



Psychometric validation of instruments measuring emotional stress and self-esteem in a dental patient population

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Abstract

Background. Patient-reported outcome measures (PROMs) are becoming more popular in dental research for measuring various psychological aspects of patients' experiences. However, it is essential to validate these measures' properties based on the setting where they are applied. This study aims to validate the Romanian versions of the Kessler Psychological Distress Scale (K10) and the Rosenberg Self-Esteem Scale (RSES) for adult dental patients.

Methods. This is a prospective study for psychometric validation of PROMs for adult dental patients conducted at the Department of Preventive Dentistry, Iuliu Hațieganu University of Medicine and Pharmacy, Cluj-Napoca, Romania. Internal consistency, structural validity, and construct validity were assessed for these PROMs. Responsiveness was evaluated based on pre-post comparisons during routine dental visits.

Results. The RSES showed high internal consistency reliability for adult dental patients ($\alpha = 0.77-0.80$), whereas K10 showed excellent internal consistency reliability ($\alpha = 0.91$). Furthermore, it was found that psychological distress was related to affective pain but not sensory pain, whereas self-esteem was not related to any of these measures. Both instruments showed responsiveness across clinical time points.

Conclusions. The Romanian versions of K10 and RSES showed satisfactory psychometric properties for adult dental patients and could potentially be useful for psychosocial research in dentistry.

Keywords: dental research, preventive dentistry, patient reported outcome measures, psychological distress, psychometrics

Introduction

Patient-reported outcome measures (PROMs) are now recognized as a vital part of the present clinical research and quality assessment in the field of dentistry. They measure various dimensions of the patient's experience that are difficult to quantify using other clinical parameters, including the subjective experience, emotions, and the impact of care [1].

Systematic reviews of the application of PROMs in dental research have demonstrated the importance and

the methodology to be adopted in the selection of the instrument. They should be applied only after the measurement properties of the instrument are demonstrated in the patient population to be studied [2,3].

A common error in the methodology is the assumption that the questionnaire validity is automatically transferred to the new context after translation or adaptation to a new culture or a new clinical practice. Current recommendations for the development and application of a questionnaire after

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translation or adaptation to a new culture or a new clinical practice recommend the demonstration of the measurement properties, including the assessment of the instrument's reliability, validity, and responsiveness in the new context [5,6].

Various tools are available to assess psychological distress and other related constructs in the clinical and research settings. Psychological distress has been measured using the Depression Anxiety Stress Scales (DASS), the Hospital Anxiety and Depression Scale (HADS), and the General Health Questionnaire (GHQ). Global self-esteem has been measured using the Rosenberg Self-Esteem Scale and other multi-dimensional self-evaluation tools [1,3].

In the field of dental research, it is common for questionnaires to be completed chairside and to be part of a time-limited clinical encounter. As such, there are obvious advantages to the use of brief measures that assess broad psychological constructs and are easily understood by respondents. This allows for the respondent to be less burdened by the experience and for the assessment to be more consistent with clinical practice, especially when working with populations who may be experiencing temporary discomfort or anxiety [1,7].

Two such brief and commonly used measures are relevant to dental research. The Kessler Psychological Distress Scale 10-item version (K10) was developed to assess nonspecific psychological distress and was intended to be a brief assessment tool for use in both population and clinical studies [4]. The focus on nonspecific psychological distress is also relevant to the field of dentistry because emotional reactions tend to be situational and temporary rather than specific to any disorder.

The Rosenberg Self-Esteem Scale (RSES) is a 10-item measure of global self-esteem and remains one of the most commonly used measures to assess this construct because of its conceptual simplicity and conciseness [8]. The RSES often yields two factor solutions in exploratory factor analyses, which are generally attributed to a method factor due to the presence of both positive and negative item wordings [9,16].

