Current Psychology (2026) 45:1398
https://doi.org/10.1007/s12144-026-09966-x

A Methodological study on the validity and reliability of the Turkish version of the social odor scale (SOS)

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Received: 16 January 2026 / Accepted: 17 August 2026

Abstract
Despite growing interest in odor perception, valid and reliable scales adapted into Turkish to assess this phenomenon are limited. To address this gap, this study adapted the Social Odor Scale (SOS) into Turkish and examined its construct validity and reliability using factor analyses and test-retest methods. We collected data from 439 participants using online convenience sampling. Exploratory Factor Analysis showed a three-factor structure familiar, partner, stranger that aligned with the original scale and explained 48.8% of the total variance ($\alpha = 0.783$ and $\omega = 0.780$). The three-factor structure was supported by Confirmatory Factor Analysis, with fit indices falling within acceptable ranges ($\chi^2/df = 3.56$, RMSEA = 0.076, SRMR = 0.061, CFI = 0.93, GFI = 0.94, TLI = 0.91). The findings provide preliminary evidence that the Turkish version of the SOS is a valid and reliable instrument for assessing social odor perception, non-clinical in Turkish adult samples. Its confirmed three-factor structure offers a practical format for examining the role of olfactory awareness in interpersonal communication. The scale serves as a useful tool for future epidemiological and interdisciplinary research in Türkiye, though further studies are needed to establish measurement invariance and clinical validity across diverse populations

Keywords Odor perception · Psychometrics · Social perception · Türkiye

Introduction

Odor is an invisible yet profoundly influential sense that deeply shapes human experience. Odors encountered in daily life, often without conscious awareness, serve as potent stimuli that modulate emotions, attitudes, and spatial perception. However, significant individual differences exist in the perception of odors, the intensity with which they are rated, and the meanings ascribed to these stimuli. Research indicates that while some individuals detect ambient odors immediately and adapt their decisions accordingly, others only achieve this awareness upon exposure to a pronounced odor or an external cue (Smeets et al., 2008). To explain this individual variation in odor perception, the concept of "odor awareness" has gained prominence, conceptualized not merely as a sensory threshold but as a metacognitive process. Odor awareness reflects an individual's attention to the sense of smell, their tendency to evaluate odor-related information, and the significance they attribute to odors in daily life. This level of awareness is shaped by the interaction of numerous biological and environmental variables. Gender-based differences, genetic predispositions, general health, personal experiences, and sociocultural characteristics are among the factors determining its boundaries (Oleszkiewicz et al., 2020). In this context, odor functions not only as a bodily defense mechanism but also as an indispensable component of social interaction and psychological equilibrium.

Social odors, defined as body-based scents inhaled subconsciously during everyday life, operate as a vital communicative signaling system between individuals. This biological process is deeply involved in the transmission of emotional states, the modification of social attitudes, and the management of intricate psychological processes (Dal Bò et al., 2020; de Groot & Smeets, 2017; Roberts et al., 2020). These odors function as a unique biological "signature" emitted by the human body. Much like a fingerprint, these olfactory profiles provide insight into stable traits

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Published online: 24 August 2026

such as an individual's genetic background, sex, age, and personality. Furthermore, research by Chen and Haviland-Jones (2000) and Havlíček et al. (2017) suggests that these signatures also reflect fluctuating conditions, including current health, hormonal fluctuations, and immediate affective states. The profound impact of human body odor on social dynamics has been increasingly highlighted in recent literature (Roberts et al., 2020). For example, when individuals encounter social odors saturated with emotion, they may experience emotional contagion, often leading to prejudiced assessments of social information (de Groot et al., 2023). Beyond emotional shifts, these odors can trigger corresponding facial muscle movements (de Groot et al., 2015) or alter cognitive efficiency (Chen et al., 2006; Singh et al., 2018). Moreover, the detection of social odors plays a key role in establishing interpersonal connections across various stages of life (Boesveldt & Parma, 2021) and exerts a direct influence on how human faces are perceived (Dal Bò et al., 2024; Rekow & Leleu, 2023).

The significant impact of human scent on interpersonal dynamics has gained substantial academic attention in recent years (Roberts et al., 2020). A review of the literature reveals that a key instrument contributing to the proliferation of odor-related studies and one of the most significant tools in the field is the Odor Awareness Scale (OAS), developed by Smeets et al. (2008). The scale was designed to measure individuals' level of awareness regarding environmental odors encountered in daily life, addressing the attention and perceptual sensitivity people show toward everyday stimuli such as food, beverages, or ambient odors (Smeets et al., 2008). Beyond general assessments, various specialized instruments have been introduced to evaluate specific dimensions of olfactory perception. For instance, Rokosz et al. (2024) developed the Odor Awareness Scale Short-Form (OAS-6), which is a refined version of the original OAS. Other notable psychometric tools include the Individual Significance of Olfaction Scale (ISO) (Croy et al., 2010), the Body Odor Disgust Scale (BODS) (Liuzza et al., 2017), and the Odors in Everyday Life Questionnaire (OELQ) (Cupchik et al., 2005). Nevertheless, the evaluation of olfactory stimuli extends beyond these standardized metrics. Existing literature indicates that social odors serve as complex informational cues capable of triggering a diverse array of affective states, such as fear, attraction, or a sense of security (de Groot & Smeets, 2017; Ferdenzi et al., 2020; Granqvist et al., 2019). This has heightened the perceived need for a specific measurement tool that captures the unique nature of social interactions. In response to this need, the twelve-item Social Odor Scale (SOS) was developed, emphasizing three core factors representing the social odors individuals encounter in daily life. The first factor, romantic partner odor (PAR), examines the odor-partner relationship. The second factor (FAM) investigates the individual's relationship with familiar odors from people in their close circle, including family members and friends. The third factor concerns body odors of strangers (STR). Initially developed in Italian and subsequently adapted into numerous languages, the SOS-12 has proven to be a valid, reliable, and robust tool for measuring social odor awareness (Cecchetto et al., 2024; Dal Bò et al., 2021).

