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What is This?
Evaluation of Factors Concerning the Olfaction Using the Sniffin’ Sticks Test

Kadir Serkan Orhan, MD¹, Burak Karabulut, MD², Nesil Keleş, MD¹, and Kemal Değer, MD¹

No sponsorships or competing interests have been disclosed for this article.

Abstract

Objective. This study aimed to research the normative values of olfactory function in the Turkish population using the Sniffin’ Sticks test and to relate olfactory performance to age, sex, smoking, educational level, and the side examined. It also aimed to compare the results with other countries’ normative values, especially Europe, using the same test and procedure.

Study Design. Prospective clinical study.

Setting. Tertiary referral center.

Subjects and Methods. This study was a prospective clinical trial conducted in a tertiary clinic. A total of 100 healthy subjects were included in the study. Of these, 50 were men and 50 were women. The mean (SD) age of the subjects was 37.7 (14.8) years (range, 18-77 years).

Results. Odor scores were lower than the scores of other countries, and the scores decreased significantly with age. There was no relationship between olfaction and sex or smoking. Subjects with a lower educational status had lower scores compared with the scores of median and highly educated subjects.

Conclusion. This is the first study that evaluated the relationship between education level and olfaction. According to the results, the cultural differences, education level, and age seemed to influence odor scores. The Sniffin’ Sticks test can be used to assess olfactory performance in a Turkish population, but identification of odors in this test battery may show variability because of local and cultural factors.

Keywords
screening test, smell, identification, discrimination, threshold

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Olfaction, which provides important and crucial data about the environment, is a pathway in which neural signals are converted into chemosensory signals. This sense is critical for certain occupations, such as gourmet chefs, wine tasters, firefighters, and natural gas workers. However, olfactory disorders are usually neglected and underestimated by physicians who lack certain knowledge about the anatomy and physiology of olfaction. Moreover, loss of this sense has a direct effect on quality of life of patients,¹ and determination of olfactory function before and after nasal surgeries has medico-legal implications.²

Although patients who have olfactory dysfunction typically complain of loss of taste, true gustatory disorders are rare. Because up to 80% of a meal’s flavor is a result of olfactory input, patients frequently interpret a loss of smell as a loss of taste.³ Many tests are available to detect smell disorders, but the most widely used ones are the University of Pennsylvania Smell Identification Test (UPSIT) and the Connecticut Chemosensory Clinical Research Center Test (CCCRC) in North America and the Sniffin’ Sticks Test in Europe and Australia.⁴⁻⁷

The main goal of this study was to determine the normal olfactory scores of Turkish people by using the Sniffin’ Sticks Test and relate olfactory performance to age, sex, smoking, education level, and the side examined. This study also aimed to compare our results with other countries’ normative values, especially Europe, using the same test and procedure.

Subjects and Methods

One hundred healthy volunteers were investigated from September 2010 to December 2010. Examination took place in the setting of the Otolaryngology Department of the Istanbul Medical Faculty, Istanbul University. Fifty subjects were male and 50 were female. Inclusion criteria were at least 18 years of age, no nasal pathology (significant septal deviation, turbinate hypertrophy, nasal polyps, rhinosinusitis, etc), no history of head or neck trauma, nasal surgery, any olfactory problem, chemical or toxic exposure, and upper respiratory tract infection within 2 weeks. First, the

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medical history was taken. This was followed by anterior rhinoscopy, nasal endoscopy with a 30° scope, and routine ear, nose, and throat examinations of all subjects performed by the same investigator (BK) before smell testing. The subjects who did not meet the criteria were excluded from the study. The care of the human subjects in this study was approved by the local ethics committee of Istanbul Medical Faculty (ref. number: 2010/599–149. 2010.09.07). All subjects were volunteers, and the aim, design, and the clinical implications of the study were fully explained to them. The investigations were performed in accordance with the principles of the Declaration of Helsinki/Hong Kong.

