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Psychometric properties of the Greek simplified medication adherence questionnaire among Iranian hemodialysis patients

Hamid Sharif-Nia[1,2], Victoria Alikari[3], João Marôco[4], Reza Fatehi[5,6]✉, Esmaeil Hoseinzadeh[7]✉ & Poorya Nowrozi[6]

Patients suffering from chronic kidney failure ultimately need kidney replacement therapies, such as hemodialysis. Adherence to treatment in these patients can play a central role in improving health levels and feelings of well-being. The aim of this study was to determine the psychometric properties of the Persian version of the modified version of the Greek Simplified Medication Adherence Questionnaire in hemodialysis patients. In a methodological study carried out in 2024, a sample of 411 hemodialysis patients was selected using a convenience sampling method. The GR-SMAQ-HD utilized in the study was translated, and its psychometric properties were evaluated through assessments of construct validity, including exploratory and confirmatory factor analysis, convergent validity, and divergent validity. Furthermore, the study examined the internal consistency of the scale to ensure its reliability. The mean age of the participants was 59.37 (SD = 12.99) years. The results of the tetrachoric correlation matrix with Varimax with Kaiser Normalization rotation using the first random dataset ($n = 205$) extracted three factors accounting for 74.4% of the variance comprising 8 items. The results of CFA showed that the data fit the model. As for construct reliability, Cronbach's alpha, CR, AIC, and MaxR for all constructs were greater than 0.7, demonstrating good internal consistency and construct reliability. In the overall population, the mean score for treatment Adherence was 5.61 (SD = 1.95, 95% CI 5.42, 5.80). Invariance analysis shows that the model has strong measurement invariance between sex ($\Delta CFI = -0.001, \Delta RMSEA = -0.004$). The findings affirm the appropriateness of employing the Persian iteration of the GR-SMAQ-HD as a dependable and valid instrument for assessing adherence to treatment in hemodialysis patients. GR-SMAQ-HD is crucial for ensuring that patients follow their prescribed treatment regimens effectively.

Keywords Treatment adherence, Hemodialysis, Validity, Reliability, Psychometrics

Chronic renal failure is a prevalent global health issue that impacts over 800 million individuals, positioning it as one of the leading causes of illness in the 21st century[1]. Chronic kidney disease (CKD) affected 9000 individuals in Iran in 2016, making it one of the leading causes of mortality in the country[2] and it is projected to become the fifth leading cause of death globally by 2040[3]. Patients suffering from chronic kidney failure ultimately need kidney replacement therapies, such as hemodialysis, peritoneal dialysis, and kidney transplantation, to sustain their lives[4]. Currently, hemodialysis is the most common treatment method for these patients in Iran and the world[5]. Hemodialysis is a complex procedure for patients who require frequent visits to a hospital or dialysis center, mostly three times a week, thereby causing significant changes in the normal lifestyle of the patients[6].

The quality of life of hemodialysis patients changes due to factors such as long-term treatment, the need for complex treatment regimens, financial problems, depression, fear of death, and lifestyle changes[7,8]. In addition, the side effects of hemodialysis such as fatigue, itching, and thirst, which impede daily activities, are

[1]Psychosomatic Research Center, Mazandaran University of Medical Sciences, Sari, Iran. [2]Department of Nursing, Amol Faculty of Nursing and Midwifery, Mazandaran University of Medical Sciences, Sari, Iran. [3]Department of Nursing, University of West Attica, Athens, Greece. [4]William James Centre for Research ISPA – Instituto Universitário, Lisboa, Portugal. [5]Department of Nursing, Behshahr Faculty of Nursing, Mazandaran University of Medical Sciences, Sari, Iran. [6]Student Research Committee, Mazandaran University of Medical Sciences, Sari, Iran. [7]Department of Nursing, Faculty of Medical Sciences, Gorgan Branch, Islamic Azad University, Gorgan, Iran. ✉email: r3fatehi@gmail.com; Esmaeel.hoseinzadeh@yahoo.com

considered disabling symptoms for patients and affect their quality of life[9–11]. Many evidences suggest that patients undergoing hemodialysis treatment report less quality of life compared to the general population[12–14]. Institutionalizing treatment adherence in hemodialysis patients is one of the important nursing goals to improve the quality of life of these patients. Adherence to treatment in these patients can play a central role in improving health levels and feelings of well-being[15].

Medication adherence is very important for hemodialysis patients with end-stage renal disease. This means following the prescribed medication and treatment plan, which usually involves taking multiple medications multiple times a day, as well as following strict dietary and fluid restrictions[16]. Research shows that medication non-adherence is a major issue for hemodialysis patients, with rates ranging from 3 to 80%. Factors like taking multiple medications daily and psychological issues like depression and anxiety can contribute to this problem[17].

