD experience deficits in cognitive functions, such as inhibitory control, impulsive behaviors, and risk-taking (RT) behavior.<sup>6,7</sup>

RT behavior involves exposing oneself to physical and psychological harm, or even death. RT not only includes engaging in risky behaviors but also refers to vulnerability and exposure to risks from the environment, peers, and incorrect or threatening personal beliefs and inclinations.<sup>8,9</sup>

Among the various treatment methods for individuals with substance addiction, methadone maintenance treatment (MMT) has received particular attention in Iran compared to other methods. MMT enables patients to refrain from using illegal substances. MMT can reduce substance use, mortality rates, and crime associated with substance use, and also improve patients' physical health and alleviate depression.<sup>10,11</sup>

In recent years, the prevalence of RT behaviors among adolescents and young adults in Iran has become a social issue, raising deep concerns at various managerial, academic, and public levels. The prevalence of substance use among young people is higher than in any other age group.<sup>12</sup> According to the 2023 report by the United Nations Office on Drugs and Crime, Iran has the highest ratio of opioid abusers to the population globally. The prevalence of SUD in Iran is approximately 5.4% of the adult population (individuals over 15 years old). This statistic indicates that Iran has one of the highest rates of substance use in the world. It is predicted that by 2030, the number of deaths and illnesses caused by tobacco use alone will reach 8 million annually.<sup>13</sup>

De Haan *et al.*<sup>14</sup> developed the young adult RT behavior-18 item (RT-18) assessment scale, which measures RT behavior as a dichotomous (yes/no) construct. This concise tool is significant due to its ability to assess RT behavior quickly with simple items. The RT-18 assessment scale consists of two subscales (RT and risk assessment [RA]), each with nine items. Higher scores on the RT subscale indicate greater involvement in RT, while higher scores on the RA subscale suggest a lower ability to perceive risks.

The RT-18 assessment scale has been applied across diverse populations and cultural contexts as a reliable tool for assessing RT tendencies. Originally validated among

Dutch university students, social drinkers, and recreational drug users, it demonstrates strong internal consistency (Cronbach's  $\alpha = 0.80\text{--}0.89$ ) and a two-factor structure distinguishing RT behavior from RA.<sup>14</sup> The scale has been cross-culturally adapted into Portuguese and Spanish, with studies in Brazil and Argentina confirming acceptable psychometric properties. In Brazil, Rasch analysis supported the construct validity of a related measure, with minimal impact of age and sex on item functioning.<sup>15</sup> In Argentina, a Spanish version reported good reliability (ordinal  $\alpha = 0.77$ ) and concurrent validity among drivers, revealing that younger and daily drivers perceive lower risk.<sup>16</sup> The RT-18 assessment scale has been used in both non-clinical and high-risk populations, exhibiting sensitivity to group differences related to substance use and behavioral patterns. Evidence supports its utility in clinical, traffic safety, and research settings, particularly for young adults.

Despite the high prevalence of substance-related and behavioral addictions among youth,<sup>17</sup> there is a lack of culturally adapted, brief, and psychometrically validated tools to assess both RT and RA in this population. Existing measures are often lengthy or fail to capture both behavioral (RT) and cognitive (RA) dimensions. The RT-18 assessment scale—with its simple yes/no format, two subscales, and brevity—fills this gap. Validating the Persian version of the RT-18 assessment scale would provide clinicians and researchers with a practical and reliable tool for evaluating risk-related behaviors in methadone-maintained patients, supporting targeted interventions and longitudinal research.

Given that RT behavior plays a decisive role in predicting SUD<sup>18</sup> and can proactively identify at-risk individuals for policymakers and addiction treatment providers, it is essential to develop and standardize related psychological tools. Therefore, this study aims to validate a young adult RT behavior assessment tool, which can be completed in the shortest time and used for psychological evaluations.

## 2. Methods

### 2.1. Study design and participant characteristics

The research method is descriptive and involved the psychometric evaluation of tools. The statistical population consisted of all substance-addicted patients undergoing MMT in Rasht, northern Iran, in 2020. Inclusion criteria were as follows: (i) age range of 18 years or older, (ii) history of substance addiction according to DSM-5 (based on a semi-structured clinical interview), (iii) undergoing MMT for at least 30 days, (iv) being in the maintenance phase of treatment (*i.e.*, having achieved a stabilized dose of methadone), and (v) no concurrent substance abuse

(based on urine tests). Exclusion criteria were the presence of withdrawal symptoms or substance abuse (indicating instability of the patient) and concurrent substance abuse (other than nicotine dependence).

