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# MOTOR IMAGERY ABILITY IN TURKISH-SPEAKING STROKE PATIENTS: STUDY ON RELIABILITY AND CONSTRUCT VALIDITY STUDY OF TWO IMAGERY QUESTIONNAIRES

**ORIGINAL ARTICLE**

## ABSTRACT

**Purpose:** Motor imagery is considered as a complementary approach for functional recovery after stroke. Thus, applying reliable assessment tools to measure imagery ability in stroke is essential. The aims of this study were to apply Turkish versions of the Movement Imagery Questionnaire-3 (MIQ-3) and the Kinesthetic and Visual Imagery Questionnaire-20 (KVIQ-20) in individuals with stroke and investigate the validity and reliability of both questionnaires.

**Methods:** Stroke patients with mild functional impairments (n=31) and healthy volunteers who age- and gender-matched were selected as a control group (n=29) were recruited to the study. The test-retest reliability was assessed using intra-class correlation coefficients (ICCs). Spearman's correlation analysis was performed to assess concurrent validity of the KVIQ-20 with the MIQ-3. Furthermore, the internal consistency (Cronbach's alpha) and factorial structures of both questionnaires were investigated.

**Results:** Each sub-score of the MIQ-3 was found statistically different between stroke and control groups ($p<0.001$). Only visual sub-score of the KVIQ-20 yielded statistically different between stroke and control groups ($p<0.001$). ICC values were in the acceptable level of reliability (0.571-0.850). Both questionnaires had good internal consistency with high Cronbach's alpha (Cronbach's alpha test/retest for MIQ-3=0.941/0.970; test/retest=0.971/0.981 for KVIQ-20.). The concurrent validity between the KVIQ-20 and MIQ-3 was good ($r=0.40$, $p<0.05$). Exploratory factor analysis confirmed that MIQ-3 had three-factor and KVIQ-20 had two-factor structure. These obtained factors were explaining 88.99% and 80.87% of the total variance, respectively.

**Conclusion:** Turkish versions of the MIQ-3 and KVIQ-20 are the tools with good reliability and validity to assess motor imagery ability in stroke patients with mild functional impairments.

**Keywords:** Body Image; Imagination; Kinesthesis; Stroke.

# TÜRKÇE-KONUŞAN İNME HASTALARINDA MOTOR İMGELEME YETENEĞİ: İKİ İMGELEME ANKETİNİN GÜVENİRLİK VE YAPI GEÇERLİK ÇALIŞMASI

**ARAŞTIRMA MAKALESİ**

## ÖZ

**Amaç:** Motor imgeleme, inme sonrası fonksiyonel iyileşme için tamamlayıcı bir yaklaşım olarak kabul edilir. Bu nedenle, inmede imgeleme yeteneğini ölçmek için güvenilir değerlendirme araçlarının uygulanması gereklidir. Bu çalışmanın amacı, inmeli bireylerde Hareket İmgeleme Anketi-3 (HİA-3) ve Kinestetik ve Görsel Görüntüleme Anketi-20'nin (KGİA-20) Türkçe versiyonlarını uygulamak ve her iki anketin geçerlilik ve güvenilirliğini araştırmaktı.

**Yöntem:** Hafif fonksiyonel bozukluğu olan inme hastaları (n=31) ile yaş ve cinsiyet açısından eşleştirilmiş sağlıklı gönüllü bireyler kontrol grubu olarak (n=29) çalışmaya dâhil edildi. Test-tekrar test güvenilirliği, sınıf içi korelasyon katsayılarıyla (ICC) değerlendirildi. KGİA-20'nin HİA-3 ile eşzamanlı geçerliliğini değerlendirmek için Spearman'ın korelasyon analizi gerçekleştirildi. Ayrıca, her iki anketin iç tutarlılığı (Cronbach alfa) ve faktör yapıları araştırıldı.

