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RESEARCH ARTICLE

TURKISH VERSION OF THE WORKING MEMORY QUESTIONNAIRE: RELIABILITY AND VALIDITY

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ABSTRACT

Introduction: The aim of this study was to develop the Turkish version of the Working Memory Questionnaire (WMQ-TR) and to examine the reliability and validity of the adapted version.
Material and Methods: The translation of the questionnaire was undertaken according to the international guidelines. The participants received an online survey including WMQ-TR and the Turkish Version of the Cognitive Failure Questionnaire (CFQ-TR). At two weeks after the first administration of the survey, the participants were asked to complete WMQ-TR again to examine test-retest reliability. Internal consistency (Cronbach's alpha coefficient) and construct validity (hypothesis testing) analyses were used to evaluate validity. The intra-class correlation coefficient (ICC) was used to determine test-retest reliability.
Results: The study was conducted with 303 healthy participants. The test-retest reliability of WMQ-TR was high (ICC=0.91, $p<0.001$), and Cronbach's alpha was 0.90. A moderate positive correlation was found between WMQ-TR and CFQ-TR ($r=0.61$, $p<0.001$).
Conclusion: WMQ-TR appears to have excellent test-retest reliability, acceptable construct validity, and good internal consistency.

Key Words: Working memory, reliability, validity, WMQ

INTRODUCTION

Working memory (WM) is defined as the ability to hold, change and store information for a short time (1-3). With aging, WM decreases as a result of changing brain interactions (4). However, WM deficits are not only seen in elderly individuals, but also in other diseases and conditions, including stroke (5), traumatic brain injury (6), Alzheimer's disease (7), stress (8), and fibromyalgia (9). In studies conducted with athletes, it has been reported that athletes with good WM perform better (10). Decreased WM negatively affects an individual's activities in daily living (5, 7); therefore, it is important to evaluate WM and identify and treat associated problems.

In clinical practice, WM is evaluated both objectively and subjectively. Although clinical methods, such as the n-back task (11) and the digit (backward) span (12) tests evaluate WM objectively, they do not provide information on the difficulties patients experience when performing daily life activities. Therefore, the evaluation of WM should be performed with a multi-dimensional approach. The Working Memory Questionnaire (WMQ) is a scale that subjectively evaluates WM (6).

WMQ is a self-administered questionnaire developed by Vallat-Azouvi to address the difficulties associated with WM in daily life. The authors examined the normative data of the questionnaire in healthy

individuals and determined its validity in patients with brain injuries (6). The Italian (13) and Farsi (14) versions of the questionnaire have also been published. However, it has not been adapted to the Turkish language and culture. The aim of this study was to develop the Turkish version of WMQ (WMQ-TR) and to investigate the validity and reliability of this version.

MATERIAL AND METHODS

This cross-sectional study was approved by the non-invasive ethics committee of Kütahya Health Sciences University (Date: 14/07/2020; Decision no: 2020/11-16). The study was conducted between August and December 2020 at Kütahya Health Sciences University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation.

Participants

Inclusion criteria were age >18 years or <65 years; not having any neurological problems and willingness to participate in the study. Individuals with neurological and mental disorders were excluded. According to the COSMIN guideline, the sample size should be at least seven times the number of items and include a minimum of 100 people for the calculation of sufficient statistical power to evaluate structural validity and internal consistency (15). Therefore, we aimed to reach 300 people in the study. Considering the maximum 25% possible loss rate, 400 individuals were included in the sample of the study (15).

Assessment Tools

Working Memory Questionnaire

WMQ, developed by Vallat-Azouvi et al., evaluates not only short-term memory but also attention and executive functions, including dual task, mental effort, and distraction. It consists of 30 questions, each scored on a five-point Likert-type scale ranging from 0 (not at all) to 4 (extremely). The total score varies between 0 and 120. Higher scores represent more memory difficulties/complaints. The internal consistency (Cronbach's alpha) of the scale was reported to be 0.93 (6).

