



## The Turkish Adult Strabismus Quality of Life Questionnaire (AS-20): A Psychometric Validation Study

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### Abstract

**Objectives:** To translate the Adult Strabismus Quality of Life Questionnaire (AS-20) into Turkish and evaluate its reliability and validity in Turkish adult patients with strabismus.

**Materials and Methods:** Adult patients diagnosed as having strabismus and followed at the pediatric ophthalmology and strabismus unit of a tertiary university hospital were consecutively recruited. Patients with previous strabismus surgery, cognitive impairment, or insufficient Turkish language proficiency were excluded. A group of 15 participants completed the questionnaire a second time after a 2-week interval to evaluate test-retest reliability.

**Results:** A total of 111 adult patients (63.1% female) were included in the analysis. The mean age was 32.0±14.5 years, and exotropia was the most common deviation pattern (85.1%). Diplopia was present in 7.2% of participants. The Turkish AS-20 demonstrated good internal consistency, with a total Cronbach's alpha of 0.874. The psychosocial subscale showed a Cronbach's alpha of 0.862, and the functional

subscale demonstrated a Cronbach's alpha of 0.822, indicating good reliability. Test-retest reliability analysis demonstrated excellent temporal stability for the psychosocial subscale, the functional subscale, and the total score ( $p<0.001$ ).

**Conclusion:** The Turkish version of the AS-20 is a reliable and valid instrument for assessing strabismus-specific quality of life, demonstrating good internal consistency, high temporal stability, and applicability in both clinical practice and research settings.

**Keywords:** Adult strabismus, AS-20, health-related quality of life, patient-reported outcomes, quality of life

### Introduction

Strabismus in adulthood is associated with functional impairments such as diplopia and asthenopia, but also with a profound psychosocial burden.<sup>1</sup> Adult patients with strabismus frequently report social anxiety, reduced self-esteem, difficulty maintaining eye contact, impaired interpersonal interactions, and limitations in daily activities.<sup>2,3,4,5</sup> In addition to its effects on self-esteem, this condition may lead to social prejudice that negatively affects job and relationship opportunities.<sup>5,6</sup> Standard ophthalmologic examinations, such as ocular alignment, motility, and visual acuity, may not fully capture the multidimensional impact of the disease. Therefore, patient-reported outcomes (PROs) have gained increasing importance.<sup>7,8</sup> Condition-specific questionnaires are essential for revealing concerns within a particular patient population and may enable more sensitive detection of change than a generic instrument.<sup>9</sup>

Several validated health-related quality of life (HRQoL) instruments may be appropriate for use in adult patients with strabismus, such as the Adult Strabismus-20 Questionnaire (AS-20).<sup>10</sup> The AS-20 was originally developed by Hatt et

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al.<sup>10</sup> in 2008 to quantify the psychosocial and functional consequences of strabismus in adults. It is a validated, disease-specific quality of life (QoL) instrument for adults with strabismus, and has been translated into multiple languages worldwide.<sup>11,12,13,14</sup> During the item generation process, 181 items were developed through interviews with groups of adult patients with strabismus. Among them, 20 items were selected as highly disease-specific. Items that discriminated against patients based on economic or educational status (e.g., driving) were excluded. The original validation demonstrated high internal consistency (Cronbach's  $\alpha$  [ $\alpha$ ] >0.90), strong test-retest reliability, and high discriminative ability between patients with strabismus, patients with other ophthalmologic pathologies, and visually normal controls.<sup>10</sup> Moreover, the AS-20 was designed to be responsive to changes in the degree of strabismus, thereby establishing its value as both a research and a clinical tool.<sup>10</sup> Systematic reviews and PRO-focused analyses emphasize that the AS-20 remains a reliable, reproducible, and disease-specific QoL tool for adults with strabismus.<sup>15,16,17</sup>

Despite the widespread international use of the AS-20, a fully validated Turkish version does not currently exist. Considering the cultural and linguistic differences that may influence the interpretation of psychosocial items and the growing emphasis on patient-centered care, the availability of a validated Turkish AS-20 is essential. A culturally adapted Turkish version will enable physicians and researchers to reliably assess strabismus-related QoL, compare outcomes across studies, and incorporate PROs into routine clinical practice. The primary aim of this study was to evaluate the validity and reliability of the Turkish version of the AS-20.