**Sonuçlar:** HİA'nin her alt bölümü, inme ve kontrol grupları arasında istatiksel olarak farklı bulundu ($p<0,001$). KGİA-20'nin sadece görsel alt skoru, inme ve kontrol grupları arasında istatistiksel olarak farklıydı ($p <0,001$). ICC değerleri kabul edilebilir güvenirlik seviyesindeydi (0,571-0,850). Her iki anket de yüksek Cronbach alfa ile iyi bir iç tutarlılığa sahipti (Cronbach alfa HİA-3 için test/tekrar test=0,941/0,970; KGİA-20 için test/tekrar test=0,971/0,981). KGİA-20 ve HİA-3 arasındaki eşzamanlı geçerlilik iyiydi ($r = 0,40$, $p <0,05$). Açıklayıcı faktör analizi HİA'nin üç faktörlü ve KGİA-20'nin iki faktörlü yapıya sahip olduğunu doğruladı. Elde edilen bu faktörler toplam varyansın sırası ile %88,99 ve %80,87'sini açıklamaktaydı.

**Tartışma:** HİA-3 ve KGİA-20'nin Türkçe versiyonları, hafif fonksiyonel bozukluğu olan inme hastalarında motor imgeleme yeteneğini değerlendirmek için iyi güvenirlik ve geçerliliğe sahip araçlardır.

**Anahtar kelimeler:** Vücut imajı; İmgeleme; Kinestezi; İnme.

## INTRODUCTION

Motor imagery is a cognitive process defined as mental rehearsal of visual and kinesthetic properties of bodily movements without physical activity (1,2). In several neurophysiological studies, it has been claimed that a desire to move a body part, conceptualizing a physical movement or observing a physical action are among a series of mental tasks that activate the sensorimotor area of the brain in the way physical actions do (1,3,4). Motor imagery trainings which have been integrated with several techniques in behavioral and psychological areas lead to make progress in different types of skills in healthy population and also in individuals with neurological diseases (4-7). Studies have also demonstrated that motor imagery practices improve cognitive parameters and motor performance in stroke rehabilitation (8-10). It is significant to manage motor imagery strategies with appropriate assessment tools to evaluate patients' imagery ability in stroke rehabilitation. Since people with brain damage suffer from several problems such as difficulty in concentrating on a task, performing physical actions, and thinking about abstract concepts, the use of reliable and valid imagery assessment tools for motor imagery is more crucial for their benefit (6,7,11).

The use questionnaires to measure imagery ability is considered as a relevant topic in the literature (2,7) and they were discussed in detail (6,7,11). Such tools aim to evaluate the vividness or ease/difficulty of an imagination task by using different imagery strategies (2,5,7). Movement Imagery Questionnaire (MIQ) (1983) is the first reliable and widely used tool for measuring imagery ability (5,12) and its first revised version was named as Movement Imagery Questionnaire-Revised (MIQ-R) (1997) (13). The last updated version of the questionnaire is MIQ-3 and it assesses an individual's ability to imagine four movements with external visual perspective, internal visual perspective, and kinesthetic imagery (14). As a result, a total of twelve movements are evaluated, and imagination of these movements is rated by asking the participant about the ease or difficulty of the imagery task according to a-seven-point Likert Scale. In the related studies, it has been demonstrated that these questionnaires are reliable and valid tools in different types of populations such as dancers, athletes, and stroke patients (2,13,14). Kinesthetic and Visual Imagery Questionnaire-20 (KVIQ-20) has been developed to assess imagery ability of the disabled individuals who are not able to stand still or perform complex physical movements (7). KVIQ-20, which is suitable for the physically disabled people who need guidance in applying imagery questionnaires, assesses the vividness of visual and kinesthetic dimensions of motor imagery according to a-five-point ordinal scale. KVIQ-20 is a valid and reliable tool both in able-body groups and in stroke patients (7,15).

Different features of both questionnaires were determined in the literature (7,11). MIQ-3 does not measure imagery vividness directly. Instead, it is used to score the ease or difficulty of imagery. While MIQ-3 includes different perspectives of imagery (external vs internal), KVIQ-20 assesses the movements imagined only from internal perspective. MIQ-3 has advantages as a self-reporting questionnaire and includes tasks that demands high physical activity. Therefore, patient safety must be observed if the individuals with physical disabilities take MIQ-3. However, KVIQ-20, which is not a self-administered test, contains of simple, one-joint axis movements of the limbs, head, and trunk in a sitting position. Hence, both imagery questionnaires offer different advantages and disadvantages in assessing imagery ability.

As far as we know, there are not any studies that evaluate imagery performance with questionnaires in a Turkish-speaking stroke population. Therefore, this study aims to apply the Turkish versions of the KVIQ-20 and the MIQ-3 in a group of Turkish stroke patients with mild functional impairments and to investigate their internal consistency and factorial structure.