There are particular reasons for the interest in the validity of these measures in the specific domain of dentistry. Specifically, the setting of dental visits is marked by rapid emotional state changes. These short-interval state effects have the potential to affect the meaning of the obtained scores. Finally, the traditional setting of validating brief chairside questionnaires in dentistry, like those measuring dental anxiety, adds to the interest in the validity of these measures in the particular setting where they are to be used [10,11].

The aim of the present study was to evaluate the Romanian versions of the K10 and RSES in Romanian adult dental patients. The evaluation of the measures was based on the internal consistency reliability of the measures (Cronbach's alpha coefficient), the structural validity

of the measures based on the exploratory factor analysis with diagnostics of factorability of the correlation matrix (Kaiser-Meyer-Olkin and Bartlett's test), the construct validity of the measures based on theoretically guided associations with the dimensions of pain experience, and the responsiveness of the measures defined as the change across two measurement occasions within the setting of routine dental visits.

Research Hypothesis: the Romanian versions of the Kessler Psychological Distress Scale (K10) and the Rosenberg Self-Esteem Scale (RSES), translated and culturally adapted are valid, reliable and responsive instruments for assessing the psychological profile of adult dental patients.

These scales are hypothesized to accurately reflect their respective theoretical constructs and to effectively detect changes in affective states occurring during routine dental treatment.

Materials and methods

Study design, setting, and ethics

The prospective psychometric validation study was conducted from June 2023 to June 2025 at the Department of Preventive Dentistry, Iuliu Hațieganu University of Medicine and Pharmacy, Cluj-Napoca, Romania. Ethical clearance was obtained from the institutional Ethics Committee (approval no. AVZ97/20.06.2023). All the procedures followed the ethical standards of the World Medical Association Declaration of Helsinki [12].

Participants

Participants were recruited through consecutive sampling of patients presenting for routine treatment at the Department of Preventive Dentistry, Iuliu Hațieganu University of Medicine and Pharmacy, Cluj-Napoca, Romania, during the study period. A total of 42 adult patients (≥ 18 years) with permanent dentition (at least 20 teeth) who required professional scaling, according to their treatment needs and provided informed consent were included. Patients with decompensated systemic diseases, severe psychiatric disorders, or pregnancy were excluded. This systematic approach ensured that the study population accurately reflects a real-world clinical cohort in a dental setting, thereby enhancing the external validity of the findings.

The sample size was determined based on the feasibility of recruitment in a clinical setting and was considered sufficient to conduct exploratory factor analysis and non-parametric tests of validity and responsiveness, consistent with validation studies of health-related quality of life measures in specialized clinical populations.

To conduct the psychometric evaluation and known-groups validity assessment, two clinical populations were used. For the purpose of the study's validity assessment, these populations are referred to as the "clinical subgroups" in the Results section.

The pre- and post-assessments were conducted within the same clinical session, with the interval determined by the duration of the dental scaling procedure and ranging from 25 to 40 minutes. This immediate follow-up design was chosen to capture short-interval state effects, allowing the study to examine whether a routine dental procedure was associated with transient changes in psychological distress and self-esteem scores.

Translation, cultural adaptation, and cognitive debriefing

The translation and cultural adaptation process for the Romanian versions of the K10 and RSES was performed using the expert committee method (NCT; RC; ICB). This method was followed to ensure semantic and conceptual similarity to the original version, as recommended in the guidelines for translation and cultural adaptation [5,6].

Cognitive debriefing was performed by interviewing five adult dental patients. All the participants stated that the questions and response options were clear to them, and no modifications were needed.

Measures

Kessler Psychological Distress Scale (K10)

This is a 10-item Likert-type scale measuring nonspecific psychological distress. It has been shown to have good reliability and validity. It is used to assess the level of distress. It is easy to administer and has a short response time. It is applicable in both clinical and research settings. The higher the score, the higher the level of distress [4].

Rosenberg Self-Esteem Scale (RSES)

This scale has 10 items and is used to measure global self-esteem. It is based on the assumption that self-esteem is a global construct. There are findings which show that the scale has good reliability and validity. It is easy to use the scale, and it has a short response time. It can be used in both clinical and research settings. High scores indicate high levels of global self-esteem [8,14].