Poor medication adherence in hemodialysis patients can lead to increased illness, death, and healthcare costs. It can result in inadequate management of other health conditions, more hospitalizations, and higher risks of adverse outcomes. It is crucial to understand the challenges these patients face in order to create effective interventions to improve their health[18].

Treatment adherence is to comply with the diet, medication, and fluid restriction[19]. For hemodialysis patients, adherence to fluid restriction is the toughest treatment regimen[20]. Dietary and fluid restrictions can play an important role in preventing complications and achieving the desired outcome[21]. Adherence to the prescribed hemodialysis regimen is a critical factor in obtaining good therapeutic outcomes for hemodialysis patients and helps reduce morbidity, mortality, and side effects of hemodialysis such as muscle cramps, malnutrition, sepsis, and infection[22]. The main factor in the successful treatment of hemodialysis patients is their adherence to the treatment regimen, and non-adherence to it, increases the incidence of hemodialysis complications and, as a result, reduces the quality of life of patients[23].

The cultural background of hemodialysis patients plays a big role in whether they stick to their treatment plan. Cultural beliefs and practices affect how people view health, illness, and medical treatments, which can affect how well they follow their treatment. It is important to understand these cultural influences to help hemodialysis patients adhere to their treatment[24]. Cultural beliefs can impact medication adherence in different ways. For example, patients' views on how necessary medication is and their concerns about side effects can influence whether or not they follow their treatment plans. Some traditional beliefs may make individuals doubt the effectiveness or safety of modern medications, leading to resistance to following prescribed regimens. Also, fatalistic attitudes towards health, where people think their health is already determined and out of their control, can reduce their motivation to stick to treatment plans[25]. Social and cultural factors like education and income can affect how well patients follow their treatment plans. People with higher education levels may understand why it's important to stick to treatment, while those with lower incomes may face obstacles like limited access to healthcare that make it harder for them to follow medical advice[26].

Patient adherence to treatment is measured by various methods. Self-report instruments are often used to measure hemodialysis patient adherence. Adherence Attitudes Questionnaire of Renal Patients (RAAQ) is a 26-item scale that measures the attitude towards adherence, while the Adherence Behavior Questionnaire of Renal Patients (RABQ) is a scale consisting of 25 items that evaluate adherence to diet and fluids[27]. The Dialysis Diet and Fluid Nonadherence Questionnaire (DDFQ) is a 4-item scale that evaluates the level of adherence to fluid and diet restrictions in the last 14 days[28]. However, these tools do not examine levels of attendance at hemodialysis sessions and medication use. As a result, there is a need for a reliable questionnaire that is exclusively used for hemodialysis patients and measures all aspects of adherence to treatment in hemodialysis patients. End-Stage Renal Disease Adherence Questionnaire (ESRD-AQ) is a 46-item questionnaire that addresses all aspects of adherence in hemodialysis patients[29]. Another scale that examines all aspects of adherence to treatment in hemodialysis patients is the Greek Simplified Medication Adherence Questionnaire-Hemodialysis (GR-SMAQ-HD). This questionnaire includes 8 questions in the fields of patient medication Adherence, attendance at hemodialysis sessions, and fluid/diet[30].

The GR-SMAQ-HD presents several advantages for assessing adherence among hemodialysis patients. First, it offers a comprehensive assessment by evaluating multiple adherence dimensions, including medication use, attendance at sessions, and dietary restrictions, thus providing a more holistic view compared to other tools like the RABQ or the DDFQ, which focus primarily on diet and fluid adherence[31]. The GR-SMAQ-HD consists of only eight questions, promoting higher patient compliance compared to longer tools like the ESRD-AQ. It demonstrates strong psychometric properties, with Cronbach's alpha values between 0.75 and 0.86, ensuring its validity and reliability. Additionally, it identifies specific areas of non-adherence, allowing healthcare providers to implement targeted interventions effectively[30].

The GR-SMAQ-HD has several disadvantages, including a limited scope that may overlook psychological and social factors influencing adherence. Its cultural specificity restricts applicability to Greek-speaking patients, necessitating further validation for diverse populations. Additionally, as a self-report tool, it is prone to biases that can affect accuracy and does not assess other important outcomes like quality of life or functional status[16,30–32].

This study aimed to determine the psychometric properties of the Persian version of the modified version of the GR-SMAQ-HD in hemodialysis patients.

Methods

This methodological study was carried out in 2024. Hemodialysis patients from Mazandaran (Amol, Iran) were recruited in this study.