## METHODS

A cross sectional design was used to assess the psychometric properties of the Turkish versions of the MIQ-3 and KVIQ-20 in stroke patients with mild functional impairments. The study has been conducted in accordance with the principles of the Declaration of Helsinki and written informed con-

sent was obtained from each participant. All participants were informed about the purpose of the study and written informed consent obtained from all participants. This study was conducted at Medipol Mega University Hospital from February 2017 to March 2018. Ethical approval was obtained from Non-Interventional Ethics Committee of Istanbul Medipol University (Approval number: E4262, date: 15.02.2017).

**Participants**

The sample size was estimated with G*Power 3.1.7 for Windows (G*Power from University of Düsseldorf, Düsseldorf, Germany)(16). The effect size in this study was 0.30, considered to be a small effect using Cohen's (1988) criteria (17) and alpha was 0.05. The result showed that a total sample of 50 subjects with two equal-sized groups of n=25 was required to achieve a power of 0.80. All individuals in the stroke group (n=31) had a neurologist-confirmed diagnosis of stroke. Healthy volunteers (n=29) whose ages and genders matched with the stroke group were included in the control group. Five criteria were set for the participants in the stroke group. They were included in the stroke group if 1) they were between the ages of 40–80; 2) had a unilateral stroke for the first time; 3) agreed not to attend any therapeutic interventions during the study; 4) got 27 or a higher score from the Mini-Mental Status Examination (MMSE) (18); 5) got ≥79 points as a total score from the Fugl-Meyer Assessment (FMA) indicating mild motor impairment (19). The exclusion criteria for stroke group were: 1) severe aphasia and perceptual impairments (apraxia, hemineglect, etc.); 2) severe cognitive impairments (<27 from MMSE); 3) severe motor impairment (<79 points as a total score from FMA); 4) clinical conditions that involve other neurological diseases (Parkinson's disease, dementia, etc.) or musculoskeletal impairments (amputation, etc.). The volunteers who did not report any neurological disease or cognitive problem were included in the control group.

**Evaluation**

All participants were asked to complete a socio-demographic form about their age, gender, height, and weight. Handedness was determined according to the Edinburgh Handedness Inventory Questionnaire (20). To define the characteristics of the stroke group, additional information such as the time elapsed since stroke (days) and the side of stroke lesion (right/left) were obtained.

Fugl-Meyer Assessment (FMA): The FMA evaluates reflex activity, coordination, and voluntary movement in and out of synergy patterns (21). Thirty-three items are rated on a 3-point ordinal scale and total possible maximum score is 226. Lower scores indicate a higher degree of impairment. The scale has high intra-rater reliability, inter-rater reliability, and construct validity (22). FMA was used to determine the degree of motor impairment in the stroke group and the scores of ≥79 in total were accepted as mild motor impairment (according to the relevant study in the literature) (19).

Movement Imagery Questionnaire-3 (MIQ-3): The Turkish version of the MIQ-3 (23) consists of 12 items that assess an individual's ability to imagine four movements (raising legs, jumping, arm abduction-adduction, and bending forward) by using visual imagery from internal or external perspective and kinesthetic imagery (14). Firstly, the movements in the questionnaire were physically performed and following, imagination of these movements were requested. Later, the participants rated their vividness of imagination from 1 (very hard to see/feel) to 7 (very easy to see/feel) for each item. The subscale scores of MIQ-3 can range from 4 to 28 (23). Higher scores indicate higher movement imagery ability. It took approximately 40 minutes to administer all procedures.

Kinesthetic and Visual Imagery Questionnaire-20 (KVIQ-20): The Turkish version of the KVIQ-20 (15) includes 10 visual and 10 kinesthetic items. The items are presented in the same order as they are in the original version. In administrating the KVIQ-20 the procedures outlined by Malouin et al. were followed (7). Firstly, the participants were asked to assume "start position". Secondly, they were asked to perform a described movement only once. Thirdly, they returned to "the start position" and imagined the same movement without performing any physical activity. Finally, the participants were asked to rate the clarity of visual image or the intensity of sensations associated with the imagined movement according to a 5-point ordinal scale (1:

"very hard" to 5: "very easy"). It took approximately 40 minutes to administer all procedures.

To evaluate the test-retest reliability of the MIQ-3 and KVIQ-20, the participants in the stroke group were assessed twice, and there were seven days between the first and the second assessments. In administrating both questionnaires, participants were guided by a physiotherapist.