External construct for construct validity

The Short-Form McGill Pain Questionnaire was used to obtain scores for sensory and affective dimensions of pain. [13] It was hypothesized that psychological distress would have a strong association with affective pain but only a weak association with sensory pain. It was also hypothesized that self-esteem would have weak associations with both sensory and affective pain over the short clinical timeframe. [20]

Exploratory moderation analyses were performed via ordinary least squares regression with cluster robust standard errors at the participant level, including an interaction term for psychological distress and self-esteem to predict pain outcomes.

Statistical analysis

All statistical analyses were conducted using Python with tools from widely used scientific libraries like SciPy and Scikit-learn. Internal consistency was assessed using

Cronbach's alpha, complemented by item-level diagnostics. Construct validity was examined through exploratory factor analysis, with sampling adequacy evaluated using the Kaiser–Meyer–Olkin (KMO) measure and Bartlett's test of sphericity. Non-parametric methods were used throughout due to the ordinal nature of the data, including Wilcoxon signed-rank tests for paired comparisons and Mann–Whitney U tests for independent group comparisons. Associations between variables were evaluated using Spearman rank-order correlations, while effect sizes were quantified using Cliff's delta. Relationships were explored using linear regression models with interaction terms. Standardized predictors and cluster-robust standard errors were used to account for repeated observations within patients. A conventional alpha level of 0.05 was used as the threshold for statistical significance in all inferential analyses.

Results

Analytic samples

The paired analyses of responsiveness included 42 subjects who participated in both the pre- and post-assessment sessions. For selected psychometric methods, such as internal consistency reliability and exploratory factor analysis, the results were supplemented with pooled data, i.e., a sample of 84, combining the pre- and post-measurement data, as reported in the statistical validation output.

Internal consistency reliability

The internal consistency estimates of the two Romanian-language instruments were found to be stable across time and are reported in table I.

The internal consistency of the RSES instrument was found to be high and stable across time, with a higher estimate obtained in the pooled dataset of pre- and post-measurement data than in the two individual datasets. Thus, the internal consistency of the RSES instrument, as measured by Cronbach's alpha, was found to be high and stable, with a value of 0.77 in the baseline dataset, a value of 0.78 in the post dataset, and a value of 0.80 in the pooled dataset.

The internal consistency of the K10 instrument was found to be excellent and highly stable, with the same value of 0.91 in all three datasets.

Table I. Internal consistency reliability for the Romanian versions of RSES and K10 (Cronbach's α).

Instrument	Time point	n	α
RSES	Pre	42	0.77
RSES	Post	42	0.78
RSES	Pooled (Pre + Post)	84	0.80
K10	Pre	42	0.91
K10	Post	42	0.91
K10	Pooled (Pre + Post)	84	0.91

α = Cronbach's alpha (internal consistency). Values are transcribed from the statistical validation document.

Structural validity: factorability and exploratory factor analysis

The preliminary diagnostics on factorability have shown that the data were suitable for exploratory factor analysis (see Table II). The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy for the Rosenberg Self-Esteem Scale (RSES) data was 0.65, and Bartlett's test of sphericity was statistically significant, $\chi^2 = 165.12$, $df = 45$, $p < 0.001$. The factorability indices for the Kessler Psychological Distress Scale (K10) were higher: KMO = 0.79, $\chi^2 = 237.86$, $df = 45$, $p < 0.001$.

The exploratory factor analysis extracted two-factor solutions for both instruments, consistent with the statistical validation output. The extracted factors from the RSES data reflected the distinction between positive and negative wordings. The two-factor solution from the K10 data differentiated between somatic-anxious and emotional-depressive distress.

Construct validity: associations with pain dimensions

The construct validity was also determined by analyzing the association between baseline psychological variables and pain dimensions based on the results from the

SF-MPQ. As indicated in table III, baseline psychological distress, based on the K10 mean score results, was significantly associated with affective pain ($\rho = 0.25$, $p = 0.023$), but there was no significant association found for sensory pain ($\rho = -0.06$, $p = 0.620$).