## 2.2. Sampling procedure and data collection

All authorized public and private centers under the supervision of the Gilan University of Medical Sciences and Welfare Organization in Rasht were initially listed. Three centers (Mehr Addiction Treatment Clinic, “Rah-e Sabz” Addiction Treatment Clinic, and Behavioral Disorders Center [ChomarSara-Rasht]) were then randomly selected from this list. After obtaining informed consent from the patients, all individuals with records who met the criteria were interviewed by a trained psychologist (with a master’s degree in psychology) for SUDs to confirm the presence of addiction disorders and related conditions (especially opioids, according to DSM-5). Finally, participants responded to the questions while waiting in the office room under the supervision of the examiner.

This study was conducted in two phases: (i) a preliminary study and (ii) a main study. Since no validated and standardized Persian version of the RT-18 assessment scale was available, a rigorous translation and adaptation process was undertaken. First, the original English version of the RT-18 assessment scale was independently translated into Persian by two psychologists with expertise in psychometric assessments. Subsequently, the Persian version was back-translated into English by a senior expert in translation studies. The principal investigator (corresponding author) then reviewed all three translations (the original, forward-translated, and back-translated versions), resolved discrepancies, and finalized the Persian adaptation of the RT-18 assessment scale in a joint session. The translated scale was then piloted on a sample of 30 individuals with SUDs to assess clarity and cultural appropriateness. This multi-step approach—combining forward translation, expert consensus, back-translation, and pilot testing—ensured linguistic accuracy and maintained the original scale’s psychometric properties.<sup>19</sup>

The RT-18 assessment scale is a tool designed to assess risk-related behaviors in youth through two subscales: (i) RT, which reflects engagement in potentially harmful behaviors, and (ii) RA, which measures cognitive evaluation of risks. The scale primarily assesses trait-like characteristics rather than transient states, aligning with theories of impulsivity and sensation-seeking<sup>20</sup> and cognitive decision-making.<sup>21</sup> Although situational factors may introduce some state-like variability, the RT-18 assessment scale is interpreted as a measure of stable individual differences. Its dual foundation in personality

and behavioral economics<sup>22</sup> enhances its utility in studying youth risk behavior.

In the preliminary study phase, 30 substance abusers undergoing MMT were tested using the RT-18 assessment scale through a convenience sampling method. To determine the test-retest reliability, the same individuals were retested after 3 weeks. The formula for estimating trait means in the population was used to determine the sample size in the main study.<sup>23</sup> The final sample size needed for normative data was calculated by inputting the standard deviation obtained from the initial RT-18 assessment (3.09). In the sample size formula, a confidence level of 95% ( $z = 1.96$ ) and a tolerable error ( $d^2$ ) of 0.05 were considered for increased accuracy.

Due to the limited number of active treatment cases in the studied treatment centers (approximately 260 patients), a corrected sample size formula was used to calculate the mean of a trait in a finite population.<sup>24</sup> The corrected sample size based on the finite population was estimated to be 192. To account for outliers and missing values, an additional 15% dropout rate was added, bringing the corrected sample size to 220 for the treatment centers. This number was selected using a non-probabilistic consecutive sampling method.

## 2.3. Ethical considerations

Before the study commenced, the purpose of the research was explained to all patients in general terms, and their informed consent was obtained. They were assured that their personal information would remain confidential with the researcher.

## 2.4. Research tools

### 2.4.1. Risk-taking behavior assessment scale (RT-18)

This tool assesses RT behavior and was developed by de Haan *et al.*<sup>14</sup> The RT-18 scale consists of 18 dichotomous (yes/no) items. The RT-18 scale has two subscales, each with nine items: (i) RT (*e.g.*, “I sometimes like to do things that are a little frightening”), which has a Cronbach’s alpha of 0.80, and (ii) RA (*e.g.*, “Do you mostly speak before thinking things out?”), with a Cronbach’s alpha of 0.57. Higher scores on the RT subscale indicate greater engagement in RT behavior, while higher scores on the RA subscale suggest lower risk perception ability. In de Haan *et al.*’s study,<sup>14</sup> the internal consistency reliability and test-retest reliability of this tool were reported as 0.886 and 0.94, respectively. The concurrent validity of RT-18 was confirmed through high correlations with the Cambridge Gambling Task. The Persian version of this tool was initially prepared through translation and back-translation processes. It was then piloted with a sample of 30 MMT