### Statistical Analyses

The Statistical Package for the Social Sciences (SPSS version 22.0; IBM, Chicago, IL, USA) was used for the statistical analysis in the study. The level of significance was determined to be 0.05. Statistical calculations were done by using arithmetic mean ± standard deviation (SD) for the variables defined by measurement, and by percent (%) values for the variables defined by counting. The Kolmogorov-Smirnov Test was used to verify the normality of the distribution. Mann-Whitney U test was used for the comparisons between the groups. Spearman's rank correlation coefficient (Spearman rho) was used to find about the relation between demographic information and imagery scores. Cronbach's alpha was used to assess the internal consistency of the stroke patients' responses. Internal consistency with a coefficient greater than 0.7 was regarded "acceptable", 0.8 at minimum "good", and higher than 0.9 "excellent" (24). Intra-class correlation coefficients (ICCs) and two-way random model (consistency type) were used to estimate the dependent variable reliability: a 95% confidence interval (CI) was used to describe the variety/difference in ICCs. ICC values were considered "very high" if they were higher than 0.90; "high" if they were between 0.70 and 0.89; and "moderate" if they were between 0.50 and 0.69 (25). The concurrent validity of the KVIQ-20 with the MIQ-3 was examined with the spearman's correlation analysis. MIQ-3 was accepted as the gold standard to measure imagery ability (13,14). Finally, Exploratory Factor Analysis (EFA) was performed to examine factor structure of both questionnaires according to the data obtained from stroke group. Based on the expectation of visual and kinesthetic factors to be correlated, oblique rotation was used. Principal Component Analysis was used to confirm the three-factor structure of the MIQ-3 and two-factor structure of the KVIQ-20. The Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity were calculated for sampling adequacy. Eigen value was used to determine the significant components and factorial structure of both questionnaires. Factor loadings that exceeded the value of 0.50 was accepted as satisfactory (26).

## RESULTS

Demographic data about the groups was given at Table 1. The relationship between the demographic data and the imagery scores of the groups were analyzed but no statistical difference was found ($p>0.05$).

Total and sub-scores of the questionnaires for each group were showed at Table 2. Statistically significant differences were found between the groups with regard to each sub-score of the MIQ-3 and the

**Table 1:** Demographic Characteristics of Participants.

| | Stroke (n=31) Mean±SD | Control (n=29) Mean±SD | Statistical Value | p |
|---|---|---|---|---|
| **Age (years)** | 59.06±9.06 | 56.00±9.61 | -1.08 | 0.28 |
| **Height (cm)** | 165.32±8.42 | 169.03±8.54 | -1.71 | 0.09 |
| **Weight (kg)** | 75.48±10.10 | 75.48±10.63 | -0.55 | 0.58 |
| **Gender (Male/Female) (%)** | 48.40/51.60 | 48.3/51.7 | 0.07 | 0.80 |
| **Handedness (Right/Left) (%)** | 90.30/9.70 | 82.8/17.2 | 0.74 | 0.38 |
| **Time Elapsed Since Stroke** (min=66, max=1460 days) | 365.70±299.35 | - | - | - |
| **Side of Stroke Lesion[#] (Right/Left) (%)** | (30/70) | - | - | - |
| **Fugl-Meyer Assessment** (min=79, max=98 points) | 92.30±6.50 | - | - | - |

SD: Standard deviation; Min: minimum; Max: maximum [#]: side of the stroke lesion could not be determined for one participant.

**Table 2:** Imagery Scores for Each Group.

| Imagery Sub-Types | Stroke (n=31) | | Control (n=29) |
|---|---|---|---|
| | 1st administration Mean±SD | 2nd administration Mean±SD | Mean±SD |
| **MIQ-3** | | | |
| Internal Visual | 15.87±3.52 | 15.19±3.30 | 16.55±3.36* |
| External Visual | 15.97±3.32 | 15.48±3.34 | 16.79±3.42* |
| Kinesthetic | 15.97±3.24 | 15.32±3.52 | 16.62±3.18* |
| **KVIQ-20** | | | |
| Visual | 38.84±8.16 | 40.39±8.16 | 42.86±7.67* |
| Kinesthetic | 38.10±8.63 | 39.61±8.51 | 40.03±8.84 |
| Total | 76.94±16.71 | 80.00±16.64 | 82.90±16.02 |

MIQ-3: Movement Imagery Questionnaire-3, KVIQ-20: Kinesthetic and Visual Imagery Questionnaire-20. , SD: Standard deviation. , *: indicates the statistical differences between stroke and control group (performed by Mann-Whitney U test)

visual sub-scores of the KVIQ-20 ($p<0.001$).

