RESEARCH ARTICLE

Treatment self-regulation questionnaire across three self-care behaviours: An instrument validation study in Iranian patients with type 2 diabetes mellitus

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Abstract

Aim: The study aimed at testing the validity and reliability of the Persian version of the treatment self-regulation questionnaire (TSRQ-15) across healthy diet, exercise and medication-use/glucose-monitoring among Iranian people with type-2 diabetes.

Design: Cross-sectional design.

Methods: Content validity was investigated by 16 experts. Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were employed. Construct validity, convergent/discriminant validity and internal consistency were examined. Concurrent validity was assessed using Spearman's rho correlation across different behaviours.

Results: Content validity was confirmed for Persian TSRQ-15. A three-factor structure was revealed, in which external regulation and introjected regulations were validated, while amotivation and autonomous failed to show discriminant validity. Internal consistency was sound, and concurrent validity was approved. The Persian version of TSRQ-15 was shown to be a valid and reliable tool for assessing motivation behind the practice of healthy diet, exercise and medication-use/glucose-monitoring in people with type 2 diabetes.

1 | BACKGROUND

As a chronic disease, diabetes might be detected in different age groups and in various communities. Type 2 diabetes mellitus (T2DM) is the most common type that is associated with dysfunction in pancreatic β-cells resulting in an imbalanced insulin secretion, or even leading to insulin resistance due to the impaired β-cell response to insulin (Hazrati-Meimaneh et al., 2020). Owing to upsurge in T2DM, the global prevalence of diabetes in 2017 was about 476 million people (Lin et al., 2020). A recent global publication has estimated an increase in T2DM prevalence by 25% and 51% in 2030 and 2045, respectively (Saeedi et al., 2019). The prevalence of diabetes in Iran was reported to be 8.94% in 2017, and it is projected to reach 13.64% by 2045 (Cho et al., 2018). In Iran, more than 1% of the urban inhabitants whose age is >20 years old are annually diagnosed with T2DM (Ramezan et al., 2019), and this is thought to be mostly associated with the unhealthy diet and sedentary lifestyle (Ketema et al., 2020).

Due to its deleterious impact on the peoples' physical function (Eid et al., 2019; Gan et al., 2020; Vijan, 2019), the treatment of diabetes and prevention of its complications are of particular importance. A latest evidence suggests the necessity for changing the existing therapeutic guidelines (Vijan, 2019). In other words, the proper management of T2DM requires engaging people in designing the treatment plan through self-care behaviours (Mogre et al., 2019). T2DM self-care includes several key activities; healthy diet, regular exercise, self-monitoring of blood sugar, adherence to medication, care of diabetic foot and smoking cessation. These activities are associated with constant control of blood sugar, minimization of complications, in addition to improving quality of life (Xu et al., 2019). Healthy diet, regular exercise and medication/glucose-monitoring are the three self-care behaviours that act as the triangle of the peoples' self-management (Hemmingsen et al., 2017; Wylie et al., 2022). Thus, investigation of such behaviours is crucial in providing people with the appropriate support in practicing self-management.

In this respect, motivation of people towards self-care seems to be of substantial (Kang et al., 2021). Accordingly, motivation programmes can support self-management of diabetes through empowering the people to set and track their goals and competencies (Karlsen et al., 2018; Pelletier et al., 2021). Self-determination theory (SDT) is a broad framework aims at understanding the factors that stimulate or inhibit intrinsic, extrinsic motivation and psychological health (Ryan & Deci, 2020). SDT mainly focuses on intrinsic and extrinsic motivation, and how to address the three basic needs of humans including; the need for autonomy, the need for competence and the need for communication (Ryan & Deci, 2017). Emphasis on motivation encompasses different levels on a continuum: (1) autonomous regulation, that is engaging in a behaviour due to internal motivation (i.e., its with intrinsic goals), (2) external regulation, that

is doing work due to external pressures or encouragements, and (3) amotivation that is a lack of motivation (Ryan & Deci, 2000, 2017). As such, intrinsic motivation is associated with improved well-being and sustained behaviour change (Flannery, 2017), while in external regulation, '*I have to*' prevails '*I want*' and this results in the persistence of self-regulatory effort due to an external source of motivation or possible external rewards (Lakerveld et al., 2020). Therefore, as SDT postulates, self-regulation is the degree to which a person engages in an activity based on his/her will, without external or internal coercion. The highest level of self-regulation involves actions that are freely chosen and considered interesting and worthwhile, whereas, the least level of self-regulation is related to those activities that are carried out under external or internal pressure (Ryan & Deci, 2000, 2017, 2020).