patients to determine test-retest reliability, with the same individuals retested after 3 weeks (during a follow-up visit). The Pearson correlation coefficient for this test-retest was 0.74 (95% confidence interval:  $-6.80$ – $-4.66$ ; degree of freedom [df] = 29,  $p < 0.0001$ ). In this study, the Cronbach's alpha was 0.70 for all items of the tool. The Cronbach's alpha coefficients (equivalent to the Kuder-Richardson formula-20 [KR20] for this type of scale) were 0.88 and 0.55 for the RT and RA components, respectively.

### 2.4.2. Brief substance craving scale (BSCS)

In this study, the BSCS was used to measure craving for relapse. Relapse was defined as patients who were previously diagnosed with substance dependence, now exhibiting a craving for relapse during their MMT period. This scale is an eight-item self-report tool developed by Somoza *et al.*<sup>25</sup> that measures the duration, frequency, and intensity of substance craving on a five-point Likert scale from never (0) to very high (4). This scale was completed through an interview conducted by a trained psychologist with the MMT patient. The test demonstrated acceptable concurrent validity with strong correlations to addiction severity scales. The internal consistency reliability of the BSCS, as measured by Cronbach's alpha, was reported to be 0.88. In Iran, Basharpour *et al.*<sup>26</sup> reported its internal consistency reliability as 0.78. In this study, after removing items one and five, which inquire about dependence on a specific substance, Cronbach's alpha for the remaining six items was 0.85.

### 2.5. Data analysis

To determine the test-retest reliability in this study, Pearson correlation coefficients of RT-18 scores were calculated between different administration times, involving at least 30 patients. To this end, 30 patients who initially completed the RT-18 assessment were re-assessed with the same tool during their follow-up visit after 3 weeks. The scores from these two assessment points were then correlated. In addition, a paired Student's *t*-test was used to determine the differences between the two measurements of RT-18. Furthermore, Cronbach's alpha was used to evaluate the internal consistency reliability of the research tools. Item-total correlations for each of the subscales of RT behavior and RA were also used for construct validity analysis. For assessing the reliability of individual RT-18 items, Cronbach's alpha was computed separately after the exclusion of each item. Concurrent validity was evaluated by examining the relationship between scores on the Persian version of RT-18 and scores from established measures that were expected to have significant correlations based on prior research (BSCS).

Given that the underlying factors of the RT-18 scale were previously identified,<sup>14</sup> this study focused solely on the

confirmatory factor analysis (CFA) of the RT-18 scale using maximum likelihood estimation in Mplus 7.4 software (Muthén & Muthén, USA).<sup>27</sup> Indices, such as Chi-square ( $\chi^2$ ), ratio of Chi-square to degrees of freedom ( $\chi^2/df$ ), Root Mean Square Error of Approximation (RMSEA), goodness-of-fit index (GFI), Bentler-Bonett normed fit index, Tucker-Lewis index (TLI), and comparative fit index (CFI), were evaluated to assess the goodness of fit of the two-factor model of the RT-18.<sup>28</sup> Moreover, the convergent and divergent construct validity of the RT-18 was assessed using the Fornell and Larcker approach,<sup>29</sup> which involved evaluating the average variance extracted (AVE), maximum shared squared variance (MSV), and average shared squared variance (ASV). To establish convergent validity, AVE values should be  $>0.5$ , and composite reliability (CR)  $>0.7$  and  $CR > AVE$ . For divergent validity, MSV and ASV should be less than AVE.<sup>30</sup> Finally, using raw scores, means, and standard deviations for the total score and subscales of RT-18, a test norm table was prepared, including percentile ranks and standardized scores (*z* and *T* scores). All analyses were performed using the Statistical Package for the Social Sciences-24 (IBM Corporation, USA).