The meanings individuals attribute to odors and the social communication they establish through them are largely shaped by cultural norms. While it is known that odor holds a significant place in the traditional and modern fabric of Turkish society, measuring this phenomenon with scientifically validated tools has not been possible until now. The adaptation of the SOS into Turkish is not merely a linguistic translation but also a step toward understanding the unique structure of social odor awareness within Turkish society. This adaptation will undoubtedly provide a solid methodological foundation for future research not only in core fields such as psychology and neuropsychology but also in applied disciplines including public health, environmental health, nursing, and even consumer behavior. Especially in the modern era where social interactions are becoming digitized, measuring awareness of social odors one of the most fundamental communication tools of human nature is essential for understanding the biopsychosocial dimension of human relationships. Therefore, this study aims to conduct validity and reliability analyses of the Social Odor Scale (SOS) within the context of Turkish culture and language.

Method

Study design

This research was designed as a methodological study, and cross-sectional research characteristics were employed in obtaining, analyzing, and interpreting sociodemographic data. The methodological framework proposed by Yılmaz et al. (2026a) was followed to ensure linguistic and cultural validity throughout the adaptation process (Yılmaz et al., 2026a).

Study setting and data collection period

Data were collected online from the provinces of Aydın and Burdur over a two-month period between November 15, 2025, and January 15, 2026.

Sampling method and sample size

A convenience sampling method was adopted for participant selection. To determine the sample size, the known-population sampling method, which aims to reach the widest possible segment of the accessible population, was used as a basis. This approach was chosen over traditional item-participant ratio rules (e.g., 5 or 10 participants per item) due to the Social Odor Scale (SOS) consisting of a relatively small number of items. A calculation based on a 5% margin of error and a 95% confidence level showed that at least 377 participants were required. Assuming the possibility of erroneous, incomplete, or outlier responses, this number was increased by 10% ($n=38$). Consequently, it was determined that a minimum of 415 individuals should be included in the study.

Using SPSS, the total sample was randomly split into two subsamples. The first subsample (S1) was used for exploratory factor analysis (EFA), and the second (S2) for confirmatory factor analysis (CFA).

For the test-retest analysis conducted to examine the scale's temporal invariance, a smaller and more homogeneous sample ($n>100$) was utilized. A volunteer subsample, with demographic characteristics similar to those of the main sample (age, gender, marital status, economic status), was recruited for test-retest reliability. The comparison of demographic characteristics between the subsample and the main sample is presented in the results section.

Participant criteria

Inclusion criteria were defined as individuals aged 18–65, those not experiencing any odor-related issues, and those possessing adequate technological equipment for online data collection. Individuals not meeting these criteria were excluded from the study.

Linguistic equivalence and pilot testing

Permission to adapt the Social Odor Scale (SOS) into Turkish was obtained from Cinzia Cecchetto on October 13, 2025. The translation process followed established guidelines for cross-cultural adaptation (Yılmaz et al., 2026a). First, the original scale items and response options were independently translated from English into Turkish by two linguists who were proficient in English-Turkish translation and had expertise in the field. A preliminary Turkish version was then developed by reconciling the two translations. Next, two different experts who had not been involved in the initial translation stage back translated this Turkish version into English. The research team then compared the original English version with the back translated English version and found no discrepancies. All experts gave their approval for the final Turkish version of the SOS. A pilot test was conducted with 34 participants to assess how comprehensible and fluent the SOS was. No negative feedback was received, and the pilot data were not included in the main study dataset.

Content validity

Feedback was obtained from a panel of seven experts with direct relevance to the subject (psychiatry, psychology, public health, nursing, and otorhinolaryngology). The experts were shown the scale's scope and items and asked to rate how well each item represented the intended construct using the ratings "Appropriate = 1" or "Inappropriate/Needs Revision = 2." The expert evaluations were formatted for calculating the Content Validity Index (CVI). The item-level CVI values ranged from 0.86 to 1, all above the recommended threshold of 0.83 for seven experts. The scale-level CVI/average was calculated as 0.86 and was considered an acceptable level (Lynn, 1986; Polit & Beck, 2006).

Data collection instruments

The instrument had three parts: a sociodemographic form, the Social Odor Scale (SOS) (Cecchetto et al., 2024), and the Generalized Anxiety Disorder Scale-7 (GAD − 7) (Spitzer et al., 2006; Konkan et al., 2013). The data collection tool was turned into an online form using Google Forms and shared with participants through social media. Completing the survey took about 10–15 min. No incentives were given, and no attention check item was included. IP addresses were not collected. After data collection, responses with straight-lining patterns (i.e., identical answers to all items) were identified and excluded. No other data cleaning procedures were applied.