The basis of the Behavior Regulation Framework has been proposed by Deci and Ryan, who have introduced several tools for regulating health behaviours in various fields, including exercise and self-regulation treatment questionnaire for health care (Center for Self-Determination Theory [CSDT], 2022; Deci & Ryan, 1985). One of these tools in healthcare context is the treatment self-regulation questionnaire (TSRQ), which is designed to assess different forms of SDT motivation for a variety of health behaviours. As the most common tool for assessing self-regulation modalities among people based on SDT (Griauzde et al., 2019; Juul et al., 2018), the TSRQ tool has been translated and psychometrically examined in various studies, embracing four American universities on smoking behaviours, exercise and diet (Levesque et al., 2007), the Portuguese version for assessing physical activity (Marques et al., 2012) and the Spanish–English version on people with human papillomavirus (Denman et al., 2016). In Iran, psychometric evaluation has not previously been carried out on this questionnaire.

As such, the aim of this study was to evaluate the reliability and validity of TSRQ on three health-related behaviours, including healthy diet, physical activity (i.e. exercise) and medication/glucose-monitoring, among Iranian T2DM people.

2 | METHODS

2.1 | Design

This cross-sectional study was carried out between May and September 2019.

2.2 | Method

Five hundred and three T2DM people were recruited from multiple diabetes centres located in Tehran and Qom cities in Iran. The study

protocol was approved by the institutional research board. The people whose age was more than 20 years, and have been diagnosed with T2DM before at least 6 months were included. On the other hand, we excluded those with a history of any major psychiatric disorders or significant comorbidities, such as cancer, those who lost of a first-degree family member in the last 6 months, people who underwent a general surgery or anaesthesia in the spinal cord in the past month, those who were unable to give independent informed consent and those who could not appropriately communicate in Persian language.

2.3 | Analysis

Descriptive statistics, including mean, standard deviation, frequency and percentage were applied. Floor and ceiling effect were determined if the responses exceeded 15% of the participants for the lowest and the highest possible answers, respectively. To test construct validity, factor structure, convergent/divergent validity and concurrent validity were employed. First, the exploratory factor analysis (EFA) was performed using SPSS software version 24 on a subsample of 250 participants (sample 1) selected randomly. The principal axis factoring method of extraction with Promax rotation was used. In addition, the pairwise exclusion was set as there was a handful missing values (18 variables in total), and the conventional rule of eigenvalue-greater-than-1 was used for determining the eligible factors. The theoretical framework of TSRQ assuming a four-factor structure was then tested using confirmatory factor analysis with the maximum likelihood estimator using robust standard errors (MLR) on the total and remaining sample (sample 2: $N = 253$) (Li, 2016). The factor analysis was performed using Mplus software version 7.4 (Muthen & Muthen, 1998–2012). The model fit was evaluated based on the Chi-square test ($p > .05$), the root mean square error of approximation (RMSEA <0.05 as excellent, and <0.08 as acceptable), the probability of close fit (PCLOSE <0.05 as accepted), the comparative fit index (CFI >0.95 as excellent and >0.90 as acceptable), the Tucker-Lewis index (TLI >0.95 as excellent and >0.90 as acceptable) and standardized root mean squared residuals (SRMR <0.05 as excellent and <0.08 as acceptable) (Gunzler & Morris, 2015). Missing values were managed via full information maximum likelihood approach. To examine the convergent/discriminant validity of the four latent constructs, the indexes of omega coefficient (ω) and average extracted variance (AVE) were employed. In terms of convergent validity, the former determined the internal consistency reliability of the latent constructs (>0.70) (Padilla & Divers, 2016), and the latter indicated the unique variance explained by the construct's indicators, with a conservative lower bound of 0.50 (i.e. 50% of the variance of the construct is explained) (Hair et al., 2010). Regarding discriminant validity, AVE of each construct should exceed any paired squared correlation (i.e. standardized estimation) among all the co-variated latent constructs in each model (Fornell & Larcker, 1981; Hair et al., 2010).