### 3. Results

The data were obtained from 248 patients, but due to defects in completing some questionnaires, the data of only 220 patients were prepared for psychometric analysis. This study presented descriptive statistics (mean and standard deviation) related to RT behavior and substance craving. The substance-craving variable had a mean of 2.77 and a standard deviation of 3.50. The RT behavior variable had a mean of 3.40 and a standard deviation of 8.39. Regarding the duration of substance use, 56.5% had used substances for  $<10$  years, 30.6% between 10 and 20 years, 10.1% for between 20 and 30 years, and 2.8% for more than 30 years. Approximately 51.6% of respondents reported a history of substance withdrawal, and among the 128 individuals with a history of withdrawal, 71.1% had only one past instance of substance withdrawal. Table 1 reports other demographic characteristics of the respondents.

Table 2 displays the results of descriptive statistics, item-total correlations, and reliability analysis for the RT-18. As displayed in this table, all item-total correlation values, except for items 1, 3, 11, and 12, were moderate to strong ( $p < 0.0001$ ), indicating the internal consistency of the RT-18. Cronbach's alpha coefficients, after item removal, ranged from 0.65 to 0.76. One reason the corrected item-total correlations are weak for items 1, 3, 11, and 12 is that their correlations were calculated with the total RT-18 score, while these items belong to the "risk assessment" subscale. Therefore, these items were not removed from the Persian version of the RT-18.

**Table 1. Demographic characteristics of substance-addicted patients undergoing methadone maintenance treatment (MMT) (n=248)**

Characteristics	n	%
Gender		
Female	22	8.9
Male	226	91.1
Age (years)		
≤30	55	22.2
31–40	135	45.2
41–50	56	22.6
Education level (years)		
<5	64	25.8
5–10	84	33.9
>10	100	40.3
Marital status		
Single	44	17.7
Married	185	74.6
Divorced	14	5.6
Widowed	5	2

**Table 2. Mean, standard deviation, and item-total correlation results and reliability analysis for young adult risk-taking behavior-18 items (n=220)**

Item	Mean	Standard deviation	Corrected item-total correlation	Cronbach's alpha if item deleted
r1	0.7696	0.42207	0.216	0.689
r2	0.6728	0.47027	-0.402	0.747
r3	0.3318	0.47195	0.276	0.683
r4	0.4009	0.49122	0.692	0.636
r5	0.3963	0.49026	0.590	0.648
r6	0.4562	0.49923	0.588	0.648
r7	0.3917	0.48926	0.639	0.642
r8	0.2627	0.44110	0.319	0.679
r9	0.5023	0.50115	-0.521	0.762
r10	0.6682	0.47195	-0.563	0.761
r11	0.4240	0.49533	0.060	0.706
r12	0.3502	0.47814	0.184	0.693
r13	0.3410	0.47515	0.429	0.667
r14	0.3871	0.48821	0.746	0.630
r15	0.6221	0.48598	0.515	0.657
r16	0.5300	0.50026	0.531	0.654
r17	0.3548	0.47957	0.630	0.644
r18	0.4747	0.50051	0.447	0.664

Table 3 presents the Pearson correlation coefficients between RT behavior and substance craving. The correlation matrix indicates a positive and significant relationship between substance craving and RT behavior ( $p < 0.01$ ). As expected, the correlation coefficients between RT behavior scores and craving for relapse on BSCS were significant at the 0.01 level, thereby confirming the construct validity of the RT-18 scale. In addition, the positive correlations displayed in Table 3 suggest that higher overall RT behavior scores are associated with greater substance craving in MMT patients ( $p < 0.01$ ), confirming the concurrent validity of the RT-18 scale.

Table 4 assesses construct validity using CFA ( $n = 220$ ). In the modified first-order CFA, the Chi-square GFI was  $\chi^2 = 324.059$  ( $p < 0.001$ ). Other fit indices were evaluated to assess model fit: RMSEA = 0.061; TLI = 0.915; weighted root mean square residual = 0.897; and CFI = 0.956; all confirming a good fit of the final model (Table 4 and Figure 1). The correlation coefficient between the two factors in Mplus 7.4 was 0.243, indicating that the overlap between the two factors was 5.9%; hence, they can be considered distinct factors.<sup>27</sup>

The results of the first-order CFA (Table 5) indicate that the AVE and CR values for both factors were  $> 0.5$  and  $0.7$ , respectively; AVE values for each factor were greater than

**Table 3. Pearson correlation matrix between risk-taking behavior and substance craving (n=220)**

Variables	I	II	III	IV
I	1			
II	0.17*	1		
III	0.04	0.24**	1	
IV	0.26**	0.94**	0.40**	1

Notes: I refers to “substance craving;” II refers to “risk-taking (RT, first subscale of the test);” III refers to “risk assessment (RA, second subscale of the test);” and IV refers to “risk-taking behavior” (total score). \* $p < 0.05$ , \*\* $p < 0.01$ .