Social odor scale (SOS)

The SOS is a Likert-type scale originally comprising 12 items across three subscales, with no reverse-scored items. The response options range from "strongly disagree" (0 points) to "strongly agree" (4 points). Items 1–4 constitute the Familiar (FAM) subscale, items 5–8 the Partner (PAR) subscale, and items 9–12 the Stranger (STR) subscale. For the SOS-12, the McDonald's ω coefficient was reported as 0.68 (Cecchetto et al., 2024).

Generalized anxiety disorder scale-7 (GAD-7)

The GAD-7 is a short, self-report, Likert-type assessment tool with no reverse-scored items, developed by Spitzer et al. (2006) based on DSM - IV - TR criteria. This seven item scale measures how severe participants' symptoms have been over the past two weeks using a four-option format ranging from "not at all" (0) to "nearly every day" (3). Based on the total score, 5, 10, and 15 are established cutoff values for mild, moderate, and severe anxiety levels, respectively. Spitzer et al. (2006) noted that a score of 10 or above serves as a screening threshold for GAD-7, requiring clinical confirmation (Spitzer et al., 2006). Kroenke et al. (2007) reported that this threshold of 10 points has 89% sensitivity and 82% specificity for identifying anxiety (Kroenke et al., 2007). The Turkish adaptation of the scale was performed by Konkan et al. (2013) (α = 0.852) (Konkan et al., 2013).

Discriminant validity test

To comprehensively evaluate the construct validity of the scale, both convergent and discriminant validity analyses were planned. To test discriminant validity, the relationship was examined between the total and subscale scores of the SOS and the scores of the GAD-7 (Spitzer et al., 2006), which measures a theoretically related but conceptually distinct construct. The GAD-7 was selected because it has been used successfully in recent psychometric studies of odor-related scales, including the Chinese validation of the Odor Awareness Scale-B (Zhang et al., 2025). The expectation for discriminant validity is to find a positive but weak-to-moderate correlation between scales measuring related yet separate constructs. A low correlation strength will be accepted as an indicator of sufficient discrimination from the criterion scale (Campbell & Fiske, 1959). Pearson correlation analysis will be conducted to determine the direction and magnitude of the relationships.

Statistical analysis

Statistical analyses were carried out using IBM SPSS Statistics (V24) and SPSS AMOS (V24). Descriptive statistics (mean (M), standard deviation (SD), frequency, percentage), reliability coefficients (Cronbach's alpha and McDonald's omega), Exploratory Factor Analysis (EFA) including the Kaiser-Meyer-Olkin (KMO) test, Bartlett's test of sphericity, total explained variance, Principal Axis Factoring with Oblimin rotation, Pearson correlation, paired-sample t-test, and independent samples t-test were all performed using SPSS. Confirmatory Factor Analysis (CFA) was run with AMOS, and model fit was assessed using the following indices: χ^2/df, RMSEA, SRMR, CFI, GFI, and NFI. The statistical significance level was set at $p < 0.05$.

Results

A total of 471 participants took part in the study, and data from 32 participants were excluded due to exclusion criteria. Consequently, the study was completed with 439 participants. Their mean age was 27.69 ± 12.82 (range: 18–65). The descriptive characteristics of the participants are presented in Table 1.

The study sample consisted predominantly of female (57.9%), single (77.2%), individuals with balanced income-expenditure (68.1%), and highly educated (82.5%) participants (Table 1).

Testing the Normality Assumption

Skewness and Kurtosis values were examined to assess whether the SOS items and the total score met the normality

Table 1 Participant Characteristics ($n = 439$)

Variables		*n*	%
Gender	Female	254	57.9
	Male	185	42.1
Marital Status	Married	100	22.8
	Single	339	77.2
Economic Status	Income equals expenses	299	68.1
	Income exceeds expenses	21	4.8
	Expenses exceed income	119	27.1
Education	Higher	362	82.4
	Secondary	68	15.5
	Primary	9	2.1

n = participant, % = participant's percent

assumption. Item-level skewness values ranged from −1.250 to 1.214, within acceptable limits. Kurtosis values ranged from −0.997 to 2.006. The Kurtosis value (2.006) for SOS-2 exceeded the recommended ± 2 threshold by a small margin. All other items, including SOS-9 (1.984), had kurtosis values within the acceptable range. For the SOS total score, skewness was 0.031 and kurtosis was 0.782. Overall, these findings suggest that the normality assumption was largely met for both the items and the total score, supporting the use of parametric tests and factor analysis (Tabachnick & Fidell, 2013).

Exploratory factor analysis (EFA) (S1, *n* = 229)

To explore the factor structure of the 12-item SOS, an EFA was run. Before proceeding, data suitability was checked using the KMO measure and Bartlett's test of sphericity (Bartlett, 1950). The extraction method was PAF, and factors were retained based on eigenvalues greater than 1 (Kaiser, 1970). A scree plot was also examined to help decide the number of factors. Given the expectation that factors would be correlated, Oblimin rotation was used (Dal Bò et al., 2021).

The KMO value was 0.778, and Bartlett's test of sphericity was significant ($\chi^2(66) = 1002.65$, $p < 0.001$), indicating that the data were suitable for factor analysis. The scree plot showed a clear break after the third factor, supporting the three-factor solution (see Fig. 1). The initial eigenvalues for the first three factors were 3.944, 1.731, and 1.669, all above the threshold of 1. The analysis revealed a three-factor structure consistent with the original scale, accounting for 48.8% of the total variance. Factor 1 explained 29.5% of the variance, Factor 2 explained 10.4%, and Factor 3 explained 8.9%. Based on Cecchetto et al. (2024), the factors were labeled Familiar (FAM), Partner (PAR), and Stranger (STR) (Cecchetto et al., 2024.