TABLE 1 Demographic and clinical characteristics of the study sample ($N = 503$)

Characteristics		
Age M (SD), Min-Max years	57.51 (10.75), 21–95	
Time since diagnosis M (SD) years	10.27 (8.13)	
Body mass index	28.67 (4.73)	
	N	**%**
Study setting		
Tehran	353	70.2
Qom	150	29.8
Gender		
Female	372	74.0
Male	131	26.0
Geographical location		
Urban	485	96.6
Rural	17	3.4
Marital status		
Married	405	80.5
Unmarried	98	19.5
Educational level		
<12 years	334	66.4
≥12 years	169	33.6
Job status		
Unemployed	330	66.3
Employed	168	33.7
Income level		
Below 370 USD	220	43.7
370 USD–720 USD	223	44.3
720 USD–1,000 USD	43	8.5
Above 1,000 USD	17	3.4
Insurance coverage		
Yes	480	95.4
No	23	4.6
Medication type		
Injection users	147	29.6
Non-injection users	350	70.4
Diabetes complications (Yes)		
Feet problems	53	10.5
Retinopathy	123	24.5
High blood pressure	164	32.6
Heart problems	89	17.7
Weight gain	64	12.7
Fatigue	113	22.5
High cholesterol	213	42.3
Kidney/bladder problems	40	8.0
Amputation	5	1.0
Oral problems	22	4.4

Note: Percentages are reported as valid. Missing data for geographical location ($N = 1$), job status ($N = 5$), and medication ($N = 4$).

Abbreviations: M, mean; Max, maximum; Min, minimum; *SD*, standard deviation.

Eventually, the Spearman's rank order correlation was used to assess the concurrent validity of the constructs in aggregated scoring across the target behaviours.

2.4 | Ethics

The ethical considerations followed version 2013 of the Declaration of Helsinki: ethical principles for medical research involving human subjects. The approval has been granted by the Ethics Committee of Qom University of Medical Sciences (ID: IR.MUQ.REC.1397.041). Informed consent was obtained from all participants, and all methods were conducted in accordance with relevant guidelines and regulations. Voluntary participation and withdrawal at any stage were assured for all people, in addition, confidentiality was ensured using anonymous data collection procedure. Official permission was also obtained from the developers of TSRQ-15 for the purpose of translation and utilization.

2.5 | Instruments

The demographic and clinical information related to the respondents were collected via a checklist, including: gender, age, educational level, marital status, geographical location and income, and the self-reported clinical information, including: time since diagnosis of diabetes, body mass index (BMI), hospitalization history, type of medication and diabetes complications.

The TSRQ was developed based on SDT by Levesque et al. (2007). The TSRQ introduces a general approach to assessing self-regulation. The original study for validation has resulted in a four-factor structure in six different datasets, encompassing autonomous motivation, introjected regulation, external regulation and amotivation (Levesque et al., 2007). The items were rated on a 7-point Likert scale from: (1 = strongly disagree) to (7 = strongly agree) (Levesque et al., 2007). Furthermore, the self-regulation types showed an acceptable internal consistency in different samples, as follows: (0.85–0.93) for autonomous motivation, (0.74–0.86) for introjected regulation, (0.73–0.91) for external regulation and from 0.73–0.79 for amotivation, except for one item in amotivation which was 0.41. Afterwards, the four-factor model was confirmed via CFA models (Levesque et al., 2007). The original scale includes an extra item within amotivation related to 'stop tobacco use', and this item has been eliminated for the three target behaviours of healthy diet, exercise and medication-use/glucose-monitoring in the current scale. The concurrent validity of the original scale was also confirmed via depression, perceived competence, dietary intake and physical activity (Levesque et al., 2007).