The baseline self-esteem results based on the RSES mean score showed weak and non-significant correlations for both sensory pain ($\rho = -0.09$, $p = 0.420$) and affective pain ($\rho = -0.08$, $p = 0.500$), suggesting the lack of a direct relationship for global self-esteem and short-term pain experience.

Convergent and discriminant validity at the factor level

Pattern analysis

In order to further elucidate the pattern of convergent and discriminant validity, the factor level of the analysis is examined. This is shown in table IV. The most significant association was found for the somatic psychological distress factor and affective pain ($\rho = 0.25$; $p = 0.023$), while a marginal association was found for sensory pain ($\rho = 0.21$; $p = 0.060$). No statistically significant associations were found for the emotional distress factor with the two dimensions of pain (all $ps > 0.19$).

Table II. Factorability diagnostics and EFA summary for the Romanian versions of RSES and K10.

Instrument	KMO	Bartlett's χ^2 (df)	p-value	Extraction / rotation (as reported)	Retained solution	Factor pattern (as reported)
RSES	0.65	165.12 (45)	<0.001	Maximum likelihood / varimax	2 factors	Positive vs negative wording polarity
K10	0.79	237.86 (45)	<0.001	EFA (rotation as reported)	2 factors	Somatic-anxious vs emotional-depressive distress

KMO = Kaiser-Meyer-Olkin measure of sampling adequacy; χ^2 = chi-square statistic; df = degrees of freedom. Factor labels are those reported in the statistical validation document.

Table III. Spearman correlations between baseline Romanian K10/RSES scores and SF-MPQ pain dimensions.

Baseline psychological measure	SF-MPQ dimension	ρ	p-value
K10 (mean score)	Affective pain	0.25	0.023
K10 (mean score)	Sensory pain	-0.06	0.620
RSES (mean score)	Sensory pain	-0.09	0.420
RSES (mean score)	Affective pain	-0.08	0.500

ρ = Spearman's rank correlation coefficient. Values are transcribed from the statistical validation document.

Table IV. Factor-level correlation pattern reported for convergent and discriminant validity.

Factor-level measure (as reported)	Sensory pain	Affective pain
Somatic psychological distress factor	$\rho = 0.21$; $p = 0.060$ (marginal)	$\rho = 0.25$; $p = 0.023$
Emotional distress factor	Not significant ($ps > 0.19$)	Not significant ($ps > 0.19$)
Positive self-esteem factor	$ps \leq 0.07$; $ps \geq 0.36$	$ps \leq 0.13$; $ps \geq 0.09$
Negative self-esteem factor	$ps \leq 0.07$; $ps \geq 0.36$	$ps \leq 0.13$; $ps \geq 0.09$

Bounds are reproduced exactly as reported in the statistical validation document.

In the case of the Rosenberg Self-Esteem Scale (RSES), weak and non-significant associations were found for the positively and negatively worded self-esteem factors with the sensory and affective dimensions of pain. Where the exact coefficients were not provided in the statistical validation document, the text within the bounds of the provided information is repeated verbatim.

Known-groups validity (external construct behavior)

For the known-groups validity, the SF-MPQ pain outcomes were compared between two clinical subgroups. Sensory pain and affective pain demonstrated significant differences between the two groups (Table V). Sensory pain had a Mann-Whitney U statistic of 509.00 ($p < 0.001$), whereas affective pain had a U statistic of 290.00 ($p < 0.001$). This implies that the external construct used for the validity behaved as expected.

Within-subject Responsiveness (change over time)

The Responsiveness analyses indicated that there were statistically significant pre-post changes for both measures (see Table VI). For RSES, the median score changed from 2.20 to 2.35 post-intervention, and the Wilcoxon Signed-Rank statistic was significant at $p < 0.001$ ($W = 17.50$). For K10, the median score changed from 1.90 to 1.50 post-intervention, and the Wilcoxon statistic was significant at $p < 0.001$ ($W = 112.00$). This suggests that both measures are responsive to change over time in routine dental care.