Both pattern and structure matrices were examined to interpret the factor solution, as recommended for oblique rotations (Tabachnick & Fidell, 2013). The pattern matrix showed minor cross-loadings for SOS5 (0.373 on FAM) and SOS9 (0.336 on FAM). However, according to the practical significance thresholds suggested by Hair et al. (2019), factor loadings below 0.40 are not considered meaningful for a sample of this size ($n = 229$). Therefore, these cross-loadings do not affect the interpretability of the factor structure. The structure matrix further confirmed that all items loaded most strongly on their intended factors, with loadings ranging from 0.594 to 0.792 for FAM (SOS1 - SOS4), 0.524 to 0.898 for PAR (SOS5 - SOS8), and 0.469 to 0.617 for STR (SOS9 - SOS12). Factor loadings below 0.30 were suppressed to present a clearer pattern (Hair et al., 2019). Detailed results are presented in Table 2.

Confirmatory factor analysis (CFA) (S2, *n* = 210)

The proposed three-factor model (FAM, PAR, STR) was first tested using CFA on the S2 subsample ($n = 210$) without any residual covariances. CFA was conducted using AMOS with Maximum Likelihood (ML) estimation, as the items had five response categories and the skewness and kurtosis values were within acceptable limits. The model yielded the following fit indices: $\chi^2(51) = 194.57$, $p < 0.001$, $\chi^2/df = 3.82$, CFI = 0.92, TLI = 0.90, RMSEA = 0.080 (90% CI = 0.068–0.092), SRMR = 0.061, GFI = 0.93. While the CFI, SRMR, and GFI indicated acceptable fit, the RMSEA was at the threshold of 0.08 and the TLI was slightly below

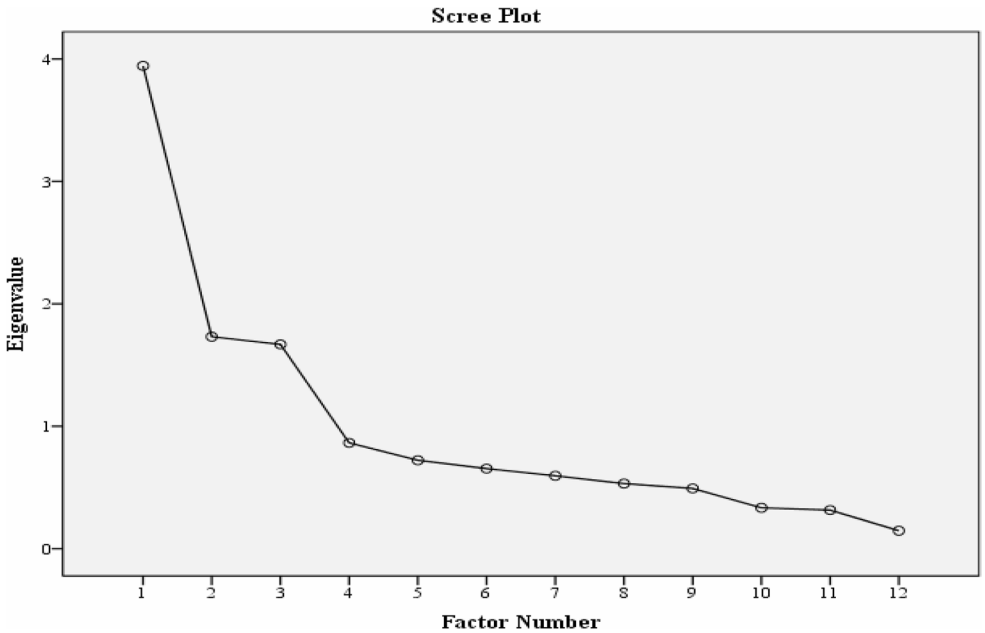

Fig. 1 Scree plot for EFA of SOS

Table 2 Pattern and Structure Matrices for the Three-Factor Solution of the SOS

Items	Pattern Matrix			Structure Matrix		
	FAM	PAR	STR	FAM	PAR	STR
SOS−1	0.541			0.594		
SOS−2	0.572			0.612		
SOS−3	0.787			0.792		
SOS−4	0.751			0.733		
SOS−5		0.542			0.623	
SOS−6		0.548			0.524	
SOS−7		0.853			0.898	
SOS−8		0.838			0.889	
SOS−9			0.438			0.488
SOS−10			0.606			0.617
SOS−11			0.463			0.469
SOS−12			0.610			0.592

EFA was conducted on the S1 subsample ($n=229$). Extraction Method: Principal Axis Factoring (PAF). *Rotation Method* Oblimin with Kaiser Normalization, *SOS* social odor scale, *FAM* familiar, *PAR* partner, *STR* stranger