Inclusion and exclusion criteria

The following requirements had to be met by participants: (i) proficiency in reading Farsi; (ii) being at least 18 years old; and (iii) having received hemodialysis treatment for at least one year. Patients with kidney transplants,

Peritoneal Dialysis, severe hearing and speech impairments, a history of alcohol or drug use, acute kidney failure, inability to provide informed consent, and those receiving emergency or temporary hemodialysis due to drug poisoning were excluded from the study. These individuals were selected using the convenience sampling method, and following a detailed explanation of the study's goals, they were provided with questionnaires to complete.

Sample size

MacCallum et al. (1999) recommended a sample size of at least 200 cases for psychometric studies[33]. Consequently, we extended invitations to 411 individuals due to the need for two separate samples to ensure construct validity.

The original version of the questionnaire

In this study, we utilized the Greek Simplified Medication Adherence Questionnaire (GR-SMAQ-HD-P), developed by Alikari et al. in 2017, specifically for patients undergoing hemodialysis[30]. The questionnaire consists of eight items designed to evaluate various aspects of treatment adherence, including medication adherence, attendance at hemodialysis sessions, and adherence to fluid and diet restrictions. The items are categorized as follows: Dichotomous Items (Yes/No Questions): Three items are structured as Yes/No questions. Likert Scale Items: Five items are answered on a five-point Likert scale but are scored as either zero or one. This means that despite having five response options, the scoring effectively reduces these items to a dichotomous format for analysis. The total score for the questionnaire ranges from 0 to 8, where higher scores indicate greater treatment adherence.

Phase I

Translation

To conduct this study, we secured written permission from the questionnaire's developer to use the GR-SMAQ-HD. Subsequently, the questionnaire was translated from English to Persian following the Gudmundsson[34] translation protocol. Two proficient English-Persian translators independently translated the GR-SMAQ-HD into Persian. An expert panel, comprised of some of the authors of this article and two professional translators, meticulously reviewed and amalgamated the two translations to create a Persian version of the GR-SMAQ-HD. Subsequently, a Persian-English translator was engaged to translate the GR-SMAQ-HD-P back into English. The panel of experts reviewed and approved this final version.

Face validity

The face validity of the scale was evaluated using a mix of qualitative and quantitative methods.

Qualitative assessment The scale was given to a group of 10 hemodialysis patients who were trained to assess the items based on difficulty, relevance, and ambiguity. Feedback from the participants showed that all found the items to be clear and easy to understand.

Quantitative assessment After conducting a qualitative evaluation, a group of 10 hemodialysis patients were asked to rate each item on a 5-point Likert scale based on its suitables. A score of 5 indicated complete appropriateness, while a score of 1 indicated the item was not appropriate at all. Following this rating process, an impact score was calculated for each item using the formula.

$$\text{Impact Score} = \text{Frequency} \times \text{Suitable}$$

An item was deemed acceptable if it achieved an impact score greater than 1.5. This dual approach ensured a comprehensive evaluation of face validity, integrating both subjective judgments and quantifiable metrics[35].

Content validity

The content validity of the GR-SMAQ-HD-P was rigorously evaluated through a combination of qualitative and quantitative methods. In the qualitative phase, the scale was distributed to 12 experts in the fields of nephrology, nursing, psychology, and psychiatry. These experts were tasked with evaluating the items for grammar, wording, item allocation, and scaling. Their insightful feedback led to the refinement of certain items, ultimately enhancing the overall quality of the scale.

In the quantitative phase, the content validity of the scale was assessed using the content validity ratio (CVR) and modified kappa coefficient (K) to ensure its accuracy in measuring the intended construct. For the CVR evaluation, 12 experts rated the essentiality of items on the scale using a 3-point Likert scale (1 = not essential, 2 = useful but not essential, 3 = essential). The CVR was calculated using the formula: (ne – (N/2)) / (N/2), where (ne) represents the number of experts who rated the items as "Essential" and (N) is the total number of experts. The interpretation of the results followed the Lawshe rule, with a minimum acceptable CVR score of 0.56[36].

In order to evaluate the modified kappa coefficient (K) and account for chance agreement for each item, a panel of 11 experts was assembled to assess the relevance of GR-SMAQ-HD-P. Each expert utilized a 4-point rating system, with 4 indicating relevance and 1 indicating irrelevance. An exceptional level of agreement among the experts was defined as a kappa value exceeding 0.75, indicating a strong consensus on the relevance of the items[37].

Phase II

Normal distribution, outliers, and missing data

Skewness (±3) and kurtosis (±7) were utilized to individually analyze severe violations of univariate normal distribution of data[38]. Furthermore, multivariate normality was assessed by calculating the Mardia coefficient of multivariate kurtosis (<8). The Mahalanobis d-squared ($p < 0.001$) was employed to determine if there were any multivariate outliers[39]. Exploratory factor analysis (EFA) was conducted using the pairwise deletion method to handle missing data[40].