2.6 | Translation

Forward–backward method for translation of health questionnaires was adopted, focusing on both conceptual and semantic equivalence of the items (Sartorius & Kuyken, 1994). Two experienced translators who were not previously familiar with the scale have independently translated it into Persian. Next, one of the professional authors have critically evaluated the two initial Persian drafts and then come up with a unified draft for the Persian scale, which was then discussed with the study supervisor for proofreading and better wording. No specific challenges were detected in terms of conceptual and semantic equivalence of the items. Further, as TSRQ addresses diabetes-related health behaviours that are dealt with in various specialties, a panel of 16 experts in health education and promotion, health psychology, and clinical experts, were invited to assess the simplicity, clarity and relevance of the initial translated items for all target behaviours. The critical content validity ratio (CVR) with a lower bound of 0.75 was set to confirm the soundness of each translated item (i.e. item-level CVR) (Ayre & Scally, 2013). In the initial round, the expert panel approved the items # 3, 4, 9, 11, 12, 13 and 14, while the remained items were in need for further improvement in either simplicity or clarity, and the three items # 6, 8 and 15 were considered for amelioration in both. The expert mainly required the use of more clear language for the items to be easily comprehensible by relatively older T2DM people. These items were then extensively discussed by the first three authors, and the translations were revised to ensure both the content domain (i.e. essential wording) and the comprehensible statement. The second revision of the Persian translation was then evaluated by the expert panel, who approved the final draft with an average CVR of 0.92 in scale-level in the second round (Zamanzadeh et al., 2015). This final Persian version was, afterwards, presented to 10 different T2DM people, who unanimously confirmed the readability and comprehensibility of the items. This procedure yielded the Persian TSRQ (P-TSRQ) for healthy diet, exercise and medication-use/glucose-monitoring and assured its face and content validity.

3 | RESULTS

3.1 | Sample characteristics

In this study, the majority of the sample were female people (N = 372, 74%). The mean (standard deviation) age of the sample was 57.51 ± 10.75 in the range of (21–95) year old. The average time since diagnosis was 10.27 (8.13) years, and only 147 (29.6%) participants were on insulin injection. People with high cholesterol (N = 213, 42.3%), high blood pressure (N = 164, 32.6%) and retinopathy (N = 123, 24.5%) were those experienced the most common diabetes complications. Table 1 shows the details of demographic and clinical information of the study participants.

3.2 | Floor/ceiling effect

As illustrated in Table 2, there was either floor effect or ceiling effect or both in all items. Notably, ceiling effect was stronger for autonomous motivation items and external self-regulation, while floor effect was remarkable for amotivation and introjected self-regulation.

TABLE 2 Exploratory factor analysis with principal axis factoring and promax rotation method (N = 250)

Items	Healthy diet						Exercise		
	FE%	CE%	Autonomous	External	Introjected	Com	FE%	CE%	Autonomous
TSRQ1	2.8	**76.3**	0.776			0.592	**15.1**	**58.2**	0.886
TSRQ2	**16.1**	**65.4**			0.754	0.523	**28.4**	**41.7**	
TSRQ3	2.6	**82.9**	0.723			0.637	8.5	**66.4**	0.836
TSRQ4	**61.6**	**20.9**		0.533		0.284	**67.9**	14.7	
TSRQ5	**80.7**	5.8	−0.601			0.351	**69.4**	8.9	−0.658
TSRQ6	3.6	**78.5**	0.893			0.807	10.7	**59.2**	0.844
TSRQ7	8.5	**75.0**			0.764	0.686	**18.4**	**53.5**	
TSRQ8	2.8	**78.5**	0.825			0.806	11.5	**57.9**	0.811
TSRQ9	**79.5**	7.8		0.567		0.323	**84.7**	5.4	
TSRQ10	**84.7**	6.0				0.096	**85.5**	5.2	
TSRQ11	4.0	**75.6**	0.943			0.806	11.6	**60.9**	0.942
TSRQ12	**81.7**	8.2		0.712		0.507	**83.3**	6.8	
TSRQ13	4.0	**80.7**	0.851			0.649	10.4	**65.7**	0.867
TSRQ14	**78.5**	7.0		0.662		0.442	**79.7**	5.4	
TSRQ15	**87.5**	5.8	−0.675			0.442	**77.9**	7.4	−0.649
EV			5.92	2.29	1.13	53.25			6.53

Note: The bolded FEs and CEs indicate the presence of floor/ceiling effect (>15%). All factor loadings are significant in $p < .001$.

Abbreviations: CE, ceiling effect; Com, communality; EV, Eigenvalue; FE, floor effect; TSRQ, treatment self-regulation questionnaire.

3.3 | Exploratory factor analysis

Exploratory factor analysis on sample 1 (N = 200) indicated the required level of KMO for healthy diet (0.895), exercise (0.895) and medication-use/glucose-monitoring (0.862), and significant Bartlett's Test of Sphericity for each scale ($p < .001$). For each scale, the first EFA recommended a four-factor structure in which the autonomous motivation and amotivation formed a unified factor, whilst the third and fourth factor included the items of external regulation. To investigate their convergence, the second EFA forced to derive three factors resulted in three conceptually solid factors, embracing autonomous motivation +amotivation, external regulation and introjected regulation. All factor loadings were eligible (i.e. >0.40) in all self-regulation types for all scales, except for item #10 in healthy diet with the communality of 0.096 (<10% contribution to the total variance). However, the eigenvalue of the external regulation in exercise scale was below 1 (the conventional criterion). Table 2 presents the details of the EFA for each scale.