0.90. These results suggested that the model fit was acceptable but could potentially be improved.

Two residual covariances were added post-hoc based on modification indices (MI) (7.6 and MI 8.4). They were not specified a priori. These covariances were added between items within the same factors: between SOS-5 and SOS-6 (both from the PAR factor, MI=7.6), and between SOS9 and SOS-11 (both from the STR factor, MI=8.4). Both SOS-5 and SOS-6 measure positive attitudes toward partner's body odor, and both SOS-9 and SOS-11 reflect avoidance behaviors toward unpleasant odors in public settings. Each covariance was justified with strong theoretical rationale. After adding these covariances, the revised model showed improved fit: $\chi^2(49)=174.23$, $\chi^2/df=3.56$, CFI=0.93, TLI=0.91, RMSEA=0.076 (90% CI=0.064–0.089), SRMR=0.061, GFI=0.94. All fit indices were within acceptable ranges, supporting the three-factor structure of the SOS in the Turkish sample (Hair et al., 2019; Hu & Bentler, 1999; Kline, 2023; Marsh & Hocevar, 1985). No other residual covariances were specified. Thus, the model is not purely data-driven but reflects a theory-informed revision. The path diagram with standardized factor loadings is presented in Fig. 2.

Table 3 presents the standardized factor loadings, standard errors, and significance levels for all 12 items. All factor loadings were statistically significant ($p<0.001$). The FAM factor showed strong loadings ranging from 0.619 to 0.804. The PAR factor demonstrated the highest loadings, ranging from 0.479 to 0.923, with SOS7 (0.923) and SOS8 (0.893) being particularly robust. The STR factor had more modest loadings, ranging from 0.383 to 0.700. Notably, SOS9 (0.399) and SOS11 (0.383) were slightly below the commonly recommended threshold of 0.40 (Hair et al., 2019), while SOS10 (0.700) and SOS12 (0.591) showed acceptable loadings. These findings indicate that the STR subscale may benefit from further refinement in future studies.

Composite reliability, convergent and discriminant validity

Convergent validity was assessed using composite reliability (CR) and average variance extracted (AVE) (Fornell & Larcker, 1981; Hair et al., 2019). The PAR factor demonstrated good convergent validity (CR=0.856, AVE=0.610). The FAM factor showed acceptable reliability (CR=0.793), with an AVE of 0.492, close to the recommended threshold of 0.50. For the STR factor, CR was 0.601, exceeding the commonly accepted threshold of 0.60, but its AVE was 0.286, falling below 0.50. According to Fornell and Larcker (1981) and Hair et al. (2019), convergent validity can still be considered adequate when CR is above 0.60, even if AVE falls short of 0.50. Thus, despite the lower AVE, the STR subscale demonstrated acceptable convergent validity.

Factor correlations among the three dimensions were weak to moderate. FAM showed a moderate correlation with PAR ($r=0.417$), but weaker correlations with STR ($r=0.210$). PAR also showed a weak correlation with STR ($r=0.200$), suggesting that the factors are related yet distinct.

Discriminant validity was assessed using the Fornell-Larcker criterion, which requires that the square root of the AVE for each factor be larger than its correlations with the other factors (Fornell & Larcker, 1981). The square roots of AVE were 0.701 for FAM, 0.781 for PAR, and 0.535 for STR. All of these values exceeded the corresponding inter-factor correlations (FAM: 0.701 > 0.417 and 0.210; PAR: 0.781 > 0.417 and 0.200; STR: 0.535 > 0.210 and 0.200). These findings support