“Sniffin’ Sticks” (Heinrich Burghart GmbH, Wedel, Germany) are odor-dispensing devices that resemble felt-tipped pens. The Sniffin’ Sticks test battery consists of 3 elaborate tests of olfactory function: odor threshold (OT), odor discrimination (OD), and odor identification (OI). Previous work has already established its test-retest reliability and its validity in comparison with established measures of olfactory sensitivity. The pens had a length of approximately 14 cm and an inner diameter of 1.3 cm. Instead of liquid dye, the tampon was filled with 4 mL of liquid odorants or odorants dissolved in propylene glycol. For odor presentation, the cap was removed by the experimenter for approximately 3 seconds in front of both nostrils. Testing involved tests for odor threshold, discrimination, and identification. Odor thresholds for n-butanol were assessed using a single-staircase, triple-forced-choice procedure. Sixteen dilutions were prepared in a geometric series starting from a 4% n-butanol solution (dilution ratio 1:2 in deionized aqua conservator as diluent). Three pens were presented in a randomized order, with 2 containing the solvent. In the third, the odorant was at a certain dilution. The subjects’ task was to identify the odor-containing pen. Triplets were presented at intervals of 20 seconds. Reversal of the staircase was triggered when the odor was correctly identified in 2 successive trials. The threshold was defined as the mean of the last 4 of 7 staircase reversal points. The subjects’ scores ranged between 0 and 16. In the odor discrimination task, triplets of pens were presented in a randomized order, with 2 containing the same odorant and the third containing a different odorant. Subjects had to determine which of 3 odor-containing pens smelled different. The presentation of the triplets was separated by 20 to 30 seconds, and the interval between the presentations of individual pens of a triplet was approximately 3 seconds. As a total of 16 triplets were tested, the subjects’ scores ranged from 0 to 16. When measuring odor thresholds and odor discrimination, the subjects were blindfolded to prevent visual identification of some of the odorant-containing pens. Odor identification was assessed by means of 16 common odors. Using a multiple-choice task, identification of individual odorants was performed from a list of 4 possible descriptors. The interval between odor presentations was 20 to 30 seconds. Again, the subjects’ scores ranged from 0 to 16. The results of the 3 subtests were presented as a composite “TDI score,” which was derived from the sum of the results obtained for the threshold, discrimination, and identification measures.

Statistical analysis of the data was performed using the Statistical Package for the Social Sciences for Windows (SPSS), version 15.0 (SPSS, Inc, an IBM Company, Chicago, Illinois). The Kolmogorov-Smirnov test was used for normality. To assess OI, OT, OD, and TDI scores in relation to age, educational level, and sex, data were analyzed with the 1-way analysis of variance (ANOVA) and the post hoc Tukey test. In all cases, P values below .05 were regarded as statistically significant.

Results

One hundred otherwise normal Turkish subjects whose age ranged between 18 and 77 years (mean [SD] age 37.7 [14.8] years) were included in the study. The data shown are mean (SD) scores. The overall mean OT, OD, and TDI scores were 4.8 (1.5), 11.7 (1.8), 11.7 (2.0), and 28.2 (4.3), respectively. The TDI score at the 10th percentile was 22.8. Scores below this value (n = 10) were considered hyposmic.

Lateralization

Mean (SD) OT values were 4.13 (1.5) for the right and 3.8 (1.4) for the left nasal side. Mean (SD) OD scores were 10.6 (2.1) for the right and 9.8 (2.3) for the left side. Mean (SD) OI scores of the right nasal side (10.8 [2.3]) were higher than those of the left side (10.1 [2.5]). All OT, OD, and OI scores of the right side were significantly higher than those of the left side (P < .001; Figure 1).

Age

The subjects were divided according to their age into 3 groups: group 1 (range, 18-35 years; n = 50), group 2

![Figure 1](https://example.com/figure1.png)
TDI and age; 0.45 for OD and age. OI scores were 10.1 (1.8) for group A, 11.8 (1.9) for group B, and 12.6 (1.7) for group C. Significant differences were found when these 3 groups were compared with each other (P < .05). Mean (SD) TDI scores were 26 (3.7) for group A, 28.9 (3.3) for group B, and 30 (4.7) for group C. Although the difference in TDI scores between group A and the other groups was quite significant (P < .01), there was no difference between groups B and C (Figure 3).