Construct validity

To evaluate the construct validity, the original dataset of 411 cases was randomly divided into two datasets of 205 cases each. For EFA, the first random dataset ($n = 205$) was analyzed using the Diagonally weighted least squares (DWLS) methods based analysis on the tetrachoric correlation matrix (to evaluate the dimensionality suggested by the items of the questionnaire) with Varimax, and Kaiser normalization rotation to determine the factor structure[41]. To ensure that the data was suitable for factor analysis, the Kaiser-Meyer-Olkin (KMO) measure was greater than 0.8, and Bartlett's test of sphericity was significant ($p < 0.001$). Given the significance of reporting eigenvalues and communalities in psychometric research[42], additionally, factor extraction was based on eigenvalues greater than 1, communalities greater than 0.2, and factor loadings greater than 0.3[43–45]. While traditional guidelines suggest a minimum of three items per factor for adequate representation, it is recognized that if item loadings exceed 0.70, fewer items can still form valid factors[46]. The tetrachoric correlation matrix was performed using JASP version 0.19.0.0.

In the next step, the factor structure obtained from the tetrachoric correlation matrix was analyzed and confirmed by conducting Confirmatory Factor Analysis (CFA) (Robust Estimation Methods) based on the second random dataset ($n = 205$). While the reported fit indices indicated good model fit—specifically, values for the Comparative Fit Index (CFI), Normed Fit Index (NFI), Tucker-Lewis Index (TLI), Goodness of Fit Index (GFI), Relative Fit Index (RFI), Incremental Fit Index (IFI) all exceeding 0.9, and Root Mean Square Error of Approximation (RMSEA) below 0.08. For Minimum Discrepancy Function divided by degrees of freedom (CMIN/DF) < 3 was considered good[47]. It is important to note that the chi-square test is sensitive to sample size. As sample size increases, even small discrepancies between the observed data and the model can lead to a significant chi-square result, which may not accurately reflect the model's overall fit. Kline (2015) emphasizes that larger samples often yield statistically significant chi-square values even when practical fit is adequate[46]. Therefore, while the chi-square statistic serves as a useful indicator of model fit, it should be interpreted alongside other fit indices to provide a more comprehensive assessment of model adequacy.

Convergent and discriminant validity

To evaluate convergent validity and discriminant validity, certain criteria were used. For convergent validity, the composite reliability (CR) should be above 0.7, and the average variance extracted (AVE) should be above 0.5 for each construct. Fornell and Larcker (1981) suggested that if the AVE is less than 0.5 for a psychological construct, but the CR is greater than 0.7, the convergent validity can still be considered acceptable[48]. In terms of discriminant validity, the study employed the Heterotrait-Monotrait Ratio (HTMT) correlation criterion, where the HTMT ratio between all constructs should be less than 0.85 to establish discriminant validity[49].

Reliability

Cronbach's alpha, McDonald's omega, average inter-item correlation coefficient (AIC), Composite Reliability (CR), and maximum reliability (MaxR) were calculated to assess the internal consistency and reliability of the construct[50,51]. If the Cronbach's alpha and McDonald's omega, CR, and MaxR values of the scale were greater than 0.7, and AIC values of 0.2 to 0.4 were interpreted as acceptable reliability[52].

Measurement invariance for sex

The invariance analysis for sex was conducted to determine whether the measurement model was equivalent across males and females. A hierarchical approach was employed, imposing constraints on factor loadings, intercepts/thresholds, and means, in line with the guidelines of Cheung and Rensvold[53]. This approach was used to assess configural, metric, scalar, and latent means invariance, respectively. The models were estimated using the `lavaan` package using robust maximum likelihood estimation with Santorra-Bentler correction[54] in R, which systematically tests the sequentially constrained models that define these forms of invariance. The evaluation of the models followed the criteria proposed by Cheung and Rensvold[53], where an absolute difference in the Comparative Fit Index (CFI) of less than 0.01 and an absolute difference in the Root Mean Square Error of Approximation (RMSEA) of less than 0.015 indicate that the hypothesis of invariance should not be rejected. Additionally, the change in the chi-square statistic ($\Delta\chi^2$) was considered, where a non-significant $\Delta\chi^2$ value ($p > 0.05$) suggests that adding constraints to the model does not significantly degrade its fit, further supporting the assumption of invariance. These combined criteria provide a robust basis for evaluating whether the measurement model remains consistent across groups.