## Materials and Methods

### Study Design and Participants

This prospective methodologic study was conducted to evaluate the validity and reliability of the Turkish version of the AS-20 questionnaire. Adult patients (aged over 18 years) who were diagnosed as having strabismus and followed at the Pediatric Ophthalmology and Strabismus Unit of Marmara University Hospital were consecutively recruited. Patients with previous strabismus surgery, best-corrected visual acuity (BCVA) worse than 0.3 (decimal), cognitive impairment, or insufficient Turkish language proficiency were excluded.

The study was approved by the Institutional Ethical Review Board of Marmara University on June 2, 2023 (protocol no: 09.2023.818) and conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants prior to enrollment.

### Clinical Evaluation

All participants underwent a comprehensive ophthalmologic examination performed by an experienced ophthalmologist (D.D.Y.). Deviation angles were measured using the prism cover test or the Krimsky method, depending on fixation status. BCVA was recorded in decimal notation. Refractive errors were assessed using autorefractometry (Nidek ARK-530, Gamagori, Japan).

### Adult Strabismus-20 Questionnaire

The AS-20 is a disease-specific QoL instrument comprising 20 items, divided into two subscales: a Psychosocial subscale (10 items) and a Functional subscale (10 items) ([Supplemental Table 1](#)). Each item is rated on a 5-point Likert scale ("never," "rarely," "sometimes," "often," "always") and scored on a 0-100 scale, with higher scores indicating better HRQoL. Subscale and total scores are calculated as the mean of completed items.

### Translation and Cultural Adaptation

The original English version of the AS-20 was independently translated into Turkish by two psychiatrists (H.S.B. and S.I.A.) fluent in English. A consensus Turkish version was generated following reconciliation. Five participants were asked to evaluate the clarity, comprehensibility, and conceptual relevance of each item in the Turkish AS-20. No major comprehension difficulties, ambiguities, or culturally inappropriate expressions were identified, and no changes to the Turkish wording were considered necessary. Back-translation into English was performed by two independent translators who were blinded to the original questionnaire. Discrepancies were resolved by expert consensus to ensure conceptual equivalence rather than a literal translation.

All participants completed the Turkish AS-20 ([Supplemental Table 2](#)), and a subset of 15 patients completed the questionnaire again after 2 weeks to assess test-retest reliability.

### Statistical Analysis

Statistical analyses were performed using Jamovi version 2.6 (The Jamovi Project) and R version 4.4 (R Core Team) software. Descriptive statistics were calculated for demographic and clinical variables. Internal consistency was assessed using Cronbach's  $\alpha$  coefficients for the total scale and subscales. Item-rest correlations were examined to evaluate individual item performance.

Temporal stability was assessed using test-retest reliability with two-way mixed single measure intraclass correlation coefficients (ICC). Construct validity was examined through principal component analysis (PCA).

with varimax rotation. Sampling adequacy was evaluated using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity. The number of components retained was determined using eigenvalues, a scree plot, and parallel analysis. P values <0.05 were considered statistically significant.

## Results

### Participant Characteristics

A total of 111 adult patients were included in the analysis. The mean age was  $32.0 \pm 14.5$  (range, 18-69) years. The majority of participants were female (63.1%). Exotropia was the most common deviation pattern (85.1%), followed by esotropia (12.9%). Diplopia was present in 7.2% of participants. Baseline demographic and clinical characteristics are summarized in [Table 1](#).

### Reliability Analysis

The Turkish AS-20 demonstrated good internal consistency, with a total Cronbach's  $\alpha$  of 0.874. The Psychosocial subscale showed a Cronbach's  $\alpha$  of 0.862, while the Functional subscale demonstrated a Cronbach's  $\alpha$  of 0.822, indicating good reliability.

Item-rest correlation analysis revealed that all items were positively correlated with the total score of the remaining items. Item 8 exhibited the lowest item-rest correlation; however, removal of this item resulted in only a minimal and statistically non-significant increase in the overall alpha coefficient (from 0.874 to 0.876). Therefore, item 8 was retained in the final version of the scale ([Table 2](#)).