**Table 4. Fit indices in confirmatory factor analysis of young adult risk-taking behavior-18 items (n=220)**

Model	$\chi^2$	df	p	CMIN/df	RMSEA	TLI	WRMR	CFI
Primary	384.858	134	<0.001	2.872	0.068	0.904	0.901	0.938
Secondary	324.059	131	<0.001	2.473	0.061	0.915	0.897	0.956

Note: Fit indices: CFI, TLI ( $> 0.9$ ); RMSEA ( $< 0.08$ ); WRMR ( $< 1$ ); CMIN/DF ( $< 3$  good;  $< 5$  acceptable).

Abbreviations: CFI: Comparative fit index; CMIN/DF: Chi-square/degree-of-freedom ratio; RMSEA: Root mean square error of approximation; TLI: Tucker Lewis index; WRMR: Weighted root mean square residual.

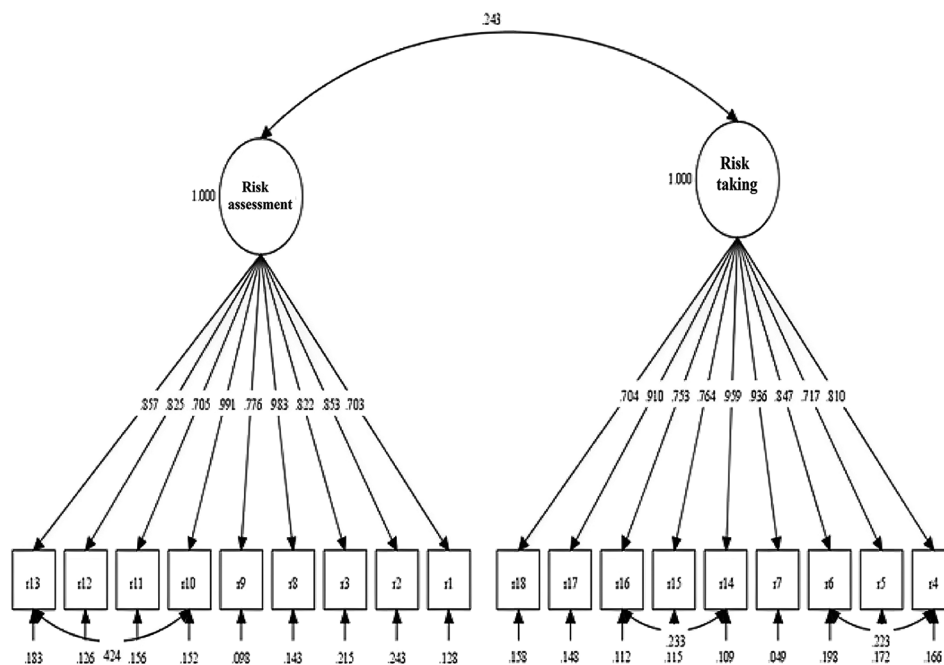


Figure 1. Risk-taking behavior-18 item structure: Modified model from first-order confirmatory factor analysis

Table 5. Convergent and divergent validity indices for the young adult RT behavior-18 items scale (n=220)

Factor	CR	ASV	MSV	AVE	Correlation	Shared variance (%)
RT	0.951	0.374	0.059	0.689	0.243	5.9
Risk assessment	0.955	0.322	0.059	0.706		

Abbreviations: ASV: Average shared squared variance; AVE: Average variance extracted; CR: Composite reliability; MSV: Maximum shared squared variance; RT: Risk-taking behavior scale.

CR; and the AVE values for each factor were greater than both ASV and MSV. Therefore, the results indicate that the RT-18 construct has adequate convergent and divergent validity.