Ethical approval

The Ethics Committee of Mazandaran University of Medical Sciences (Sari, Iran) gave its approval to this study (Ethics code: IR.MAZUMS.REC.1402.535). Study data were gathered after explaining the aim of the study to participants and ensuring their participation voluntariness and data confidentiality. Written Informed consent was obtained from all subjects and/or their legal guardian(s). Permissions to use the data collection instruments were obtained from their developers. All procedures adhered to the appropriate guidelines and regulations.

Results

Demographic characters

The mean age of the participants was 59.37 (SD = 12.99) years. Among the participants, 205 (49.9%) were women and 206 (50.1%) were men.

The results of the tetrachoric correlation matrix

The results of the tetrachoric correlation matrix with Varimax with Kaiser Normalization rotation using the first random dataset ($n = 205$) extracted three factors accounting for 74.4% of the variance comprising 8 items (Figure, and Table 1). Moreover, the results of the KMO (0.797, 95% CI 0.726 to 0.825) and Bartlett's test of sphericity ($p < 0.001$, Chi-square = 11649.427, $df = 28$) showed the sampling is adequate and appropriate for conducting the factor analysis. The detailed results of the tetrachoric correlation matrix are shown in Table 1.

The results of CFA

The CFA was conducted to confirm and validate the factor structure obtained from the tetrachoric correlation matrix using the second random dataset ($n = 205$). The results showed that the data fitted the model well as evidenced by ($\chi^2(16) = 41.987$, $p < 0.001$, $\chi^2/df = 2.624$, CFI = 0.956, IFI = 0.956, TLI = 0.927, NFI = 0.944, RFI = 0.907, PNFI = 0.573, GFI = 0.957 SRMR = 0.062, RMSEA (90% CI): 0.063 [0.040, 0.078]). The final model is presented in Fig. 1; Table 2.

Convergent and discriminant validity

The results of the CFA indicated that the AVE for the factors of Medication Adherence and Attendance at Hemodialysis Sessions exceeded the accepted threshold of 0.5, demonstrating good convergent validity. However, the AVE for the Fluid/Diet factor was below this threshold at 0.412, which raises concerns about its convergent validity. Additionally, the CR for the Fluid/Diet factor was close to 0.6, which is below the recommended level of 0.7 for establishing reliability. Given these findings, while we acknowledge that the AVE for the Fluid/Diet factor does not meet the optimal threshold, it is important to interpret these results with caution. The lower AVE suggests that this factor may not fully capture the variance associated with treatment adherence as effectively as desired. Therefore, further investigation into the items constituting this factor may be warranted to enhance its validity and reliability.

As for discriminant validity, the results of the HTMT ratio showed that the correlation between Medication Adherence, and Attendance at Hemodialysis Sessions (0.112), Medication Adherence, and Fluid/Diet (0.398), and Attendance at Hemodialysis Sessions, and Fluid/Diet (0.181), demonstrating good discriminant validity for all constructs.

Reliability

As for construct reliability, the Cronbach's alpha, CR, AIC, and MaxR for all constructs were greater than 0.7, demonstrating good internal consistency and construct reliability, Also, based on Table 2, McDonald's omega of all of the latent variables was in an acceptable range (except factor 3).

Invariance for sex

The analysis of measurement invariance across sex, following Cheung and Rensvold's (2002) criteria, evaluates changes in fit indices ($\Delta\chi^2$, ΔCFI, and ΔRMSEA) across different levels of invariance: configural, metric, scalar, and means. Configural invariance, which tests whether the overall factor structure is the same across groups, shows an acceptable fit (CFI = 0.952, RMSEA = 0.092) and serves as the baseline with no change in CFI or RMSEA. Based on Table 3, Metric invariance, testing equality of factor loadings, results in a small, nonsignificant $\Delta\chi^2$ (5.740, $p = 0.332$) and minimal changes in CFI (−0.001 to 0.951) and RMSEA (−0.005 to 0.088), supporting metric invariance. For scalar invariance, which assesses equality of intercepts/thresholds, the changes remain minimal ($\Delta\chi^2 = 6.494$, $p = 0.261$, ΔCFI = −0.001, ΔRMSEA = −0.004), confirming scalar invariance. However, for means invariance, testing equality of latent means, the fit deteriorates slightly, with a significant $\Delta\chi^2$ (10.065, $p = 0.018$), a larger drop in CFI (−0.005 to 0.944), and a slight increase in RMSEA (+0.002 to 0.085). While the significant $\Delta\chi^2$ and the larger drop in CFI suggest issues with full means invariance, the small ΔCFI and