3.4 | Confirmatory factor analysis

In sample 2 (N = 303), the original four-factor structure indicated sound model fit for healthy diet (Chi-square [71] = 109.779, $p = .002$, scaling correction factor = 1.5836, RMSEA = 0.046 [0.028, 0.063], PCLOS = 0.618, CFI = 0.949, TLI = 0.935, SRMR = 0.048), exercise Chi-square [71] = 110.452, $p = .002$, scaling correction factor = 1.3394, RMSEA = 0.047[0.029, 0.063], PCLOS = 0.603, CFI = 0.970,

TLI = 0.961, SRMR = 0.053) and medication-use/glucose-monitoring (Chi-square [70] = 98.035, $p = .015$, scaling correction factor = 1.8701, RMSEA = 0.040 [0.018, 0.057], PCLOS = 0.818, CFI = 0.962, TLI = 0.950, SRMR = 0.045). The model fit for the medication-use/ glucose-monitoring model, nevertheless, was improved introducing the error covariance between items #8–#13.

The CFA models were further tested in the total sample. The model fit was sound for all models, with no need to employ error covariance, for healthy diet (Chi-square [71] = 115.269, $p < .001$, scaling correction factor = 1.5719, RMSEA = 0.035 [0.023, 0.047], PCLOS = 0.985, CFI = 0.974, TLI = 0.966, SRMR = 0.035), exercise (Chi-square [71] = 137.402, $p < .001$, scaling correction factor = 1.3453, RMSEA = 0.042[0.033, 0.054], PCLOS = 0.848, CFI = 0.975, TLI = 0.968, SRMR = 0.040) and medication-use/glucose-monitoring: Chi-square [71] = 115.991, $p < .001$, scaling correction factor = 1.8413, RMSEA = 0.035 [0.023, 0.047], PCLOS = 0.983, CFI = 0.969, TLI = 0.960, SRMR = 0.036). The pattern of the factor loadings was almost identical to sample 2. Thus, CFA results indicated a four-factor structure for the scales.

3.5 | Internal consistency reliability

The ω coefficient for the latent constructs were in the range of 0.91–0.94 for autonomous motivation, 0.67–0.71 for external regulation, 0.80–0.86 for introjected regulation and 0.57–0.71 for amotivation. Thus, the internal consistency reliability of the amotivation was revealed to be problematic, although in only included two items.

| External | Introjected | Com | Medication-use/glucose-monitoring | | | | | |
			FE%	CE%	Autonomous	External	Introjected	Com
		0.616	3.4	**79.7**	0.783			0.650
	0.720	0.298	14.3	**66.4**			0.772	0.549
		0.739	3.0	**80.7**	0.844			0.734
0.541		0.321	**65.6**	16.9		0.592		0.354
		0.406	**82.7**	4.2	−0.384			0.135
		0.819	3.6	**78.5**	0.870			0.771
	0.883	0.503	7.4	**78.1**			0.846	0.760
		0.787	3.0	**80.1**	0.844			0.719
0.550		0.298	**82.7**	7.0		0.648		0.423
0.405		0.151	**84.1**	6.6		0.411		0.178
		0.843	4.4	**78.7**	0.845			0.784
0.740		0.530	**82.7**	7.2		0.657		0.433
		0.783	3.6	**83.0**	0.866			0.686
0.610		0.374	**80.5**	6.2		0.602		0.387
		0.377	**86.9**	5.2	−0.464			0.226
2.27	0.991	56.94			5.54	2.38	1.22	56.12

3.6 | Convergent/discriminant validity

As displayed in Table 3, self-regulation types of all scales demonstrated AVE >0.50 as another confirmation of the convergent validity, except for external regulation with AVE from 0.35–0.38 and amotivation with AVE from 0.40–0.55. The four constructs in each scale indicated acceptable discriminant validity as each construct's AVE exceeded any squared paired correlation, save autonomous motivation and amotivation in all scales. This pattern of the results was replicated in the total sample. Thus, the internal consistency and convergent/discriminate validity of amotivation were inadequately achieved, and the convergent validity of external regulation was questionable (i.e. marginal internal consistency reliability and utmost 38% variance explained).