**Table 1. Demographic and clinical characteristics of the study population (n=111)**

| Variable                                              | Value                   |
|-------------------------------------------------------|-------------------------|
| Age (years), mean $\pm$ SD (range)                    | 32.0 $\pm$ 14.5 (18-69) |
| Sex, n (%)                                            |                         |
| Female                                                | 70 (63.1)               |
| Male                                                  | 41 (36.9)               |
| Type of deviation, n (%)                              |                         |
| Exotropia                                             | 96 (86.4)               |
| Esotropia                                             | 13 (11.7)               |
| Other (e.g., hypertropia)                             | 2 (2.0)                 |
| Diplopia, n (%)                                       |                         |
| Present                                               | 8 (7.2)                 |
| Absent                                                | 103 (92.8)              |
| Angle of deviation at distance, mean $\pm$ SD (range) | 34.8 $\pm$ 13.6 (10-80) |
| SD: Standard deviation                                |                         |

Test-retest reliability analysis conducted in 15 participants demonstrated temporal stability. ICC values for the psychosocial subscale, functional subscale, and total score between the two administrations were 0.996, 0.997, and 1.000, respectively ([Table 3](#)).

### Construct Validity: Principal Component Analysis

Prior to PCA, the suitability of the data for factor analysis was confirmed. The KMO measure of sampling adequacy was 0.69, and Bartlett's test of sphericity was statistically significant ( $\chi^2=1400$ , df=190,  $p<0.001$ ), indicating that the correlation matrix was appropriate for factor extraction. The KMO value of 0.69 falls within the mediocre range according to Kaiser's classification, and

**Table 2. Reliability analysis of the Turkish AS-20**

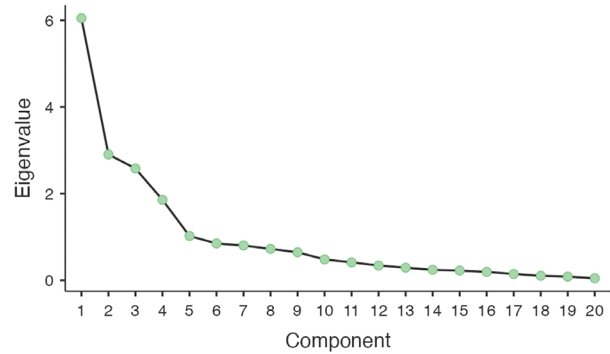
| Item reliability statistics              |                       |                                     |
|------------------------------------------|-----------------------|-------------------------------------|
| Item                                     | Item-rest correlation | If item dropped Cronbach's $\alpha$ |
| 1                                        | 0.562                 | 0.865                               |
| 2                                        | 0.426                 | 0.869                               |
| 3                                        | 0.388                 | 0.871                               |
| 4                                        | 0.543                 | 0.865                               |
| 5                                        | 0.578                 | 0.864                               |
| 6                                        | 0.632                 | 0.862                               |
| 7                                        | 0.585                 | 0.864                               |
| 8                                        | 0.196                 | 0.876                               |
| 9                                        | 0.541                 | 0.866                               |
| 10                                       | 0.559                 | 0.865                               |
| 11                                       | 0.385                 | 0.871                               |
| 12                                       | 0.313                 | 0.873                               |
| 13                                       | 0.462                 | 0.868                               |
| 14                                       | 0.509                 | 0.867                               |
| 15                                       | 0.443                 | 0.869                               |
| 16                                       | 0.456                 | 0.868                               |
| 17                                       | 0.548                 | 0.865                               |
| 18                                       | 0.447                 | 0.869                               |
| 19                                       | 0.341                 | 0.873                               |
| 20                                       | 0.507                 | 0.867                               |
| AS-20: Adult Strabismus-20 Questionnaire |                       |                                     |

**Table 3. Test-retest reliability of the Turkish AS-20**

| Scale                                                                                                      | ICC   | 95% CI    | p value |
|------------------------------------------------------------------------------------------------------------|-------|-----------|---------|
| Psychosocial subscale (factor 1)                                                                           | 0.996 | 0.99-1.00 | <0.001  |
| Functional subscale (factor 2)                                                                             | 0.997 | 0.99-1.00 | <0.001  |
| Total AS-20 score                                                                                          | 1.000 | 1.00-1.00 | <0.001  |
| AS-20: Adult Strabismus-20 Questionnaire, ICC: Intraclass correlation coefficient, CI: Confidence interval |       |           |         |

the two components explained 45.1% of the total variance. Therefore, these findings provide moderate support for the proposed two-component structure.