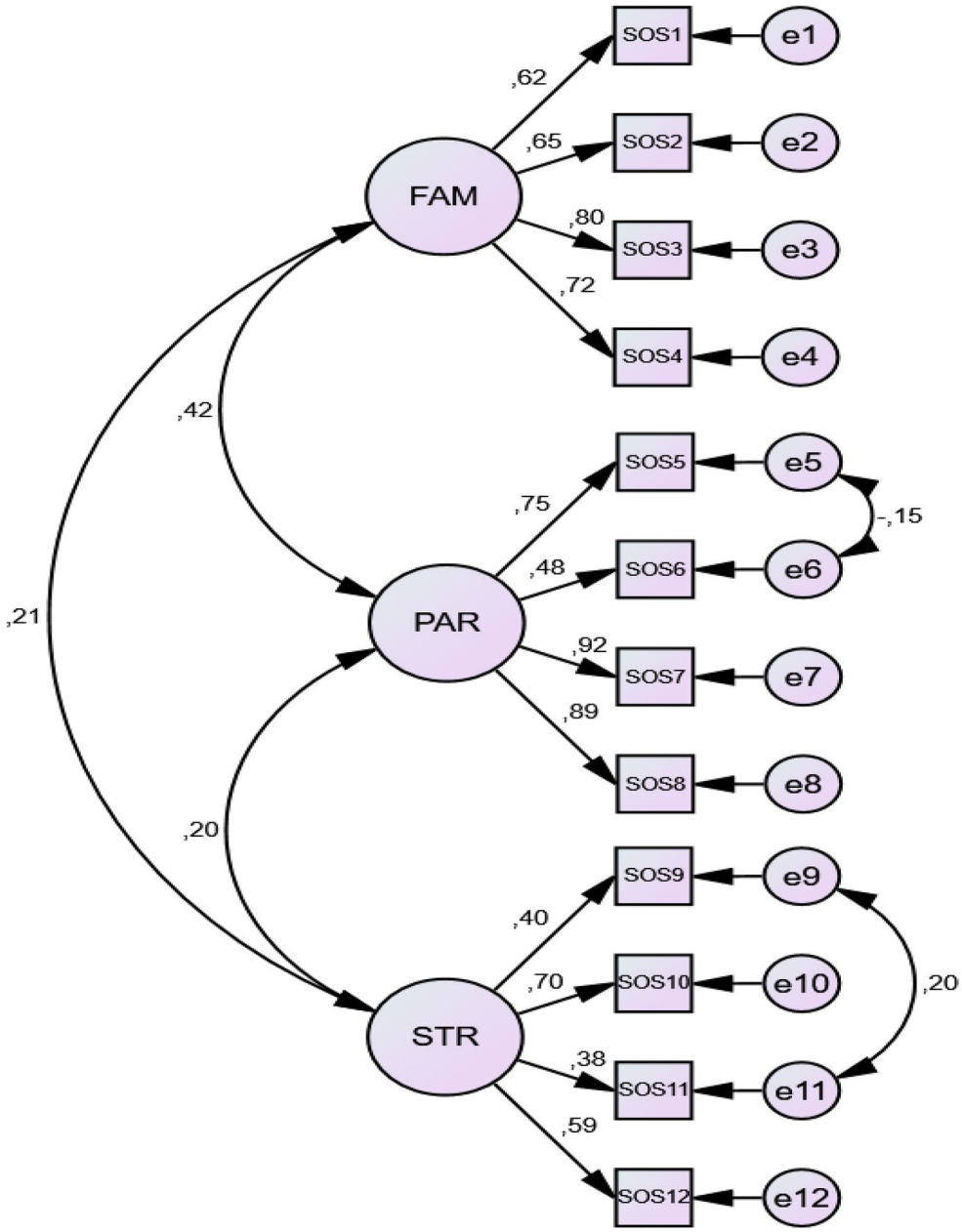

Fig. 2 Path diagram of the three-factor SOS model with standardized factor loadings (S2 subsample, $n=210$). FAM = Familiar, PAR = Partner, STR = Stranger

the discriminant validity of the three-factor model, indicating that each subscale measures a distinct aspect of social odor perception.

Reliablity

Internal consistency of the SOS subscales and the total scale was evaluated using Cronbach's alpha (α) and McDonald's omega (ω). According to established guidelines (Cohen et al., 2018), Cronbach's alpha values above 0.70 indicate acceptable reliability, values between 0.80 and 0.90 indicate good reliability, and values between 0.60 and 0.69 are considered marginally acceptable. For McDonald's ω, similar thresholds apply, and it is considered a more accurate reliability estimate than Cronbach's α for multidimensional scales (Dunn et al., 2014). Based on these criteria, the PAR subscale demonstrated good reliability ($\alpha=0.837$, $\omega=0.856$), the FAM subscale showed acceptable reliability ($\alpha=0.790$, $\omega=0.793$), and the STR subscale had marginally acceptable reliability ($\alpha=0.619$, $\omega=0.601$). The total scale demonstrated acceptable reliability ($\alpha=0.783$, $\omega=0.780$). Item-total statistics for each subscale showed that corrected item-total correlations ranged from 0.540 to 0.681 for FAM, from 0.427 to 0.828 for PAR, and from 0.357 to 0.446 for STR.

Table 3 Standardized Factor Loadings, Standard Errors, and Significance

Item	Factor	Standardized Loading	S.E.	*p*
SOS − 1	FAM	0.619	-	***
SOS − 2		0.652	0.097	***
SOS − 3		0.804	0.115	***
SOS − 4		0.717	0.106	***
SOS − 5	PAR	0.748	-	***
SOS − 6		0.479	0.067	***
SOS − 7		0.923	0.069	***
SOS − 8		0.893	0.070	***
SOS − 9	STR	0.399	-	***
SOS − 10		0.700	0.388	***
SOS − 11		0.383	0.184	***
SOS − 12		0.591	0.303	***

SOS social odor scale, *FAM* familiar, *PAR* partner, *STR* stranger. *S.E.* standard error. SOS1, SOS5, and SOS9 were fixed to 1.00 for scale identification, $^{***}p < 0.001$

Table 4 Correlation Matrix for SOS Subscales and GAD-7 ($n = 439$)

Variable	GAD-7	SOS	FAM	PAR	STR
GAD-7	1				
SOS	0.256^{**}	1			
FAM	0.155^{**}	0.730^{**}	1		
PAR	0.208^{**}	0.806^{**}	0.371^{**}	1	
STR	0.176^{**}	0.552^{**}	0.200^{**}	0.151^{**}	1

Correlations between SOS and GAD-7

Pearson correlation analysis was conducted to examine the relationships among SOS subscales, total SOS score, and GAD-7 scores. As presented in Table 4, the SOS subscales were moderately to strongly correlated with the total SOS score (ranging from $r = 0.552$ to $r = 0.806$). The correlations among the subscales were weak to moderate (ranging from $r = 0.151$ to $r = 0.371$), indicating that they measure related but distinct dimensions. GAD-7 scores showed weak but significant positive correlations with all SOS subscales (ranging from $r = 0.155$ to $r = 0.208$) and the total SOS score ($r = 0.256$). These weak correlations provide additional support preliminary evidence for discriminant validity (Cohen, 1988).