### Sex

There was no significant difference in age between men (mean, 40.2 years) and women (mean, 35.4 years; P = .1). The mean (SD) OT score for women and 4.9 (1.6) for men. Mean (SD) OD score was 11.8 (1.6) for women and 11.6 (2.0) for men. Mean (SD) OI score was 11.9 (1.9) for women and 11.4 (2.0) for men. Mean (SD) TDI scores, which are the sum of all the above, were 28.5 (3.9) for women and 27.9 (4.6) for men. There was no statistically significant effect of the subjects’ sex on the OT, OD, OI, and TDI scores (P > .1; r = 0.06 for OT and sex, r = 0.07 for OD and sex, r = 0.12 for OI and sex, r = 0.06 for TDI and sex).

Forty-six subjects were smokers of 1 to 50 packs/y (mean [SD] smoking condition, 18.39 [13.20] packs/y). There was no difference in OT, OD, OI, and TDI scores between smokers and nonsmokers.

The correct answer ratios for the identification test for licorice, turpentine, and apple were 42 out of 100, 20 out of 100, and 36 out of 100, respectively. These ratios were remarkably

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**Figure 2.** The relationship between olfactory scores and age. Odor threshold (OT), odor discrimination (OD), odor identification (OI), and the results obtained for the threshold, discrimination, and identification (TDI) scores (means, standard deviation of means) separately for the 3 age groups as group 1 (range, 18-35 years; n = 50), group 2 (range, 36-55 years; n = 36), and group 3 (older than 55 years; n = 14). + vs +, x vs x, * vs *, ** vs ***: statistically significant, P < .01.

**Figure 3.** The relationship between olfactory scores and education level. Changes of odor threshold (OT), odor discrimination (OD), odor identification (OI), and the results obtained for the threshold, discrimination, and identification (TDI) scores (means, standard deviation of means) separately for the 3 educational levels: subjects who graduated from primary school (n = 36) as group A, from high school (n = 33) as group B, and from college (n = 31) as group C. * vs *, ** vs **, *** vs ***; statistically nonsignificant. Other comparisons: statistically significant, P < .01.

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**Education Level**

Subjects were divided into the following 3 groups based on their educational level: subjects who had graduated from primary school (n = 36) as group A, subjects who had graduated from high school (n = 33) as group B, and subjects who had graduated from college (n = 31) as group C. The mean (SD) OT scores were 4.4 (1.1) for group A, 5.0 (1.5) for group B, and 5.2 (1.8) for group C. The differences among all groups were not statistically significant. Mean (SD) OD scores were 11.8 (1.8) for group A, 12 (1.5) for group B, and 12.2 (1.9) for group C. Despite there being no significant difference between the OD scores of groups B and C (P = .5), there were meaningful differences in the scores between groups A and B (P < .01) and groups A and C (P < .01). Mean (SD) OI scores were 10.1 (1.8) for group A, 11.8 (1.9) for group B, and 12.6 (1.7) for group C. Significant differences were found when these 3 groups were compared with each other (P < .05). Mean (SD) TDI scores were 26 (3.7) for group A, 28.9 (3.3) for group B, and 30 (4.7) for group C. Although the difference in TDI scores between group A and the other groups was quite significant (P < .01), there was no difference between groups B and C (Figure 3).
lower than the correct answer ratios of the other odorants (Figure 4).

**Discussion**

Because of cultural and geographical effects on olfaction, it is important to determine local normative values to detect hyposmic and anosmic subjects. Although many tests are available for examining olfactory function, the UPSIT and CCCRC in North America and the Sniffin’ Sticks test in Europe and Australia are the most commonly used.7 Most of the tests aim to detect identification scores. An extended version of the Sniffin’ Sticks test is superior to the others because of its ability to measure OT, OD, OI, and TDI scores.11 Because of these points, and as Turkey is a European country, the Sniffin’ Sticks test was preferred for our study.