3.7 | Concurrent validity

Finally, Table 4 presents the Spearman's coefficients amongst the aggregated scores of the self-regulation types across the target behaviours; healthy diet, exercise and medication-use/glucose-monitoring in the total sample. The autonomous motivation types lied between moderate and almost strong correlations ranged from 0.46–0.74 ($p < .001$). There were also moderate to almost highly positive correlations between the amotivation types, which ranged from 0.57–0.71 ($p < .001$), and moderately negative correlations between autonomous types and amotivation across all behaviours, which ranged from −0.32–−0.66 ($p < .001$). These patterns of correlation

confirmed the concurrent validity of both autonomous motivation and amotivation for all scales.

In addition, the external regulation types showed strong associations ranged from 0.86–0.91 ($p < .001$), while the results were moderate to almost strong for introjected regulation, which ranged from 0.43–0.74 ($p < .001$). The associations between the external and introjected regulations exhibited varied levels of correlation, as such, lower negative correlation were recognized in healthy diet, ranged from −0.14–−0.17 ($p < .01$), and medication-use/glucose-monitoring, ranged from −0.22–−0.26 ($p < .001$); however, there was a lower positive correlation for exercise. Given amotivation, the external regulation types indicated lower positive associations for healthy diet, ranged from 0.12–0.13 ($p < .01$) and medication-use/glucose-monitoring, ranged from 0.22–0.24 ($p < .001$), while the results were non-significant for exercise. Lastly, there were weak to almost moderately negative correlations between amotivation and introjected self-regulation for healthy diet ranged from −0.21–−0.31 ($p < .001$), exercise which ranged from −0.10 ($p < .05$) to −0.42 ($p < .001$), and medication-use/glucose-monitoring that also ranged from −0.14 ($p < .01$) to −0.33 ($p < .001$). These results assured the concurrent validity of the external and introjected self-regulation types across all behaviours.

4 | DISCUSSION

The study aimed at testing the validity and reliability of the Persian version of TSRQ-15. The content validity was confirmed based on

TABLE 3 Confirmatory factor analysis with maximum likelihood estimator with robust standard errors (N = 253)

Subscales	Healthy diet				Exercise				Medication-use/Glucose-monitoring			
	Est	SE	Std Est	t-value	Est	SE	Std Est	t-value	Est	SE	Std Est	t-value
Autonomous	ω = 0.908		AVE = 0.623		ω = 0.938		AVE = 0.718		ω = 0.917		AVE = 0.649	
TSRQ1	1.000	0.000	0.722	**10.302**	1.000	0.000	0.760	**18.132**	1.000	0.000	0.812	**15.445**
TSRQ3	0.900	0.132	0.835	**11.760**	0.911	0.066	0.825	**21.849**	0.862	0.107	0.754	**10.815**
TSRQ6	0.988	0.070	0.787	**10.406**	1.057	0.067	0.896	**39.928**	0.909	0.155	0.809	**15.439**
TSRQ8	1.101	0.093	0.890	**27.419**	1.097	0.067	0.906	**48.145**	0.900	0.106	0.877	**21.556**
TSRQ11	1.164	0.113	0.720	**12.341**	1.061	0.076	0.835	**25.008**	1.142	0.107	0.797	**16.267**
TSRQ13	1.134	0.129	0.767	**13.487**	0.968	0.082	0.853	**26.245**	0.838	0.120	0.781	**14.199**
External	ω = 0.701		AVE = 0.382		ω = 0.671		AVE = 0.348		ω = 0.706		AVE = 0.383	
TSRQ4	1.000	0.000	0.400	**4.596**	1.000	0.000	0.421	**4.357**	1.000	0.000	0.445	**5.980**
TSRQ9	1.199	0.262	0.657	**7.121**	0.906	0.246	0.558	**6.240**	0.992	0.208	0.616	**7.474**
TSRQ12	1.435	0.447	0.787	**9.341**	1.340	0.450	0.755	**8.317**	1.256	0.287	0.779	**11.456**
TSRQ14	1.022	0.328	0.564	**6.485**	0.992	0.318	0.577	**6.951**	0.937	0.243	0.591	**7.282**
Introjected	ω = 0.795		AVE = 0.666		ω = 0.856		AVE = 0.751		ω = 0.796		AVE = 0.663	
TSRQ2	1.000	0.000	0.665	**11.237**	1.000	0.000	0.753	**19.272**	1.000	0.000	0.745	**10.991**
TSRQ7	1.164	0.099	0.943	**18.269**	1.164	0.083	0.967	**28.969**	0.906	0.140	0.878	**13.794**
Amotivation	ω = 0.572		AVE = 0.403		ω = 0.710		AVE = 0.551		ω = 0.620		AVE = 0.450	
TSRQ5	1.000	0.000	0.703	**6.063**	1.000	0.000	0.759	**12.618**	1.000	0.000	0.662	**7.606**
TSRQ15	0.696	0.197	0.559	**5.218**	0.830	0.098	0.725	**11.083**	0.999	0.222	0.679	**7.206**