Factor	Items	Factor loading	h^2	λ	% Variance
Medication Adherence	Q_3. Have you ever forgotten to take your medications on the days between the two dialysis sessions?	0.904	0.833	3.402	39.6
	Q_2. Have you ever forgotten to take your medications?	0.892	0.815		
	Q_4. In the last week, how many times have you not taken your medications?	0.772	0.708		
	Q_1. When you feel bad, have you ever stopped taking your medications?	0.566	0.366		
Attendance at Hemodialysis Session	Q_5. Last month, how many times was the session shortened on your own initiative?	0.972	0.968	1.878	22.5
	Q_6. Last month, on average, how many minutes was the session cut off on your own initiative?	0.964	0.940		
Fluid/Diet	Q_8.During the past week, how many times did you follow dietary recommendations?	0.896	0.861	3.219	12.3
	Q_7. During the past week, how many times did you follow fluid restrictions?	0.810	0.682		

Table 1. The result of tetrachoric correlation matrix factor analysis on the three factors persian version of the GR-SMAQ-HD ($n = 205$). h^2: Communalities, λ: Eigenvalues

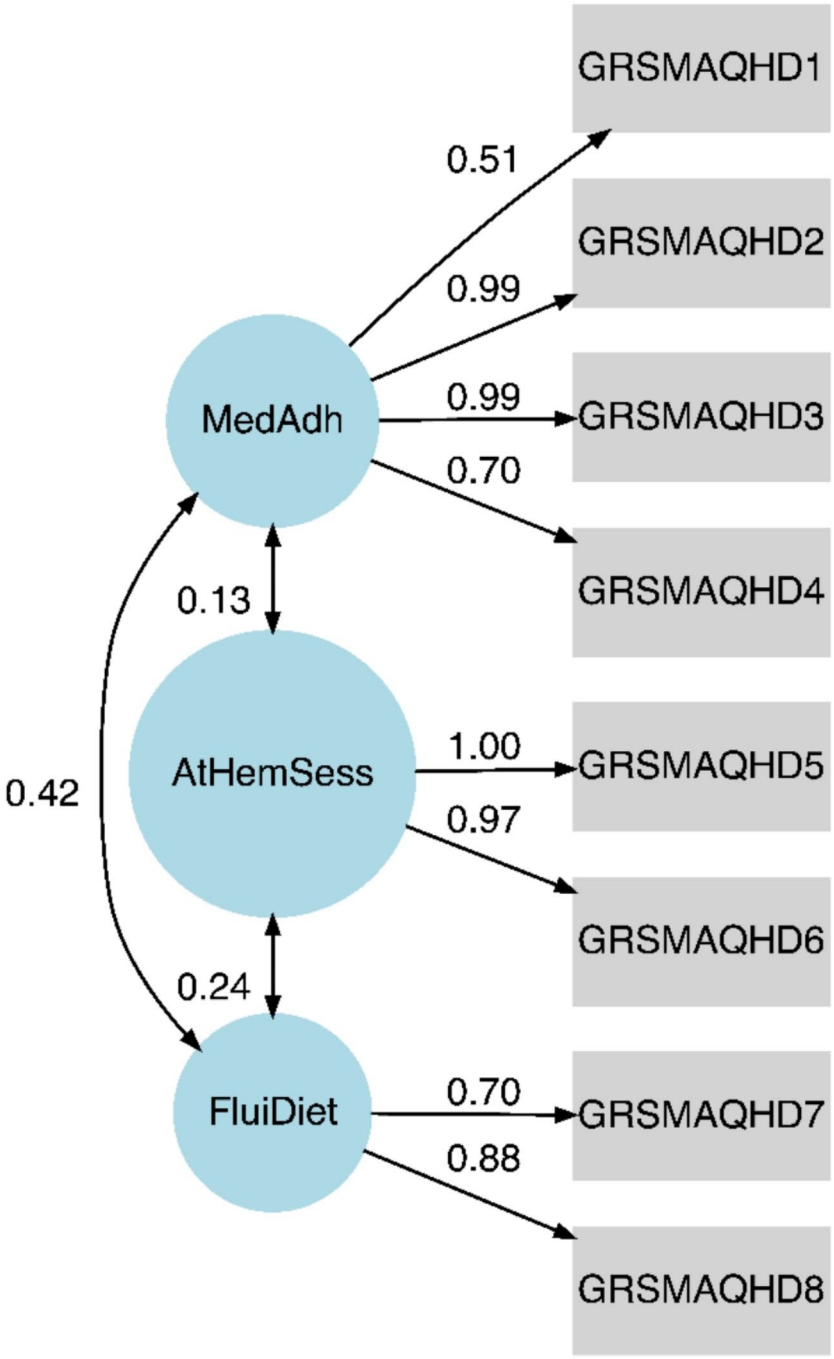

Fig. 1. Standardized loadings and interfactor correlations for CFA of GR-SMAQ-HD on the tetrachoric correlation matriz ($n = 411$). Error variance for item GRSMAQHD5 was fixed at 0.001. Overall model fit to the total sample was good ($\chi^2(17) = 41.64$, CFI = 0.999, TLI = 0.998, NFI = 0.998, SRMR = 0.081, and RMSEA = 0.059 IC90% [0.037, 0.083] and a probability of close P[RMSEA $\leq$ 0.05] = 0.226.). MedAdh – Medication Adherence, AtHemSess – Attendance at hemodyalis section; FluiDiet - Fluid/Diet.

Index (C.I. %95)						
Factors	α	Ω	CR	MaxR	AVE	AIC
Medication adherence	0.734 (0.69 to 0.77)	0.794 (0.79 to 0.84)	0.870 (0.85 to 0.89)	0.939	0.612 (0.57 to 0.64)	0.389 (0.33 to 0.44)
Attendance at Hemodialysis session	0.894 (0.87 to 0.91)	0.894 (0.84 to 0.93)	0.897 (0.84 to 0.90)	0.915	0.808 (0.77 to 0.82)	0.810 (0.78 to 0.83)
Fluid/Diet	0.582 (0.49 to 0.65)	0.583 (0.47 to 0.661)	0.586 (0.56 to 0.64)	0.593	0.412 (0.40 to 0.43)	0.412 (0.31 to 0.50)

Table 2. The results of the convergent validity and construct reliability ($n = 205$).

	Df	AIC	BIC	χ^2	$\Delta\chi^2$	Δdf	*p*	CFI	RMSEA	ΔCFI	ΔRMSEA
Config	36	2416.403	2625.370	99.072				0.952	0.092	0.000	0.000
Metric	41	2412.927	2601.800	105.595	5.740	5	0.332	0.951	0.088	−0.001	−0.005
Scalar	46	2409.345	2578.126	112.014	6.494	5	0.261	0.950	0.084	−0.001	−0.004
Means	49	2413.237	2569.962	121.906	10.065	3	0.018	0.944	0.085	−0.005	0.002