Turkish Version of the Cognitive Failure Questionnaire

The Cognitive Failure Questionnaire (CFQ) was developed by Broadbent et al. as a self-report scale designed to evaluate daily memory failures and mental deficits. CFQ consists of 25 questions, each scored on a five-point Likert-type scale ranging from 0 (never) to 4 (always). The total score ranges from 0 to 100. High scores indicate increased cognitive impairment (16). The Turkish adaptation of CFQ (CFQ-TR) was undertaken by Ekici et al., and its internal consistency (Cronbach's alpha) and intra-class correlation coefficient (ICC) score were reported to be 0.90 (17).

Study Procedure

After the translation of WMQ to Turkish according to the international COSMIN guidelines (15, 18), WMQ-TR and CFQ-TR were sent to the participants on online platforms. After two weeks, WMQ-TR was sent by email to 180 people again to examine test-retest reliability.

Translation Procedure

Step I: Forward translation

Necessary permissions were obtained for the translation of WMQ to Turkish. The scale was translated from English to Turkish independently by two native speakers of Turkish who are fluent in English.

Step II: Synthesis

The two translations were then merged into a single version by a translation coordinator.

Step III: Back translation

The Turkish version was translated back into English by a native English speaker who is fluent in Turkish.

Step IV: Expert committee review

The expert committee consisted of translators, researchers, health and language experts. The opinions of the authors who developed the original version of the questionnaire were also taken to ensure that the intended meaning was maintained in the items of the scale. The expert committee reviewed all the translations and expert reports, made decisions on any inconsistencies, and created the pre-final version.

Step V: Pre-testing

A small sample was used for the pilot study of the pre-final version of the questionnaire (n = 10). The questionnaire was tested for clarity, and after necessary revisions were made, the final version was approved.

Statistical Analysis

Validity

Internal Consistency

Cronbach's alpha coefficients were calculated to assess internal consistency. A Cronbach's alpha coefficient equal to or greater than 0.70 indicates good internal consistency (19).

Construct Validity

Construct validity was assessed using the hypothesis test in the COSMIN guideline (20). Spearman's correlation coefficient 'r' was used for the correlation between WMQ-TR and CFQ-TR. Correlation strength was interpreted to be following; very strong (r= 0.90–1.00), strong (r = 0.70–0.89), moderate (r = 0.40–0.69), weak (r = 0.10–0.39) or negligible (r = 0.00–0.10) (21). Since both scales evaluate similar structures (cognitive and memory) (6, 13), the expected hypothesis of this analysis is a moderate positive correlation ($0.40 \leq r \leq 0.69$) between WMQ-TR and CFQ-TR. If this hypothesis is confirmed, the construct validity is considered sufficient (22).

Reliability and Measurement Error

Reliability refers to the proportion of total variance in the measurement of 'true' differences between participants (23). The ICC values (absolute agreement, two-way random effects model) were calculated as a measure of reliability. An ICC value of 0.70 and greater was considered sufficient (24). An ICC of 0.90-1.00 was accepted as excellent reliability, 0.70-0.89 as good reliability, 0.50-0.69 as moderate reliability, 0.30-0.49 as poor reliability, and 0.00-0.29 as very poor reliability (25). Measurement error was calculated with the standard error of measurement (SEM). Minimal detectable change (MDC) was calculated to refer the minimal amount of change outside of error (24).

Floor and Ceiling Effects

Floor/ceiling effects examine the proportion of participants with the lowest/highest score on a measurement. If the percentage is ≥15%, a floor/ceiling effect is considered to be present (22).