Results about the internal consistency, the test-re-test reliability, and the correlation coefficients of the imagery questionnaires for stroke group were given at Table 3. Cronbach's alpha (α) values showed a high internal consistency for both questionnaires (Cronbach's α test/retest= 0.941/0.970 for the MIQ-3; test/retest=0.971/0.981 for the KVIQ-20). The ICC values of both questionnaires were regarded "acceptable" (the lowest: 0.571 and the highest: 0.850). Overall, the analyses showed that both questionnaires have "good" test-retest reliability for the stroke group.

We found a statistically significant positive correlation between the total scores of the MIQ-3 and the KVIQ-20 ($r=0.40$, $p<0.05$). Significant statistical correlations between these two questionnaires were also explored based on the visual and kinesthetic aspects ($r=0.44$, $p<0.001$ for visual sub-scores and $r=0.36$, $p=0.05$ for kinesthetic sub-scores).

KMO and Bartlett's sphericity test results revealed that both questionnaires had good fit indexes with KMO (0.896 for the MIQ-3 and 0.863 for the KVIQ-20) and Bartlett's test of sphericity ($x^2=1010.60$, df = 66, $p<0.001$ for the MIQ-3; $x^2=1887.60$, df = 190, $p<0.001$ for the KVIQ-20). These results demonstrated that the sample size in the study was adequate to perform EFA. Three-factor structure of the MIQ-3 and two-factor structure of the KVIQ-20 were confirmed with an eigenvalue higher than 1 (Table 4). The total variance was approximately 88.99% for the MIQ-3 and 80.87% for the KVIQ-20.

**Table 3:** Internal Consistency and Test-Retest Reliability for Stroke Group (n=31).

| | Cronbach's α | | ICC | 95%CI | Cronbach's α if Item Deleted |
|---|---|---|---|---|---|
| | Test | Retest | | | |
| **MIQ-3** | | | | | |
| Internal Visual | 0.914 | 0.914 | 0.571 | 0.433-0.718 | 0.936 |
| External Visual | 0.936 | 0.935 | 0.645 | 0.515-0.775 | 0.933 |
| Kinesthetic | 0.947 | 0.910 | 0.690 | 0.567-0.807 | 0.932 |
| Total | 0.941 | 0.970 | 0.665 | 0.536-0.791 | 0.970 |
| **KVIQ-20** | | | | | |
| Kinesthetic | 0.941 | 0.949 | 0.652 | 0.528-0.778 | 0.964 |
| Visual | 0.944 | 0.957 | 0.691 | 0.573-0.806 | 0.966 |
| Total | 0.971 | 0.981 | 0.850 | 0.767-0.915 | 0.981 |

MIQ-3: Movement Imagery Questionnaire-3, KVIQ-20: Kinesthetic and Visual Imagery Questionnaire-20. , ICC: intra-class correlation coefficients, CI: Confidence Interval.