Test - retest

The subsample was initially formed with 127 volunteers. After excluding those who did not complete the second measurement or had outlier data, 113 participants remained. The two measurements were administered two weeks apart, and responses were matched using assigned ID numbers. To determine whether the test-retest subsample ($n = 113$) represented the main sample ($N = 439$), demographic characteristics were compared between the two groups. The subsample closely resembled the main sample across all measured variables. Age distributions were similar (t = -1.53, $p = 0.126$), and the proportion of female participants was nearly identical in both groups (57.1% vs. 57.9%, $p > 0.05$). Likewise, no meaningful differences emerged for marital status (83.9% single in the subsample vs. 77.2% in the main sample, $p = 0.191$) or economic status (70.5% with low income in the subsample vs. 68.1% in the main sample, $p = 0.62$). These findings suggest that the volunteer subsample adequately represented the main sample in terms of key demographic features.

To assess test-retest reliability, paired-sample t-tests, Pearson correlation coefficients, and Intraclass Correlation Coefficients (ICC) were used. For ICC, the two-way mixed, absolute agreement model (3,1) with single measurement values was applied. According to the paired-sample t-test results, the significance level for all dimensions was above 0.05: SOS (t = -0.286, $p = 0.775$), FAM (t = -1.881, $p = 0.063$), PAR (t = 1.448, $p = 0.15$), and STR (t = 0.223, $p = 0.824$). These findings indicate no systematic shift between the measurements over the two-week period. Consistency between the two administrations was also examined using Pearson correlation, and all coefficients were found to be statistically significant ($p < 0.001$): SOS $r = 0.871$, FAM $r = 0.736$, PAR $r = 0.838$, STR $r = 0.747$. Similarly, ICC values [ICC (95% CI: lower - upper)] also point to high consistency: SOS ICC = 0.871 (0.818–0.909), FAM ICC = 0.731 (0.632–0.807), PAR ICC = 0.838 (0.774–0.886), STR ICC = 0.747 (0.653–0.819). In conclusion, it was assessed that the scale exhibits a high level of measurement consistency over time, both overall and at the subscale level, and that its test-retest reliability is at acceptable levels.

Gender and SOS

To investigate how gender relates to the overall SOS score and each of its subscales, Student's t tests were conducted. Accordingly, no significant difference was found between the SOS means of female (M = 27.36, SD = 6.54) and male (M = 28.05, SD = 6.25) participants (t = -1.115, $p = 0.265$). For FAM, no statistically significant difference was detected between females (M = 11.69, SD = 2.85) and males (M = 11.88, SD = 2.75) (t = −0.688, $p = 0.492$). For STR, no statistical difference was observed between the STR means of female (M = 9.63, SD = 2.29) and male (M = 9.29, SD = 2.56) participants (t = 1.476, $p = 0.141$). However, for PAR, a statistically significant difference emerged between males (M = 6.89, SD = 3.79) and females (M = 6.04, SD = 3.73) (t = −2.339, $p < 0.02$). These results were interpreted as indicating that gender differentiation on the SOS may present a specific profile, depending on variation in the PAR subscale.

Discussion

The aim of this study was to examine the validity and reliability of the Turkish version of the SOS within a linguistic and cultural context. The adaptation process followed a multi-layered methodology fundamentally aimed at integrating the scale into the target culture while preserving its conceptual integrity and psychometric value. Within this scope, the principles of linguistic equivalence, cultural appropriateness, and methodological rigor fundamental components of cross-cultural validity were systematically integrated (Yılmaz et al., 2026a).

The EFA results offer preliminary psychometric support for the Turkish adaptation of the scale. Prior to the analysis, the KMO test indicated adequate sampling adequacy. The analysis revealed that the scale exhibits a structure of 12 items across three factors, consistent with its original form. Cronbach's alpha internal consistency coefficients for the overall scale and two of its subscales were found to be above the acceptable threshold. However, the value for the STR subscale was below this threshold. The literature notes that in scales with a limited number of items or in short forms, internal consistency coefficients may fall below the traditional threshold; alpha should not be regarded as a sufficient criterion alone, yet values above 0.60 can be considered within acceptable limits (Gliem & Gliem, 2003; McNeish, 2018; Taber, 2018). In this context, considering the holistic structure of the scale, the value obtained for the four-item STR subscale was accepted as representing a reasonable level of internal consistency for this study. The relatively lower internal consistency of the STR subscale ($\alpha = 0.619$) warrants cultural consideration. In collectivist societies such as Turkey, the concept of "stranger" carries distinct social connotations compared to individualistic Western cultures. Social boundaries between familiar and unfamiliar individuals are more clearly defined, and interactions with strangers are often governed by norms of formality and distance. This cultural context may influence how individuals perceive and report odors emanating from strangers, leading to greater response variability compared to odors from FAM or partner PAR which are embedded in close, familiar relationships. Cultural and religious context has been shown to shape health-related perceptions in Türkiye; for instance, Yılmaz et al. (2026b) reported that religiosity independently predicted positive nutrition attitudes, suggesting that value-based motivations influence how individuals respond to health-related stimuli (Yılmaz et al., 2026b). Similarly, the lower reliability of the STR subscale may reflect culturally specific norms regarding social distance from strangers. Additionally, the wording of certain STR items may not fully capture the nuanced ways Turkish individuals experience stranger-related odors. Future research should employ cognitive interviewing techniques and DIF analysis to examine whether specific items function differently across cultural groups. Another significant finding regarding construct validity is that the three-factor structure accounted for 48.8% of the total variance, which is considered acceptable in social sciences (Costello & Osborne, 2005; Hair et al., 2019). All items had factor loadings above 0.30 on their intended factors, although minor cross-loadings were observed for two items. Nevertheless, these findings demonstrate that the items adequately represent the constructs they aim to measure and meet the recommended minimum criteria (Hair et al., 2019; Nunnally & Bernstein, 1994). These positive EFA findings provided strong preliminary evidence for the scale's three-factor structure within the Turkish cultural context. Consequently, CFA was conducted to test this structure more definitively, and the results confirmed the three-factor model. All fit indices were within acceptable limits, indicating that the three-dimensional structure of the scale demonstrates sufficient and acceptable model fit for the Turkish version (Hair et al., 2019; Hu & Bentler, 1999; Kline, 2023; Marsh & Hocevar, 1985).