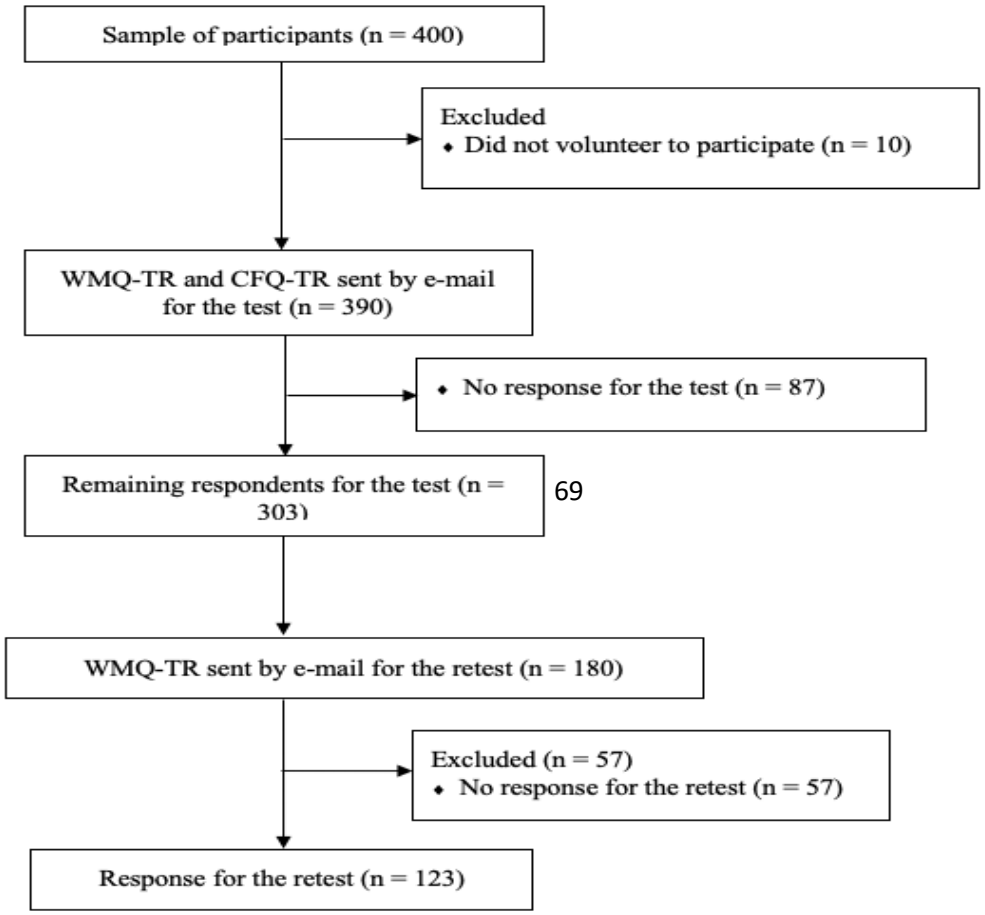

Figure 1. Flow diagram of the study

RESULTS

This study initially included 400 individuals, but 97 did not agree to participate in the study or did not complete the distributed scales. Thus, the analysis was performed on the data of 303 participants (response rate = 78%) with a mean age of 28.16 ± 8 years. Of the participants, 180 were asked to complete WMQ-TR a second time at a two-week interval to examine test-retest reliability, and 123 (68%) responded (Figure 1). The descriptive characteristics of the individuals and the mean, standard deviation and minimum-maximum scores of the scales are shown in Table 1.

Table 1. Demographic characteristics of the participants and mean, standard deviation and minimum-maximum scores of scales

Variable		n	%
Sex	Male	84	27.7
	Female	219	72.3
Education Level	High school	129	42.7
	Undergraduate degree	96	31.7
	Postgraduate degree	78	25.6
Place of Employment	Student	113	37.3
	Academic staff	61	20.1
	Physiotherapist	56	18.5
	Nurse	22	7.3
	Civil servant	21	6.9
	Teacher	19	6.3
	Midwife	11	3.6
	X ± SD	**Min-Max**	
WMQ-TR	32.79 ± 13.92	2-87	
CFQ-TR	34.4 ± 13.34	1-83	

n: number of cases; %: percent, X ± SD: mean ± standard deviation, Min-Max: minimum-maximum, WMQ-TR: Turkish version of the Working Memory Questionnaire, CFQ-TR: Turkish version of the Cognitive Failures Questionnaire

Reliability

The Cronbach's alpha coefficient of WMQ-TR was determined as 0.90. The deletion of no item in WMQ-TR increased the Cronbach alpha value (Table 2). The test-retest reliability of the scale was excellent [ICC (2,1) = 0.91, 95% confidence interval (CI): 0.87-0.94, $p < 0.001$). SEM was calculated as 4.18, and MDC as 11.59.