**Table 4:** Exploratory Factor Analysis of Both Questionnaires for Stroke Group (n=31).

| MIQ-3 Component | Total Variance Explained | | | | | | |
|---|---|---|---|---|---|---|---|
| | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings |
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total |
| 1 | 9.16 | 76.33 | 76.33 | 9.16 | 76.33 | 76.33 | 8.55 |
| 2 | .82 | 6.81 | 83.14 | .82 | 6.81 | 83.14 | 7.82 |
| 3 | .70 | 5.84 | 88.99 | .70 | 5.84 | 88.98 | .81 |
| 4 | .41 | 3.41 | 92.40 | | | | |
| 5 | .30 | 2.49 | 94.89 | | | | |
| 6 | .22 | 1.81 | 96.70 | | | | |
| 7 | .09 | .82 | 97.52 | | | | |
| 8 | .08 | .73 | 98.24 | | | | |
| 9 | .07 | .61 | 98.86 | | | | |
| 10 | .05 | .46 | 99.31 | | | | |
| 11 | .05 | .40 | 99.72 | | | | |
| 12 | .03 | .28 | 100.00 | | | | |
| **KVIQ-20 Component** | | | | | | | |
| 1 | 14.45 | 72.27 | 72.26 | 14.45 | 72.26 | 72.26 | 12.75 |
| 2 | 1.72 | 8.61 | 80.87 | 1.72 | 8.60 | 80.86 | 12.72 |
| 3 | .90 | 4.51 | 85.37 | | | | |
| 4 | .61 | 3.07 | 88.45 | | | | |
| 5 | .41 | 2.05 | 90.50 | | | | |
| 6 | .40 | 1.98 | 92.48 | | | | |
| 7 | .30 | 1.51 | 93.99 | | | | |
| 8 | .25 | 1.27 | 95.23 | | | | |
| 9 | .22 | 1.09 | 96.36 | | | | |
| 10 | .18 | .88 | 97.25 | | | | |
| 11 | .14 | .67 | 97.92 | | | | |
| 12 | .11 | .54 | 98.46 | | | | |
| 13 | .08 | .40 | 98.86 | | | | |
| 14 | .06 | .30 | 99.17 | | | | |
| 15 | .05 | .24 | 99.41 | | | | |
| 16 | .05 | .22 | 99.64 | | | | |
| 17 | .03 | .14 | 99.78 | | | | |
| 18 | .02 | .11 | 99.88 | | | | |
| 19 | .01 | .07 | 99.95 | | | | |
| 20 | .01 | .05 | 100.00 | | | | |

Extraction Method: Principal Component Analysis.

Since the factor loadings higher than 0.50 were taken into consideration, the items with high factor loadings in more than one factor were removed from the scale. After removing the irrelevant items, a further analysis was completed. For the MIQ-3, two items (4 and 10) were loaded on Factor 1 (kinesthetic imagery) (0.81 and 0.68, respectively); two items (3 and 9) were loaded on Factor 2 (external visual imagery) (0.75 and 0.81, respectively) and two items (2 and 11) were loaded on Factor 3 (internal visual imagery) (0.72 and 0.80, respectively). For the KVIQ-20, five items (1,2,3,7, and

9) were loaded on Factor 1 (kinesthetic imagery) (0.72; 0.87; 0.97; 0.93; and 0.89 respectively); and five items (4,5,6,8, and 10) were loaded on Factor 2 (visual imagery) (0.90; 0.98; 0.52; 0.94; and 0.88, respectively).

## DISCUSSION

This study demonstrates that the Turkish versions of the Movement Imagery Questionnaire-3 (MIQ-3) and Kinesthetic and Visual Imagery Questionnaire-20 (KVIQ-20) are valid and reliable in stroke patients with mild motor impairment. Both questionnaires have been translated into several different languages and used to for assess the imagery ability in able-body groups and people with physical disabilities (2,7,11,27-30). This study is the first to show the reliability, the internal consistency, and the factorial structure of the imagery questionnaires in a Turkish-speaking stroke population.

In our study, significant differences in imagery abilities were found between the stroke group and control group with respect to their imagery abilities. Each MIQ-3 sub-score (internal, external, and kinesthetic) was statistically higher in the control group. Likewise, both sub-scores of the KVIQ-20 (visual and kinesthetic) were higher in the control group, however, only visual imagery scores showed a statistically difference between the groups. Although the KVIQ-20 was developed for individuals with physical impairments and is more appropriate than the MIQ-3 in the way of discriminating visual and kinesthetic aspects of the imagery, in our study we could not determine the differences between sub-scores via KVIQ-20. It is possible that this lack of difference may have appeared as a result of having relatively small sample size. Thus, future studies with larger sample sizes are needed to investigate the relations between these variables. Since stroke patients may have cognitive problems such as paying attention to a task and concentration on a duty (31), the amount of time used to perform the items in the questionnaires should be concerned. To overcome this problem, the KVIQ-10 which is the short form of the KVIQ-20 may be preferred (7).

Differences between the groups regarding the imagery perspectives (internal vs external) and types (visual vs kinesthetic) of imagery were also studied. Our study revealed that the visual imagery scores of both questionnaires were slightly higher than the kinesthetic imagery scores in both groups. These outcomes were in line with the results in the literature. Since visual imagery is easier than kinesthetic imagery, participants are likely to get more scores in visual imagery than kinesthetic imagery (5,7,8). Therefore, visual imagery technique is considered as a useful strategy to explain the theoretical concept of motor imagery for the people who are less familiar with motor imagery and have limited attention and concentration skills (2). Additionally, assessing visual imagery at first and then evaluating kinesthetic imagery may be appropriate for older people with physical disabilities (7).