Olfactory disorders, which are usually underestimated by clinicians, have direct effects on quality of life and may have dangerous consequences. The etiology may be obstructive nasal and sinus disorders, upper respiratory tract infections, head trauma, aging, congenital disorders, and toxins. In some subjects, there is no identified cause, and this group is therefore referred to as idiopathic. Olfactory dysfunction can be reliably classified as follows:

- **Anosmia**: inability to detect olfactory sensations (ie, absence of smell function)
- **Partial anosmia**: ability to perceive some, but not all, such sensations
- **Hyposmia or microsmia**: decreased sensitivity to odors
- **Hyperosmia**: enhanced odorant sensitivity
- **Dysosmia**: distorted or perverted smell perception to odor stimulation (sometimes termed *cacosmia* or *parosmia*, depending on the nature of the perversion)
- **Phantosmia**: a dysosmic sensation perceived in the absence of an odor stimulus (ie, an olfactory hallucination)
- **Olfactory agnosia**: inability to recognize an odor sensation even though olfactory processing, language, and general intellectual functions are essentially intact, as seen in some stroke patients

Recent studies have argued that environmental factors and climate can affect olfaction.7,13,14 Our test center in Istanbul has similar climatic conditions to Athens and Alexandroupolis, where the normative values of Greeks using the Sniffin’ Sticks test have been reported.15,16 However, our OD, OI, and especially OT scores were lower than the scores in the Greek study. These results may suggest that climatic conditions do not have a great effect on olfaction. On the other hand, our olfaction scores were lower compared with European and Taiwan olfaction test scores10,14 (Table 1). This difference may be explained by the possible effects of cultural differences on olfaction.

The age-related decrease of olfaction is an expected result. Many studies have shown the decline of olfactory sensitivity with aging.8,13,17-19 Age-related olfactory disorders may be due to changes in neural and cortical pathways, psychological factors such as memory loss, alteration in olfactory epithelial blood flow, increase in mucus viscosity, and decrease of metabolic activity.13 Doty et al19 determined major olfactory problems in three-quarters of subjects older than 80 years and in half of subjects aged between 65 and 80 years from a total of 1955 participants. Hummel et al10 argued that OT scores displayed a more dramatic decline than OI and OD. In addition, Boesveldt et al20 showed that OD scores decreased in women but not significantly in men in 150 German subjects older than 45 years (87 men, 63 women). For
Dhong et al.24 showed that estrogen had a protective influence specifically estrogen, on olfactory epithelium. In addition, study. They related this to the positive effects of hormones, higher in the female group than in the male group in their effect of hormonal status on olfaction.21-23 Katotomichelakis relationship between olfaction and educational level. more subjects to have statistically significant results for the addition to aging. We need to perform further studies with in olfactory scores might be related to educational status in respect of the subjects. In our study, when the educational status of the subjects was compared, the olfactory scores of with lower educational status were found to have a higher status of the subjects was compared, the olfactory scores of poorly educated subjects were found to be significantly lower than the scores of medium and highly educated subjects. However, when these groups were assessed for age, subjects with lower educational status were found to have a higher average age. The mean (SD) age was higher in the subjects with a poor educational status than the medium to highly educated subjects: 46.3 (12.3), 33.2 (15.2), and 33.8 (11.9), respectively. Nevertheless, it is not clear whether the decline in olfactory scores might be related to educational status in addition to aging. We need to perform further studies with more subjects to have statistically significant results for the relationship between olfaction and educational level.

According to the literature, there are no clear data on the effect of hormonal status on olfaction.21-23 Katotomichelakis et al.13 reported that OT and TDI scores were significantly higher in the female group than in the male group in their study. They related this to the positive effects of hormones, specifically estrogen, on olfactory epithelium. In addition, Dhong et al.24 showed that estrogen had a protective influence on experimentally induced olfaction disorders in rats. It has also been suggested that women had better identification scores because they have much better verbal skills than men.25 Hummel et al.10 showed that there was no significant difference between TDI scores of men and women in 3000 subjects. Although female subjects had better scores in our study, this was not statistically significant. Thus, the relationship between olfaction and sex remains a controversial issue and requires further investigation.