Table 3. Analysis of invariance for sex.

ΔRMSEA remain within Cheung and Rensvold's acceptable thresholds ($|\Delta CFI| < 0.01$, $|\Delta RMSEA| < 0.015$), indicating that partial means invariance may still be plausible (Table 3). Overall, invariance is supported up to the scalar level, with some potential concerns at the means level.

Treatment adherence score

In the overall population, the mean score for Treatment Adherence was 5.61 (SD = 1.95, 95% CI 5.42, 5.80). Furthermore, there weren't significant differences ($p = 0.201$) in the mean scores of Treatment Adherence between men (5.49, SD = 1.88) and women (5.74, SD = 2.01).

Discussion

Hemodialysis is more dependent on hospital treatment, so treatment adherence is more important. However, treatment adherence is a common problem in hemodialysis patients, leading to acute and chronic complications and increased morbidity and mortality[55]. Therefore, hemodialysis patients must adhere to fluid intake, diet, and medication management[56]. This study aimed to determine the psychometric properties of the Persian version of the modified version of the GR-Simplified Medication Adherence Questionnaire in hemodialysis patients. The findings of this investigation and reliability.

The results of the study revealed that the Persian version of the GR-SMAQ-HD included 8 items that were categorized into three factors (Medication, Attendance to HD sessions, and Diet/Fluid restrictions) accounting for 74.4% of the overall variance in adherence to treatment among Iranian hemodialysis patients that is good for a brief, self-administered questionnaire. The three factors revealed in this study are similar to the original study[24].

The first factor of the GR-SMAQ-HD is Medication adherence. Medication adherence is the study of how patients follow their prescribed treatment regimens. It involves assessing how well patients stick to their medications or therapies over time. It is essentially the patient's willingness to follow their treatment plan[57]. Non-compliance with medication therapy is a major problem for hemodialysis patients, with rates varying from 3 to 80%. This lack of adherence can lead to a decrease in quality of life, as well as an increase in mortality and hospitalizations[58]. Therefore, providing support and education to patients is crucial for enhancing medication adherence. It is important to educate patients about the significance of following their medication schedule and how to effectively handle their medication routine.