Although items 1, 3, 11, and 12 had weak corrected item-total correlations with the total RT-18 score (Table 2), these items demonstrated strong factor loadings (0.703, 0.822, 0.705, and 0.825, respectively) according to Figure 1 in relation to their associated latent variable (i.e., RA) in the first-order CFA. These results support the decision to retain these items in the Persian version of RT-18.

A bivariate regression analysis was conducted to assess predictive criterion validity and determine how much of the variance in craving for relapse (as the criterion variable) could be explained by the total score of RT-18 (as the predictor variable) (n = 220). The results indicated that RT behavior (total RT-18 score) significantly

explained only 3% ( $R^2 = 0.028$ ) of the variance in craving for relapse scores ( $F_{(1,218)} = 6.34$ ;  $p=0.013$ ). Considering the standardized regression coefficients ( $\beta$ ), it can be inferred that individuals with higher RT behavior report greater craving for relapse ( $\beta = 0.17$ ;  $p=0.013$ ). Thereafter, a norm table was prepared based on converting raw scores to standardized scores (z and T scores) and calculating percentile ranks (Table 6). According to the results in Table 6 and the raw scores of each participant, it is possible to determine what percentage of individuals have higher RT behavior compared to the participants. For example, a standardized z-score of 0.479 for a person scoring 10 on RT-18 indicates that their level of RT is higher than 67% of substance users.

#### 4. Discussion

The present study aimed to validate, assess the reliability, and establish norms for the RT-18 scale for Iranian youth in a sample of substance users undergoing MMT. The findings from Pearson correlation coefficients indicated that all items, except for items 1, 3, 11, and 12, were moderately to strongly related to the total test score. This result reflects the internal consistency of the RT-18 scale.

In this study, Cronbach's alpha for the Persian version of RT-18 was found to be 0.70. The Cronbach's alpha coefficients for the components of RT behavior and RA were 0.88 and 0.55, respectively. These findings are consistent with the overall RT-18 score in the study by de Haan *et al.*,<sup>14</sup>

**Table 6. Conversion of raw RT scores and subscales (RTB and RA) to standardized scores for percentile ranks of the entire sample (n=220)**

Normative data of RT total score				Normative data of the RTB subscale				Normative data of the RA subscale			
PR	RS	z	T	PR	RS	z	T	PR	RS	z	T
<5	3	-1.54	34	<16	0	-1.25	37	<1	1	-2.88	21
13	4	-1.25	37	31	1	-0.942	40	5	2	-2.02	29
30	5	-0.965	40	44	2	-0.628	43	25	3	-1.15	38
39	6	-0.676	43	54	3	-0.314	46	54	4	-0.294	47
45	7	-0.387	46	57	4	0	50	84	5	0.569	55
56	8	-0.098	49	63	5	0.314	53	99	6	1.433	64
64	9	0.19	51	70	6	0.628	56	>99	7	2.297	72
67	10	0.479	54	80	7	0.942	59	-	-	-	-
77	11	0.768	57	89	8	1.256	62	-	-	-	-
86	12	1.05	60	>99	9	1.517	65	-	-	-	-
90	13	1.346	63	-	-	-	-	-	-	-	-
98	14	1.635	66	-	-	-	-	-	-	-	-
>99	15	1.923	69	-	-	-	-	-	-	-	-

Abbreviations: PR: Percentile ranks; RA: Risk assessment subscale; RS: Raw scores; RT: Risk-taking behavior scale (total); RTB: Risk-taking behavior subscale.

where Cronbach's alpha for RT-18 in a student population and a general population of Dutch youth were reported as 0.886 and 0.80, respectively. These results indicate that the reliability of the RT behavior component and the unified form of the RT-18 tool is at least at an acceptable level,<sup>31</sup> and each measures a similar concept and structure. However, internal consistency was weak for the RA component. Consistent with the present study, Stamates and Lau-Barraco<sup>32</sup> found that only the RT subscale could predict alcohol use, while RA was not associated with any alcohol use outcome. This finding likely reflects the inverse and cautious nature of the RA questions, which explore the positive aspect of RT behavior and may not be well-aligned with the RT component.

Cross-culturally, RT is consistently higher in men and drug users, as seen in both Dutch and Iranian samples. However, in the Iranian MMT sample, RA demonstrated poor reliability and weak association with craving, suggesting a cultural or clinical divergence where risk behavior may be more habitual and less cognitively regulated compared to the general Dutch youth population.