Validity

There was a statistically significant correlation between WMQ-TR and CFQ-TR ($r = 0.61$, $p < 0.001$). The floor-ceiling effect was not greater than 1%, and therefore this effect was considered to be not present in our study.

A priori hypothesis was supported, indicating satisfactory construct validity. A moderate positive correlation was found between WMQ-TR and CFQ-TR ($r = 0.61$, $p < 0.001$) (Table 3).

DISCUSSION

Cognitive disorders affect the quality of life negatively because they cause deviations and errors in daily activities (16). This negative effect is even more pronounced when an individual's attention is reduced and memory is overloaded due to high work capacity. Although cognitive failure is a very common and important problem, the number of scales developed for its assessment is limited, and to the best of our knowledge, there is no Turkish scale in the literature that specifically assesses difficulties related to WM. Therefore, the aim of the current study was to evaluate the validity and reliability of the Turkish adaptation of WMQ, which is a self-administered scale measuring difficulties related to WM in daily life. According to the results of our study, WMQ-TR is a reliable and valid tool.

Internal consistency which indicates the reliability of the scale determines whether the items are correlated to with each other. In the current study, the internal consistency of WMQ-TR was determined to be excellent. The internal consistency of WMQ-TR was similar to the original scale (6) and the Farsi version (14). The internal consistency of the Italian version (13) has not yet been evaluated.

The test-retest reliability of WMQ-TR was found to be excellent in our study. Similarly, test-retest reliability was previously reported to be excellent in CFQ-TR, in which cognitive disorders were evaluated in general. The acceptable internal consistency, test-retest reliability, SEM and MDC values we obtained from WMQ-TR confirm that this scale is reliable. Since these values have not been reported in the other versions of WMQ, we consider that our data will make an important contribution to the literature.

Construct validity is another important concept in adapting assessment tools to different languages. In the literature, there is no other scale specifically evaluating WM. Therefore, the construct validity of the different language versions of WMQ was examined using a similar scale, CFQ (6, 13). Hypothesis testing was used to support the construct validity of WMQ-TR. As hypothesized, the correlation

Table 2. Item analyses of WMQ-TR

Item no	X ± SD	Item-to-total correlation	Cronbach's alpha if item deleted	Item no	X±SD	Item-to-total correlation	Cronbach's alpha if item deleted
1	1.67 ± 0.82	0.36	0.89	**16**	2.10 ± 0.99	0.53	0.89
2	1.32 ± 0.99	0.35	0.90	**17**	0.50 ± 0.83	0.41	0.89
3	1.25 ± 0.93	0.39	0.89	**18**	0.69 ± 0.79	0.40	0.89
4	0.89 ± 0.94	0.52	0.89	**19**	1.10 ± 0.97	0.48	0.89
5	1.39 ± 1.19	0.39	0.89	**20**	1.98 ± 1.02	0.57	0.89
6	1.30 ± 1.01	0.26	0.90	**21**	0.64 ± 0.81	0.50	0.89
7	1.37 ± 0.93	0.54	0.89	**22**	1.22 ± 1.03	0.29	0.90
8	1.37 ± 1.17	0.45	0.89	**23**	0.75 ± 1.02	0.41	0.89
9	0.49 ± 0.75	0.51	0.89	**24**	0.83 ± 0.91	0.47	0.89
10	1.26 ± 1.04	0.47	0.89	**25**	1.39 ± 1.02	0.45	0.89
11	1.50 ± 0.83	0.55	0.89	**26**	0.69 ± 0.81	0.46	0.89
12	1.10 ± 0.98	0.50	0.89	**27**	1.06 ± 0.86	0.51	0.89
13	0.52 ± 0.81	0.46	0.89	**28**	0.95 ± 0.86	0.46	0.89
14	0.87 ± 0.82	0.53	0.89	**29**	0.81 ± 0.97	0.30	0.90
15	0.77 ± 0.78	0.56	0.89	**30**	1.00 ± 0.87	0.50	0.89