Exploratory moderation model

An exploratory moderation model was conducted

to examine whether baseline self-esteem moderated the relationship between baseline psychological distress and the pain outcomes (Table VII). The interaction between distress and self-esteem was statistically significant for sensory pain ($b = 0.21$, $SE = 0.11$, $p = 0.049$) and approached significance for affective pain ($b = -0.11$, $SE = 0.06$, $p = 0.059$).

As with the statistical validation model, these findings are considered exploratory and hypothesis-generating.

Discussion

Principal findings

The purpose of the current study was to investigate the measurement properties of the Romanian versions of the K10 and RSES in adult dental patients. This was accomplished through a rigorous validation process, which incorporated a combination of methods, including expert committee translation and cultural adaptation, cognitive debriefing, and quantitative psychometric evaluation. The results of the current study indicate that the RSES and K10 are functioning as psychometrically sound and interpretable instruments in the dental clinical context. This was accomplished by demonstrating the measurement properties of the RSES and K10 in the measurement areas of internal consistency reliability, structural validity, construct validity, known groups validity, and responsiveness. Cognitive debriefing results supported the face validity of the RSES and K10, indicating that the items and scales are easily understood and feasible in the dental clinical context.

Table V. Known-groups validity: between-group differences in pain outcomes (Mann–Whitney U test).

Outcome	Grouping variable (clinical subgroups)	U	p-value
Sensory pain	Subgroup comparison (as reported)	509.00	<0.001
Affective pain	Subgroup comparison (as reported)	290.00	<0.001

U = Mann–Whitney U statistic. Effect sizes were not reported in the statistical validation document.

Table VI. Responsiveness of Romanian RSES and Romanian K10 (Wilcoxon signed-rank tests).

Instrument	n (paired)	Median (pre)	Median (post)	W	p-value
RSES	42	2.20	2.35	17.50	<0.001
K10	42	1.90	1.50	112.00	<0.001

W = Wilcoxon signed-rank test statistic.

Table VII. Exploratory moderation: interaction between baseline distress and baseline self-esteem predicting pain outcomes.

Outcome	Interaction term	b	SE	p-value
Sensory pain	K10 × RSES	0.21	0.11	0.049
Affective pain	K10 × RSES	−0.11	0.06	0.059

b = unstandardized regression coefficient; SE = standard error.

Quantitative evaluation of the RSES and K10 measurement properties in the area of internal consistency reliability showed good internal consistency reliability of the RSES and excellent internal consistency reliability of the K10. Factor-analytic evaluation supported the interpretable scale structure of the RSES and K10. Construct validity was supported by the theory-based findings of the RSES and K10, which showed a strong relationship between distress and affective pain appraisal, as well as a non-significant relationship between self-esteem and the dimensions of pain. Finally, the results of the responsiveness evaluation showed a strong relationship, which is important in the dental clinical context, in which emotional state can change rapidly. In summary, the RSES and K10 are functioning as useful and interpretable instruments in the dental clinical context, and the results of the current study support the use of the Romanian versions of the RSES and K10 in dental clinical research in Romania [1,2].

Overall, the findings of the present study supported the research hypothesis. The Romanian versions of the Kessler Psychological Distress Scale (K10) and the Rosenberg Self-Esteem Scale (RSES) demonstrated satisfactory reliability, structural validity, and responsiveness in adult dental patients, supporting their use in this clinical context. In addition, the observed construct validity pattern, including the association of psychological distress with affective pain and the expected weak associations of self-esteem with pain dimensions, suggests that the instruments adequately reflect their intended theoretical constructs and are capable of detecting short-term affective changes during routine dental treatment.