Note: The bolded t-values are significant in $p < .001$.

Abbreviations: AVE, average variance extracted; Est, unstandardized estimation; SE, standard error; Std Est, standardized estimation (Factor loading); TRSQ, treatment self-regulation questionnaire; ω, coefficient omega.

TABLE 4 Spearman's rank-order coefficients between the self-regulation types across the target behaviours ($N = 503$)

Variables		M (SD)	SI	KI	1	2	3	4	5	6	7	8	9	10	11	12
1	Autonomous-HD	6.45 (1.13)	−2.93	9.37	1											
2	Autonomous-Ex	5.62 (1.83)	−1.27	0.54	0.51***	1										
3	Autonomous-MG	6.45 (1.17)	−2.86	8.58	0.74***	0.46***	1									
4	External-HD	2.09 (1.47)	1.35	0.99	−0.30***	−0.04	−0.36***	1								
5	External-EX	1.89 (1.33)	1.54	1.56	−0.29***	0.03	−0.39***	0.86***	1							
6	External-MG	1.97 (1.42)	1.44	1.22	−0.29***	−0.03	−0.38***	0.89***	0.91***	1						
7	Introjected-HD	5.87 (1.84)	−1.57	1.25	0.46***	0.15*	0.33***	−0.14*	−0.15*	−0.17***	1					
8	Introjected-EX	4.80 (2.27)	−0.53	−1.21	0.20***	0.61***	0.17***	0.11*	0.17***	0.10*	0.50***	1				
9	Introjected-MG	5.96 (1.80)	−1.66	1.50	0.38***	0.14**	0.53***	−0.22**	−0.26***	−0.25***	0.74***	0.43***	1			
10	Amotivation-HD	1.62 (1.37)	2.40	5.21	−0.59***	−0.36***	−0.41***	0.13**	0.12**	0.12**	−0.31***	−0.21***	−0.21***	1		
11	Amotivation-EX	2.01 (1.68)	1.68	1.94	−0.38***	−0.66***	−0.32***	0.00	−0.02	0.01	−0.13**	−0.42***	−0.10*	0.62***	1	
12	Amotivation-MG	1.59 (1.29)	2.36	5.20	−0.46***	−0.33***	−0.58***	0.22***	0.24***	0.24***	−0.18***	−0.14**	−0.33***	0.71***	0.57***	1

Note: $*p < .05$, $**p < .01$, $***p < .001$.

Abbreviations: EX, exercise; HD, healthy diet; KI, Kurtosis index; M (SD), means (Standard deviation); MG, medication-use/glucose-monitoring; SI, Skewness index.

quantitative evaluation conducted by experts and the face validity of the scale. In addition, the construct validity was assured in terms of a three-factor structure, convergent/discriminant validity and concurrent validity. The motivation types reflected in the TSRQ-15 indicated sound internal consistency reliability as well. Overall, the results were consistent with the previous findings concerning the validity and reliability of the scale (Levesque et al., 2007; Marques et al., 2012).

The main finding of this study was the lack of discriminant validity between autonomous motivation and amotivation subscales. In the original study of the developers, no convergent/discriminant validation was reported, while by inspecting their CFA results, the violation of discriminant criterion was indicated for autonomous motivation (AVE = 0.704) and amotivation (AVE = 0.435) with a squared paired correlation of 0.50. In other words, amotivation subscale theoretically assumes the lack of motivation to be a distinct type of self-regulation, it could not be supported by the empirical examination showing that the subscale is not grounded on a separate factor. However, TSRQ-15 can be used in its full format since the two items of amotivation may add some substantial values in identifying at-risk people during the course of treatment (Nouwen et al., 2011). Nonetheless, construct validity is a critical issue, thereby, future studies are highly recommended to assume the TSRQ's amotivation subscale as a valid subscale in empirical research.