X ± SD: mean ± standard deviation, WMQ-TR: Turkish version of the Working Memory Questionnaire

Table 3. Relationship between the WMQ-TR and CFQ-TR

Instruments	Hypothesized correlation	Observed correlation
WMQ-TR and CFQ-TR	$0.40 \leq r \leq 0.69$	0.61^{*}

*p≤0.001, r: Spearman correlation coefficient

between WMQ-TR and CFQ-TR was moderate. Similarly, a moderate positive correlation was reported between the Italian version of the WMQ (13) and the CFQ. In addition, for the original version of WMQ, it was reported that there was a high level of positive correlation with CFQ (6).

Although traditional tests using pen and paper are generally used in the evaluation of cognitive disorders, it has been reported that an online survey is also a sensitive and reliable method in identifying moderate cognitive disorders (26, 27). In addition, with the use of online surveys, more people can be reached and data can be obtained at a lower cost (28). In our study, we preferred to perform the scales online, since we aimed to reach more participants in a short time.

This study has certain limitations. Firstly, no criteria were used regarding possible psychological disorders (depression, anxiety, etc.) that might have affected the participants' performance in cognitive tests, especially those related to memory. Secondly, the low number of participants in the re-test compared with of beginning of the study was another limitation. Lastly, the participants in our study consisted of only healthy individuals, although difficulties with WM are frequently seen in individuals with pathologies such as chronic pain and brain damage.

The results of this study show that WMQ-TR, as in the original (6), Italian (13) and Farsi (14) versions of the scale is a valid and reliable scale to assess WM difficulties in healthy individuals. Future studies can be planned for the use of this scale in patient groups, such as fibromyalgia syndrome, chronic low back pain, and brain injury.

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Conflict of interests: The authors declare no conflict of interest.

Ethical approval: This study was approved by the noninvasive ethics committee of Kütahya Health Sciences University (Date: 14/07/2020; Decision no: 2020/11-16).