Reliability and practical implications for dental workflows

Internal consistency was found to be satisfactory for the RSES ($\alpha = 0.77$ to 0.80) and good to excellent for the K10 ($\alpha = 0.91$). These findings are consistent with previous reports for the RSES and the K10 in community and clinical populations [4,14].

From a methodological standpoint, these levels of internal consistency suggest that the items comprising the RSES and the K10 measure a fairly coherent construct, yet retain enough item variability, which is important for heterogeneous populations found in dental clinical settings.

Meaningful interpretation of the scores from the PROMs is important, especially for between-person and within-person comparisons [3].

In the dental population, emotional states may change frequently because of anxiety about the treatment and relief after the treatment. In this context, reliable measures are necessary to interpret the score results accurately. In the context of the importance of

psychosocial factors in dental care, the need for reliable measures becomes clear [10,11].

From a practical standpoint, the brevity and reliability of the K10 and the RSES make these measures good candidates for a psychosocial assessment tool in dental studies.

Structural validity and score interpretation

The exploratory factor analysis (EFA) used in this study found interpretable two-factor solutions for both measures. The factor structure found in the RSES consisted of a polarity effect between positive and negative worded items. This has been found in all studies and is thought to be a “wording/method effect,” rather than a distinction between two types of self-esteem constructs [9,15,16]. The interpretation of total scores on the RSES appears to be the most justifiable course, pending evidence from confirmatory modeling in larger samples.

For the K10, the two-factor solution was consistent with the differentiation of somatic-anxious distress from emotional-depressive distress. This was also found in recent studies on the validation of the K10. Nevertheless, the K10 was found to be used as a total score tool for the assessment of overall nonspecific distress and for cross-study comparability [17-19]. For clinical research studies, factor level clustering may be interpreted as supportive evidence for structured item behavior but does not require subscale reporting.

Construct validity: expected and discriminating relationships

The finding that distress was related to affective pain appraisal but showed negligible association to both sensory and affective pain for self-esteem was found to be consistent with contemporary models of pain perception that highlight emotional and cognitive aspects in affective pain appraisal [20].

The use of the SF-MPQ was found to be appropriate for construct testing since it allows for the differentiation of sensory and affective pain components [13,20].

Known groups validity and responsiveness as measurement properties

Results of known groups analyses showed that there were differences in the pain outcomes between the different clinically defined subgroups, which supported the interpretability of the external construct in the validation framework. Responsiveness analyses showed there were significant changes in the outcomes of both instruments, which supported the sensitivity of the instruments to change over time. These results, in the context of the validation framework, support the responsiveness of the measurement tools rather than any psychological change, especially in the context of the time frame and the situational nature of the dental visit [3,1].

Limitations and recommended next steps

Although the sample size was adequate to support

the use of exploratory factor analysis and nonparametric validity tests, it is not adequate to support confirmatory factor analysis, the investigation of the effects of wordings in the RSES, and the examination of measurement invariance of the measurement tools in different demographic and clinical subgroups [3].

Future research studies are needed to support test-retest reliability, especially if the K10 will be used in threshold-based decision-making, in which the calibration of the measurement tool will be needed in the Romanian context [4].

Conclusions

The results suggest that the Romanian versions of the K10 and RSES are psychometrically sound measures in adult dental patients. The study succeeded in its aim by demonstrating the reliability, structural validity, construct validity, known groups validity, and responsiveness of the measures in a dental clinical context.

The cross-cultural adaptation process, which included the translation by an expert committee and cognitive debriefing, confirmed the feasibility and comprehension in routine dental care settings. Quantitative analysis supported the stability and internal consistency, interpretable factor structures, and construct validity, all of which were in line with theoretical predictions. Responsiveness findings supported the measures' ability to detect change over time in a clinical dental context, which would support the use of these measures in longitudinal designs.

The findings suggest that the Romanian version of the K10 and RSES could be used in dental clinical research and in the assessment of dental patients in Romania, specifically in the context of psychosocial measures in a patient reported outcome measures battery or as a covariate in models of patient reported experience.

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