PCA with varimax rotation revealed a two-component structure, consistent with the original AS-20 design. These two components explained 24.1% and 21.0% of the total variance, respectively, with a cumulative explained variance of 45.1%. Inspection of the scree plot demonstrated a clear inflection point after the second component, supporting retention of a two-component solution (Figure 1). This structure was further confirmed by parallel analysis, in which only two components exhibited eigenvalues exceeding those derived from randomly generated datasets of equal size (Table 4). Component loadings indicated that items clustered meaningfully within the Psychosocial and Functional domains, with acceptable uniqueness values, supporting the construct validity of the Turkish AS-20. Items 5, 13, 14, and 17 exhibited cross-loadings. Items 5 (0.570 vs. 0.349) and 13 (0.452 vs. 0.314) were assigned to the factor with the higher loading. For items 14 (0.435 vs. 0.401) and 17 (0.466 vs. 0.399), where the difference



**Figure 1.** The scree plot with a clear inflection point after the second component

between loadings was relatively small, theoretical integrity and consistency with the original scale structure were considered in addition to the statistical results. These items were therefore retained within their original domains.

## Discussion

In this study, the Turkish version of the AS-20 demonstrated good reliability and validity, with strong internal consistency and excellent test-retest reliability, indicating stable and reproducible measurements over time. Item-level analyses supported the coherence of the scale without the need for item removal. In addition, construct validity was confirmed by a two-component structure consistent with the original instrument, further supported by parallel analysis.

Clinical practices are evolving in a way that increases the importance of PROs.<sup>7,8,18</sup> The United States Food and Drug Administration defines PRO as “any report coming from patients about a health condition and its treatment.”<sup>18</sup> Condition-specific instruments are considered more sensitive, reliable, and practical than generic instruments because they enable the detection of even subtle changes within a specific patient population using a limited number of items.<sup>9,19</sup>

Identifying the aspects of strabismus most relevant to patients is essential for clinical decision-making, and the AS-20 was designed to assess both functional impairments and psychosocial concerns associated with the condition. The AS-20 items were developed based on patient interviews, ensuring that they directly reflect the PROs of adults with strabismus. The AS-20 has been shown to address the majority of adult patients with strabismus, regardless of strabismus type, and is also sensitive in measuring treatment outcomes following strabismus surgery.<sup>20,21</sup> It is one of the most widely used instruments

**Table 4. Principal component analysis component loadings of the Turkish AS-20**

| Item | Component 1*<br>(psychosocial) | Component 2*<br>(functional) | Uniqueness |
|------|--------------------------------|------------------------------|------------|
| 1    | 0.721                          |                              | 0.469      |
| 2    | 0.386                          |                              | 0.764      |
| 3    | 0.580                          |                              | 0.663      |
| 4    | 0.780                          |                              | 0.392      |
| 5    | 0.570                          | 0.349                        | 0.554      |
| 6    | 0.756                          |                              | 0.394      |
| 7    | 0.710                          |                              | 0.464      |
| 8    | 0.543                          |                              | 0.627      |
| 9    | 0.729                          |                              | 0.463      |
| 10   | 0.680                          |                              | 0.511      |
| 11   |                                | 0.682                        | 0.532      |
| 12   |                                | 0.645                        | 0.580      |
| 13   | 0.314                          | 0.452                        | 0.698      |
| 14   | 0.435                          | 0.401                        | 0.650      |
| 15   |                                | 0.611                        | 0.604      |
| 16   |                                | 0.789                        | 0.377      |
| 17   | 0.466                          | 0.399                        | 0.624      |
| 18   |                                | 0.659                        | 0.552      |
| 19   |                                | 0.424                        | 0.792      |
| 20   |                                | 0.810                        | 0.338      |

\*Component loadings  $\geq 0.30$  were reported  
AS-20: Adult Strabismus-20 Questionnaire

for evaluating HRQoL in adult strabismus and has been translated into many languages.<sup>11,14,15</sup>

Comparing previous studies on the translation of AS-20 is highly challenging due to differences in age, sex, deviation angle, and symptoms across populations. The mean ages of the Indian (28 years) and Chinese (30 years) samples may be considered comparable to our study's mean age (32 years), but they were lower than the Dutch population means (52 years).<sup>13,14,15</sup> Furthermore, diplopia was observed in 36% of the Chinese and 74% of the Dutch samples, while this rate was only 7.2% in our sample.<sup>13,14</sup> This discrepancy may be due to differences in the etiology of strabismus across samples, such as neurogenic or amblyogenic causes, or to differences in chronicity.