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REFERENCES

1. Goldman-Rakic PS. Cellular basis of working memory. Neuron 1995;14(3),477-485.
2. Chatham CH, Badre D. Multiple gates on working memory. Current opinion in behavioral sciences 2015;1:23-31.
3. Baddeley A. Working memory. Science 1992;255(5044):556-9.
4. Pläschke RN, Patil KR, Cieslik EC, et al. Age differences in predicting working memory performance from network-based functional connectivity. Cortex 2020;132:441-459.
5. Fitri FI, Fithrie A, Rambe, AS. Association between working memory impairment and activities of daily living in post-stroke patients. Med Glas (Zenica) 2020;17(2):433-438.
6. Vallat-Azouvi C, Pradat-Diehl P, Azouvi P. The Working Memory Questionnaire: A scale to assess everyday life problems related to deficits of working memory in brain injured patients. Neuropsychological rehabilitation 2012;22(4):634-649.
7. Kirova AM, Bays RB, Lagalwar S. Working memory and executive function decline across normal aging, mild cognitive impairment, and Alzheimer's disease. BioMed research international 2015;2015.
8. Goodman JB, Freeman EE, Chalmers KA. The relationship between early life stress and working memory in adulthood: A systematic review and meta-analysis. Memory 2019;27(6):868-880.
9. Ferrera D, Gómez-Esquer F, Peláez I, et al. Effects of COMT Genotypes on Working Memory Performance in Fibromyalgia Patients. Journal of Clinical Medicine 2020;9(8):2479.
10. Vaughan RS, Laborde S. Attention, working-memory control, working-memory capacity, and sport performance: The moderating role of athletic expertise. European journal of sport science 2021;21(2):240-249.
11. Calamia M, Markon K, Tranel D. Scoring higher the second time around: meta-analyses of practice effects in neuropsychological assessment. The Clinical Neuropsychologist 2012;26(4):543-570.
12. Kane MJ, Engle RW. The role of prefrontal cortex in working-memory capacity, executive attention, and general fluid intelligence: An individual-differences perspective. Psychonomic bulletin & review 2002;9(4):637-671.
13. Guariglia P, Giaimo F, Palmiero M, Piccardi L. Normative data and validation of the Italian translation of the Working Memory Questionnaire (WMQ). Applied Neuropsychology: Adult 2020;27(4),376-389.
14. Arjmandnia AA, Gholam Ali Lavasani, M, Hajian Z, Maleki S. Psychometric Properties of the Farsi Version of Adults Working Memory Questionnaire (WMQ). Journal of Applied Psychological Research 2017;8(2):97-112.
15. Mokkink LB, Prinsen CA, Patrick DL,et al. COSMIN Study Design checklist for Patient-reported outcome measurement instruments. Amsterdam, The Netherlands; 2019.
16. Broadbent DE, Cooper PF, FitzGerald P, Parkes KR. The cognitive failures questionnaire (CFQ) and its correlates. British journal of clinical psychology 1982;21(1):1-16.
17. Ekici G, Uysal, S. A., & Altuntaş, O. The validity and reliability of Cognitive failures questionnaire in university students. Fizyoterapi Rehabilitasyon 2016;27(2):55-60.

18. Beaton DE, Bombardier C, Guillemin F, Ferraz MB. Guidelines for the process of cross-cultural adaptation of self-report measures. Spine 2000;25(24):3186-3191.
19. Nunnally JC. Psychometric theory 3E. Tata McGraw-hill education; 1996.
20. Prinsen CA, Mokkink LB, Bouter LM, et al. COSMIN guideline for systematic reviews of patient-reported outcome measures. Quality of Life Research 2018;27(5):1147-1157.
21. Schober P, Boer C, Schwarte LA. Correlation coefficients: appropriate use and interpretation. Anesthesia & Analgesia 2018;126(5),1763-1768.
22. Terwee CB, Bot SD, de Boer MR, et al. Quality criteria were proposed for measurement properties of health status questionnaires. Journal of clinical epidemiology 2007;60(1):34-42.
23. Mokkink, L. B., Terwee, C. B., Patrick, D. L., et al. The COSMIN study reached international consensus on taxonomy, terminology, and definitions of measurement properties for health-related patient-reported outcomes. Journal of clinical epidemiology 2010;63(7):737-745.
24. De Vet HC, Terwee CB, Mokkink LB, Knol DL editors. Measurement in medicine: a practical guide. Cambridge university press; 2011.
25. Koo TK, Li MY. A guideline of selecting and reporting intraclass correlation coefficients for reliability research. Journal of chiropractic medicine 2016;15(2):155-163.
26. Di Girolamo M, Giromini L, Winters CL, Serie CM, De Ruiter C. The questionnaire of cognitive and affective empathy: A comparison between paper-and-pencil versus online formats in Italian samples. Journal of Personality Assessment 2019;101(2):159-170.
27. Seelye A, Mattek N, Howieson DB, et al. Embedded online questionnaire measures are sensitive to identifying mild cognitive impairment. Alzheimer disease and associated disorders 2016;30(2):152.
28. Hohwü L, Lyshol H, Gissler M, Jonsson SH, Petzold M, Obel C. Web-based versus traditional paper questionnaires: a mixed-mode survey with a Nordic perspective. Journal of medical Internet research 2013;15(8):e173.