In addition, in a pilot study involving 30 individuals undergoing MMT, the test-retest reliability coefficient after 3 weeks was 0.74. In the main study by de Haan *et al.*,<sup>14</sup> the test-retest reliability with a 2–4 week interval was reported as 0.94. Although test-retest reliabilities in both the Iranian and Dutch studies are considerable, the primary differences in these coefficients are likely understandable due to the differences between the Iranian substance user sample and the Dutch students.

The CFA results indicated that the best-fitting model for MMT patients included two modified factors: RT and RA. This is consistent with de Haan *et al.*'s<sup>14</sup> study, which also emphasized the two-factor structure of the tool through CFA. CFA indicated that freeing the covariance terms between the errors of items 13 and 10 in the RA component, as well as between the errors of items 16 and 14 and items 6 and 4 in the RT component, would confirm the fit of this two-factor model in the Iranian substance user population. This contrasts with the study by Stamates and Lau-Barraco,<sup>32</sup> where RA was not associated with alcohol use, and only the RT factor predicted alcohol use and its consequences.

Regarding concurrent and predictive criterion validity, the findings of this study revealed that the total RT-18 scores have a weak relationship with the substance craving scale ( $r = 0.26$ ;  $p < 0.01$ ) but explain a significantly small amount of its variance (only 3%;  $F = 6.34$ ;  $p = 0.013$ ). Previous studies, including de Haan *et al.*'s,<sup>14</sup> also indicated a significant correlation between RT-18 scores and scores on the Cambridge Gambling Task, with recreational substance users scoring significantly higher on RT-18 compared to those consuming alcohol. In addition, Soni *et al.*<sup>12</sup> found a significant correlation between RT-18 scores and impulsive behaviors. These results partially align with the present study and marginally support the concurrent and predictive validity of the RT-18 tool.

These findings can be interpreted from two perspectives. First, the RT-18 scale is relatively reliably

correlated with external criteria that have previously been validated in the Iranian population. Second, it suggests that interventions aimed at reducing RT behavior, improving behavioral control, and enhancing precautionary behaviors could play a significant role in reducing substance cravings. This study found that only a negligible proportion of variance in relapse propensity was explained by RT-18 total scores. One explanation for this finding relates to the multidimensional and complex nature of substance craving.<sup>33</sup> In other words, RT behavior represents just one psychological dimension of craving and cannot alone account for its extensive variability. Even if RT behavior correlates with craving, this association may be mediated or moderated by other factors, such as dopaminergic activity, stress levels, or drug availability,<sup>34</sup> thereby diminishing its independent predictive power. Furthermore, prior research indicates that some individuals with high RT propensity may experience reduced craving due to stronger self-control or better social support.<sup>35</sup> Such individual differences further attenuate the explanatory contribution of RT behavior. Biological factors also play a significant role; for instance, dysregulation of the dopaminergic system and reduced D2 receptor density in addicted individuals are known to intensify craving.<sup>36</sup>

These findings suggest an important hypothesis for future investigation: incorporating a battery of biological, psychological, and social measures could yield a more accurate prediction of substance craving. An alternative interpretation of the minimal variance explained relates to our study's sample characteristics. Participants were all undergoing MMT, meaning they had consistent access to pharmacological craving suppressants. This likely constrained the observable variance in relapse propensity that could be attributed to RT-18 scores.

RT and RA represent distinct yet interrelated constructs in behavioral decision-making. RT reflects a propensity toward engaging in potentially harmful behaviors, often associated with impulsivity and reward sensitivity.<sup>20</sup> In contrast, RA involves the cognitive appraisal of potential risks and benefits, relying on intact executive functions and prefrontal regulation.<sup>21</sup> Although these dimensions typically show moderate intercorrelation in the general population, the present study found a notably weak correlation ( $r = 0.24$ ) among individuals undergoing MMT, suggesting a functional dissociation in this clinical group. This attenuated relationship may stem from several interrelated factors. Chronic opioid use is associated with structural and functional impairments in prefrontal brain regions critical for risk evaluation,<sup>37</sup> potentially decoupling behavioral choices from rational deliberation. In addition, prolonged substance use may lead to desensitization

to negative consequences, weakening the influence of cognitive risk appraisal on behavior.<sup>38</sup> While methadone stabilizes cravings, it may not fully reverse underlying decision-making deficits, allowing impulsive or habitual RT to persist despite partial cognitive recovery. Furthermore, in the context of addiction, behaviors such as drug use may be motivated more by immediate relief from withdrawal than by a deliberate cost-benefit analysis.