The second factor of the GR-SMAQ-HD is attendance at hemodialysis sessions. Attendance at hemodialysis sessions is important for patients to regularly and punctually participate in their scheduled treatments. This means showing up for all appointments on time and staying for the entire treatment. It is crucial for the health and well-being of patients receiving hemodialysis because it helps in the timely removal of excess fluid, electrolytes, and toxins from the body[59,60]. Nurses must educate patients on their treatment plans, emphasizing the significance of adhering to hemodialysis sessions, attending them regularly, and understanding the potential consequences of non-adherence. Nurses play a crucial role in involving patients in their care, empowering them to actively participate in managing their treatment. By addressing any concerns that may hinder adherence and assisting patients in overcoming barriers, nurses can ensure optimal outcomes for their patients.

The final factor of the GR-SMAQ-HD is fluid/diet restrictions. Adherence to diet and fluid recommendations is important for hemodialysis patients. It means following dietary restrictions like limiting salt, phosphorus, and potassium intake, as well as sticking to fluid restrictions to avoid complications from excessive fluid accumulation[61,62]. Nurses need to teach patients about their dietary and fluid restrictions, explaining the importance of adherence and the potential consequences of non-adherence. This includes providing clear information on which foods and fluids to limit or avoid. Nurses also must encourage involving family members in dietary education and support, as they can help patients stick to their restrictions at home.

The findings from this study indicate that the Greek Simplified Medication Adherence Questionnaire effectively captures essential dimensions of medication adherence among Iranian hemodialysis patients. Although two factors consist of only two items each, their strong loading values above 0.70 justify their inclusion in the model. This approach not only enhances the questionnaire's applicability in clinical settings but also minimizes cognitive burden on patients who may experience fatigue during treatment. The brevity of these factors allows for efficient assessment while maintaining robust measurement properties, thereby facilitating better patient adherence monitoring and intervention strategies.

The results of the study indicate that the items of this scale show good convergent and divergent validity for all constructs. Divergent validity implies complete separation between constructs, whereas convergent validity is evident when the elements of a construct are semantically closely related and explain variance[35]. The internal consistency coefficient of the scale shows that the items of each subscale have significant internal correlations and thus contribute to the explanation and measurement of the general construct.

Considering the existing cross-cultural gap in health outcomes research[63], the use of the GR-SMAQ-HD in Persian culture with appropriate cultural variables may facilitate the identification of adherence to treatment in hemodialysis patients and provide necessary interventions to increase it.

Limitations

One significant limitation of this study is the utilization of convenience sampling to choose participants. Although this approach made it easier to recruit individuals from a specific population of Iranian hemodialysis patients, it inherently restricts the applicability of the results to larger populations. Convenience sampling can introduce selection bias, as the sample may not accurately represent the diverse characteristics and experiences of all hemodialysis patients. Future research should consider utilizing probability sampling methods to enhance the representativeness of the sample and enhance the external validity of the findings.

Clinical implications

Establishing a valid and reliable questionnaire to assess medication adherence in this population is important, as poor adherence can lead to adverse health outcomes in hemodialysis patients.

Identifying Non-Adherence: If the GSMAQ demonstrates good psychometric properties, it can identify hemodialysis patients who are non-adherent to their medication regimens. This information can help healthcare providers target interventions to improve adherence in this high-risk population.

Tailoring Interventions: Understanding the factors that influence medication adherence in Iranian hemodialysis patients, as revealed by the GSMAQ, can guide the development of adherence-enhancing interventions that are culturally appropriate and address the specific needs of this patient group.

Cross-Cultural Validation: The validation of the GSMAQ in an Iranian hemodialysis population expands the tool's applicability beyond the original Greek setting. This can facilitate cross-cultural comparisons of medication adherence and support the use of a common assessment measure in international research and clinical practice.

Informing Clinical Practice: The findings from this study can inform clinicians caring for hemodialysis patients in Iran about the reliability and validity of the GSMAQ. This can help integrate the tool into routine clinical practice to monitor and improve medication adherence in this vulnerable patient population.

Conclusion

The scale consists of three factors containing a total of 8 items, which collectively account for 74.4% of the total variance in Greek simplified medication adherence among Iranian hemodialysis patients. The findings affirm the appropriateness of employing the Persian of the GR-SMAQ-HD as a dependable and valid questionnaire for assessing adherence to treatment in hemodialysis patients. GR-SMAQ-HD is crucial for ensuring that patients follow their prescribed treatment regimens effectively.

Data availability

The data supporting this study's findings are available from the corresponding author upon reasonable request.

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Author contributions

Performance of data gathering: R.F.; Planning and supervision of the work: H.S.H.; Performance of the analysis: H.S.H., and J.M., Manuscript draft: E.H., and All authors; and comment on the final manuscript: P.N., V.A., and All authors.

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Declarations

Competing interests

The authors declare no competing interests.

Additional information

Correspondence and requests for materials should be addressed to R.F. or E.H.