The MIQ-3 is a more useful tool than the KVIQ-20 to discriminate between the types of visual imagery. The MIQ-3 was designed to allow the participant to choose between first- and third-person visual imagery (11). The scores for the external visual imagery subscale were the highest in both groups. According to this result, third-person perspective, which means external visual imagery is easier than first-person perspective, which means internal visual imagery (11). Gregg et al suggested that practice complex and functional movements in graded stages by using third-person perspective for stroke survivors. Thus, it could be asserted that third-person perspective might be a more efficient therapeutic application for individuals with stroke (2). Overall, these findings show that the Turkish versions of both questionnaires are sensitive and convenient tools to assess imagery abilities in stroke patients with mild motor impairment.

We confirmed the internal consistency of both questionnaires with high Cronbach alpha values and these results matched with the findings reported in the previous studies (2,7). Butler et al. showed the internal consistency of the MIQ-RS was found to be high in able-bodied and stroke groups (11). Malouin et al. developed the KVIQ for the individuals with physical disabilities and needed guidance in applying imagery questionnaires. According to their results, the internal consistency of the Cronbach's alpha values was accepted in the range of 0.87-0.94 in individuals with stroke (7). Additionally, our test-retest analysis resembled the outcomes of such studies in the literature with respect to the ICC values of both questionnaires. The ICC values for kinesthetic and visual items were in accept-

able levels. The ICC values for the visual imagery subscale were lower than the ICC values for the kinesthetic imagery subscale in the MIQ-3. Similarly, Butler et al. (11) reported lower visual imagery scores in their stroke group (ranging from 0.54 to 0.80). On the other hand, the ICC values for the kinesthetic imagery subscale were higher than the ICC values for the visual imagery subscale in the KVIQ-20. These outcomes matched with the results of other studies about the issue (7,32). However, there has been no consensus about the correlation coefficient values in the literature (2,7,11). Researchers explained that subjective variables might be among the reasons of such results. In addition, distinctions in the way of instructions of the imagery procedures may affect the scores (2,7,32). Moreover, some items that include movements with different levels of difficulty may be challenging for stroke patients (7). As a result, the methods of applying the procedures of imagery questionnaires needs to be standardized before the assessments. In our study, both questionnaires had good to excellent reliability and demonstrated very good consistency with respect to their items and purposes in the Turkish-speaking stroke patients.

The exploratory factor analysis was used for the concurrent validity of both questionnaires (2,7,11,12,14,27-30). Previous studies reported the two-factor model of the MIQ-RS (2,27). However, the two-factor model was found to be inappropriate to distinguish some items and did not have satisfactory adjustment indexes. Alternatively, the three-factor model of the MIQ-3 was accepted as the most appropriate model to evaluate imagery ability comprehensively (14). Our results were in the line with the literature and the factor analysis confirmed the use of three-factor model for MIQ-3 in the Turkish-speaking stroke population. The exploratory factor analysis revealed the two-factor structure of the KVIQ-20 as shown in the literature (7,15). Additionally, a statistically significant correlation was found between its items with the MIQ-3' items and the use of two-dimensional structure of the KVIQ-20 was confirmed for our group. Similar outcomes were reported in the previous studies (7,13,27). Malouin et al. (7) confirmed the bifactorial structure of the KVIQ-20 by showing the correlations between visual and kinesthetic factors (0.46). Although our results showed the validity of both questionnaires, it should be emphasized that either questionnaire is not adequate to assess motor imagery in stroke patients with lesions that may disrupt the capacity to perform imagery (2,11). Therefore, researchers who developed these questionnaires suggested that validation studies in imagery questionnaires need further exploration in all types of clinical properties in stroke (2,7,13).

Our study had some limitations. Its sample size was relatively small, and it was performed only in the stroke patients with mild motor impairment. Thus, our findings might not be adequate for the entire clinical conditions stroke patients complain about.

In conclusion, the Turkish versions of the MIQ-3 and the KVIQ-20 have satisfactory reliability and validity to assess motor imagery ability in Turkish-speaking stroke patients with mild functional impairments. Therefore, we suggest future studies should investigate the motor imagery ability of moderate to severe stroke patients as well as individuals with different physical disabilities.

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