Research demonstrates that self-determination programmes can reinforce diabetes self-management, and this can be accomplished by empowering T2DM people to set their self-determined goals and competencies (Karlsen et al., 2018). According to the developers' recommendations, autonomous regulation contributes to optimizing the peoples' self-esteem and is consistently associated with persistent behaviour change and positive health care outcomes (CSDT, 2022). In fact, empirical studies also showed that autonomy plays a crucial role in practicing self-management regarding healthy diet, exercise and adherence to medication in T2DM people (Griauzde et al., 2019; Juul et al., 2018; Kang et al., 2021; Koponen et al., 2019; Pelletier et al., 2021). Mechanism of action related to autonomous motivation can be attributed to capabilities and skills needed for self-care implementation (Koponen et al., 2019).

As such, the Persian version of TRSQ-15 can be utilized in both practice and research to tap into SDT in improving the self-management of T2DM people. For instance, studies have reported that continuous education and patient self-care support are essential to prevent the potential acute and long-term complications (Ketema et al., 2020). Thus, practitioners can employ SDT using Persian TSRQ-15 to recognize the demotivated people, and then urge them towards self-management. Likewise, researchers may adopt Persian TSRQ-15 to assess the peoples' motivational system and the mechanism through which it affects the practice of self-care and diabetes outcomes.

4.1 | Limitations

This study has faced some challenges and limitations. First, the current sample might not be representative in regards to the

Iranian population with T2DM, as they were recruited from only two main cities, thereby, generalizability and interpretation of the findings should be considered cautiously. Furthermore, the establishment of scale validity requires substantial research to address various psychometric properties and functionality of the scale (Messick, 1998). Therefore, further research is needed to determine the predictive validity, test-retest reliability and common factor bias. Importantly, the scale's items are originally anchored on a seven-point Likert scale, which might not be taken cognitively equivalent (i.e. task difficulty) across age and educational groups. Although there are some evidence suggesting the equivalence between five- versus seven-point scales (Rosnick & Presser, 2010), future studies are suggested to examine the scale's measurement invariance to ensure the reliability of the responses across age, gender and educational groups. Despite the study adopted a supervised interviewer-administered method to reduce the response bias due to mis-understanding and missing item rating, the current findings might be affected by social desirability bias. The higher rate of floor/ceiling effect in items requires further investigation about the effect of response style on filling in the scale. Further, more studies should be devoted to determine the nature of the shared variance between amotivation and autonomous motivation, which are assumed to form distinct phenomena (Ryan & Deci, 2000, 2017). Finally, this study has not addressed the relationship between TSRQ and HbA1c to examine its concurrent validity. Although some review studies suggested motivational interventions to have limited effect on glycaemic control (i.e. HbA1c levels) (Jones et al., 2014), the utilization of TSRQ and its underlying theoretical framework may advance current practice to reach this essential treatment goal, and future studies may investigate the ways through which T2DM people can optimize glycaemic control via functional motivations.

5 | CONCLUSION

This study confirms the face, content and construct validity, and reliability of the Persian version of TSRQ-15. However, the study has not supported the empirical distinction between TSRQ's amotivation and autonomous motivation subscales. Future studies can use the Persian TSRQ-15 as a valid and reliable tool to assess the motivation behind the practice of healthy diet, exercise and medication-use/glucose-monitoring amongst T2DM people. Researchers can also employ the instrument to investigate the psychosocial factors influencing motivational system among T2DM people. Nevertheless, more caution should be considered when interpreting the amotivation subscale.

CONFLICT OF INTEREST

The authors declare no competing interests.

AUTHOR CONTRIBUTIONS

Zahra Hazrati-Meimaneh: administration, investigation, interpretation and Writing – review and editing; Hadi Zamanian: conceptualization, methodology, supervision and Writing – review and editing; Somayyeh Shalchi Oghli, Shima Moradnejad and Fatemeh Karkehabadi: investigation and Writing – review and editing; Ata Pourabbasi: methodology, interpretation and Writing – review and editing; Mohammadali Amini-Tehrani: data curation, formal analysis, interpretation, Writing – original draft preparation. All authors approved the final version of the manuscript.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author, [MAT], upon reasonable request.

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