As a component of construct validity, discriminant validity was tested against the GAD-7. The findings revealed a statistically significant but weak positive relationship between social odor perception and anxiety. When evaluated within the framework of Campbell and Fiske's (1959) multitrait-multimethod matrix principles, these low correlations indicate that the SOS measures a distinct construct separable from general anxiety (Campbell & Fiske, 1959). This pattern is consistent with previous research, which has reported similarly weak, positive, and statistically significant correlations between odor-related scales and GAD-7 scores in Chinese samples (Zhang et al., 2023, 2025). Anxiety-related constructs such as negative affectivity and social inhibition have also been shown to influence health-related behaviors (Atan et al., 2025), further supporting the weak but meaningful distinction between social odor perception and general anxiety. Thus, our results are consistent with the existing literature and support the discriminant validity of the Turkish SOS.

The test-retest reliability of the SOS was found to be acceptable. The paired t-test indicated no statistically significant change between the two measurements (Bland & Altman, 1986), correlation coefficients showed a positive linear relationship (Cohen, 1988), and ICC (3,1) values indicated moderate to good consistency (Koo & Li, 2016). The ICCs for FAM and STR suggested somewhat higher variability over time. Since test-retest reliability was assessed only over a two-week period and in a relatively homogeneous sample, future studies should incorporate longer intervals or longitudinal designs with more

heterogeneous populations to enhance generalizability (Portney & Watkins, 2015).

Finally, no statistically significant difference was found between SOS scores and gender, except for the PAR subscale. This finding suggests that gender-related differentiation may be specific to partner-related odor perceptions. That said, because this analysis was exploratory, these findings should be treated with caution. The literature indicates that odor awareness may be associated with various demographic and epidemiological parameters, some of which may have limiting characteristics (Oleszkiewicz et al., 2020; Rokosz et al., 2024). Future studies with more diverse samples are needed to further explore these associations.

Conclusion

This study offers initial evidence that the Turkish version of the Social Odor Scale (SOS) is a valid and reliable tool for measuring social odor perception in a non-clinical Turkish adult sample. The three-factor structure, which aligns with the original scale, was confirmed in the Turkish sample. This short and practical format can be used to assess social odor perception in research settings. Furthermore, its multidimensional nature allows for a detailed examination of the role of the sense of smell in interpersonal communication. With these qualities, the SOS may serve as a useful tool for future epidemiological and interdisciplinary research in Türkiye. However, further studies are needed to establish measurement invariance, clinical validity, and generalizability across different regions and populations.

Study limitations

Several limitations should be acknowledged. First, the sample was recruited through convenience sampling from only two provinces (Aydın and Burdur), which limits the generalizability of the findings to Turkey's geographically, socioeconomically, and culturally diverse population. The sample was also predominantly highly educated and single, which may not represent the broader Turkish adult population. Second, online recruitment may have introduced selection bias, as participants with higher digital literacy and different health awareness may have been overrepresented. Third, content validity was assessed using a binary rating scale; a four-point relevance scale is more commonly recommended in content validity studies (Polit & Beck, 2006). Fourth, test-retest reliability was assessed over a two-week period in a relatively homogeneous sample; longer intervals and more heterogeneous populations are needed to enhance generalizability (Portney & Watkins, 2015). Finally, the STR subscale had lower internal consistency, which may reflect cultural specificities in perceiving stranger-related odors in the Turkish context. These limitations should be considered when interpreting the findings.

Acknowledgements We thank all the participants for their contribution.

Author contributions SK: Permission of Scale, Conceptualization, Methodology, Formal Analysis, Data Curation, Writing-Original Draft Preparation, Writing-Review & Editing, Project Administration. BC: Data Collection, Investigation, Writing-Original Draft Preparation, Writing-Review & Editing. All authors have read and approved the final version of the manuscript.

Funding This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data availability The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical approval The ethical committee approval for this study was reviewed and granted by the XXX Non-Interventional Research Ethics Committee (Approval No: 2025–2196, Date: November 5, 2025). Data collection commenced ten days after this date. The Helsinki Declaration was followed in all procedures related to the research.

Consent for publication Not applicable

Informed consent Informed consent was obtained from participants before their inclusion in the study, within the data collection period. The initial page of the online data collection instrument contained a consent text explaining the research purpose, methodology, potential risks and benefits, confidentiality principles, the voluntary nature of participation, and the right to withdraw. Participants could only access the survey questions after reading this text and clicking the "I Agree" button. This digitally recorded approval process, logged by the system, was accepted as the electronic equivalent of written informed consent and was obtained from all participants.

Competing interests The authors declare no competing interests.

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