Furthermore, percentile norms for the total scores and each subcomponent of RT-18 have been prepared and made available in a norm table. The key feature of norm tables is that they allow experts and counselors to compare an individual's scores with a reference group—considered representative of the population—using percentile ranks. However, it should be noted that the sample of this study was predominantly young and consisted of substance users undergoing MMT, thus limiting the generalizability of the results to other populations. The introduced tool for assessing RT behavior, aimed at evaluating the potential and likelihood of risky behaviors among substance users as a trait, may not be suitable. This is because the intensity of risky behaviors is a function of various factors, such as duration of abstinence, dosage of addiction treatment medications, being under treatment, or the lack of psychological interventions, among others. In addition, using this tool and its norms to assess RT in situations where the substance user has not yet committed to their treatment is not recommended.

The present study had several limitations. The findings are limited to individuals over 18 years old who were undergoing MMT. In addition, the samples were consecutively selected from treatment units, indicating a non-random sampling method. Based on these limitations, future research should consider developing this tool or other appropriate tools for adolescent populations who are at risk for RT behaviors, especially regarding substance use and unprotected sexual relationships. Future studies are also recommended to compare substance users with normative groups and to determine the cutoff points of this tool for screening at-risk individuals. It is also recommended that, due to potential cultural and linguistic effects on the structure of RT-18, future studies employ exploratory factor analysis to re-examine the underlying factors of RT-18 in the Iranian population. Furthermore, the observed negative or low item-total correlations for several items in the RA subscale suggest potential issues with the internal structure of the scale, which should be further examined in future studies. To enhance convergent validity and improve the accurate prediction of substance craving, it is recommended to employ multifactorial models that incorporate a combination of biological, psychological, and social variables. For instance, behavioral tasks

(e.g., delay discounting, go/no-go paradigms) or biological indicators could be utilized to triangulate risk-related constructs beyond self-report measures. In addition, age, gender, cultural background, education level, and even distinct substance use patterns may significantly influence RT behavior scores. Therefore, we recommend that future research employ subgroup analyses to examine the role of these factors. Where appropriate, separate norm tables should be developed for different subgroups to enhance measurement precision. To minimize the effects of memory and response recall for a more accurate assessment of test-retest reliability, it is recommended to increase the time interval for administering the RT-18 scale.

## 5. Conclusion

The Persian version of the RT-18 scale demonstrated acceptable reliability and construct validity for assessing RT behavior in Iranian patients undergoing MMT, with the two-factor model exhibiting adequate fit when covariance terms were released. The RT-18 scale yielded consistent results and may be useful in outpatient addiction settings for evaluating RT tendencies. However, the RA subscale presented low internal consistency, and the total RT-18 score accounted for only a small proportion of variance in substance craving, indicating limited predictive utility. These findings suggest that while the RT-18 scale is a practical tool for measuring RT in this population, caution is warranted in interpreting the RA dimension and its clinical implications.

## Acknowledgments

The authors would like to thank all members of the addiction treatment centers (“Mehr Addiction Treatment Clinic”, “Rah-e Sabz Addiction Treatment Clinic”, and “Behavioral Disorders Center” [ChomarSara-Rasht]) for their assistance in this study.

## Funding

None.

## Conflict of interest

The authors declare that they have no competing interests.

## Author contributions

*Conceptualization:* Sajjad Rezaei, Iraj Shakerinia

*Formal analysis:* Sajjad Rezaei

*Investigation:* Sajjad Rezaei, Yasaman Larijani

*Methodology:* Sajjad Rezaei

*Writing—original draft:* Yasaman Larijani, Khadijeh Rezaei

*Writing—review & editing:* Iraj Shakerinia, Yasaman Larijani, Khadijeh Rezaei

## Ethics approval and consent to participate

All study procedures were in compliance with the ethical guidelines of the Declaration of Helsinki (2013). All participants provided informed consent, confirming their satisfaction with participating in this research.

## Consent for publication

The participants gave informed consent to publish their data in this study.

## Availability of data

The data that support the findings of this study are available on request from the corresponding author.

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