The results of this study indicate that the Turkish version of the AS-20 is a reliable and valid instrument for assessing strabismus-related QoL. The scale demonstrated good internal consistency, with a Cronbach's  $\alpha$  of 0.874, comparable to that of the original AS-20 (0.94). The psychosocial and functional subscales also showed good reliability, with Cronbach's  $\alpha$  values of 0.862 and 0.822, respectively.

These findings are consistent with previous validation studies, including the Dutch and Chinese versions of the AS-20.<sup>10,13,14,22</sup> In the Dutch version, Cronbach's  $\alpha$  values were reported as 0.93 for the psychosocial subscale and 0.87 for the functional subscale, with test-retest reliability coefficients of 0.91 and 0.88, respectively.<sup>14</sup> Similarly, the Turkish version demonstrated excellent test-retest reliability, with ICCs of 0.996 for the psychosocial subscale and 0.997 for the functional subscale, confirming its high temporal stability.

PCA was preferred in the present study as an exploratory, data-driven approach to evaluate whether the underlying factor structure of the Turkish AS-20 was consistent with that of the original instrument. Given that this study represents the first validation of the scale in a Turkish population, PCA was considered appropriate to assess dimensionality without imposing a predefined model. The emergence of a stable two-component structure, supported by eigenvalues, scree plot inspection, and parallel analysis, confirms the conceptual integrity of the AS-20's psychosocial and functional domains. Although item 8 showed the lowest item-rest correlation, it was retained because its removal did not significantly improve internal consistency and it represents a key psychosocial construct relevant to strabismus-related QoL, thereby preserving content validity and comparability with the original instrument. While several items (5, 13, 14, and 17) exhibited cross-loadings between the two components, they were ultimately retained

in their respective domains. This decision was guided by their primary factor loadings, alongside considerations of theoretical integrity and alignment with the original scale's structure, as these items conceptually represent constructs that frequently bridge psychosocial and functional dimensions. Future studies may further evaluate these items in larger and more diverse samples.

### Study Limitations

Several limitations of this study should be acknowledged. First, the sample was recruited from a single tertiary referral center, which may limit the generalizability of the findings to broader or community-based populations. Second, although the overall sample size was adequate for psychometric analyses, the test-retest reliability assessment was conducted in a relatively small subsample, which may limit the robustness of temporal stability estimates. Third, the cross-sectional design precluded evaluation of responsiveness to clinical change or sensitivity to treatment effects over time. Fourth, the predominance of exotropia and the low prevalence of diplopia limit the generalizability of the functional subscale findings to patients with paralytic, restrictive, traumatic, or other symptomatic forms of strabismus. Future studies should include more diverse samples and evaluate floor/ceiling effects and differential item functioning. Finally, confirmatory factor analysis was not performed. Although PCA provided preliminary evidence of the internal structure of the Turkish AS-20, Rasch analysis, confirmatory factor analysis, other item response theory methods, and convergent, known-groups, or criterion validity were not performed. Future studies should apply these methods in larger, more diverse samples.

### Conclusion

The findings of this study demonstrate that the Turkish version of the AS-20 exhibits sound psychometric properties for assessing strabismus-specific QoL in Turkish adults. Both the psychosocial and functional subscales showed good internal consistency and excellent test-retest reliability. In addition, the scale demonstrated a stable structure consistent with the original questionnaire, supporting its construct validity.

### Ethics

**Ethics Committee Approval:** The study was approved by the Institutional Ethical Review Board of Marmara University on June 2, 2023 (protocol no: 09.2023.818) and conducted in accordance with the Declaration of Helsinki.

**Informed Consent:** Written informed consent was obtained from all participants prior to enrollment.

## Declarations

## Authorship Contributions

Surgical and Medical Practices: D.D.Y., Concept: D.D.Y., E.K., H.Ş.B., S.İ.A., Ö.Ş., Design: D.D.Y., E.K., H.Ş.B., S.İ.A., Ö.Ş., Data Collection or Processing: D.D.Y., E.K., H.Ş.B., S.İ.A., Analysis or Interpretation: D.D.Y., H.Ş.B., S.İ.A., Literature Search: D.D.Y., E.K., Writing: D.D.Y., E.K., H.Ş.B., S.İ.A., Ö.Ş.

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