In our study, all the scores of the right nostril were higher than those of the left nostril. Many studies have also shown a right nostril advantage in olfactory sensitivity.13,26,27 Hummel et al.28 showed that in the odor discrimination task, left-handed people performed significantly better on the left side compared with the right nostril; this pattern was reversed in right-handed people. Zatorre et al.29 showed that the piriform cortex, the primary olfactory cortex, was activated bilaterally by odor presentation. In addition, activation of the right orbitofrontal cortex, also called the secondary olfactory cortex, occurred. The authors reported that the unilateral activation of the orbitofrontal cortex indicated its functional specialization and its involvement in a higher order processing of odor. On the contrary, Qureshy et al.30 in their positron emission tomography (PET) study, showed that the left orbitofrontal cortex was also activated together with the right orbitofrontal cortex. The authors emphasized that cognitive analysis is also important as well as these imaging studies. As a result, the neural pathways of olfaction seem to be more complex, and new studies are needed to identify its function and physiology.

### Table 1. Comparison of All Scores (Mean ± SD) with Other Countries

<table>
<thead>
<tr>
<th>Age 18-35 y</th>
<th>Female</th>
<th>Male</th>
<th>Greece</th>
<th>Taiwan</th>
<th>Turkey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjects, No.</td>
<td>704-827</td>
<td>552-672</td>
<td>—</td>
<td>66</td>
<td>50</td>
</tr>
<tr>
<td>OT</td>
<td>9.4 ± 2.6</td>
<td>9.2 ± 3.0</td>
<td>9.0 ± 1.0</td>
<td>7.7 ± 2.2</td>
<td>5.4 ± 1.5</td>
</tr>
<tr>
<td>OD</td>
<td>13 ± 1.9</td>
<td>12.6 ± 1.9</td>
<td>15.8 ± 0.4</td>
<td>12.8 ± 1.9</td>
<td>12.5 ± 1.6</td>
</tr>
<tr>
<td>OI</td>
<td>13.7 ± 1.6</td>
<td>13.5 ± 1.7</td>
<td>15.0 ± 0.8</td>
<td>14.0 ± 1.5</td>
<td>12.3 ± 1.9</td>
</tr>
<tr>
<td>TDI</td>
<td>36.1 ± 4.2</td>
<td>35.3 ± 4.73</td>
<td>39.8 ± 1.4</td>
<td>34.6 ± 3.8</td>
<td>30.2 ± 3.6</td>
</tr>
<tr>
<td>10th percentile</td>
<td>30.5</td>
<td>29.5</td>
<td>38.8</td>
<td>30.0</td>
<td>25.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age 36-55 y</th>
<th>Female</th>
<th>Male</th>
<th>Greece</th>
<th>Taiwan</th>
<th>Turkey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjects, No.</td>
<td>288-586</td>
<td>207-491</td>
<td>—</td>
<td>55</td>
<td>36</td>
</tr>
<tr>
<td>OT</td>
<td>9.1 ± 3.1</td>
<td>8.4 ± 3.5</td>
<td>9.2 ± 0.5</td>
<td>7.2 ± 1.7</td>
<td>4.6 ± 1.2</td>
</tr>
<tr>
<td>OD</td>
<td>12.5 ± 2.0</td>
<td>12.0 ± 2.2</td>
<td>16.0 ± 0.4</td>
<td>12.2 ± 2.0</td>
<td>11.4 ± 1.6</td>
</tr>
<tr>
<td>OI</td>
<td>13.5 ± 1.6</td>
<td>13.1 ± 1.9</td>
<td>15.1 ± 0.5</td>
<td>13.4 ± 1.9</td>
<td>11.3 ± 1.8</td>
</tr>
<tr>
<td>TDI</td>
<td>35.2 ± 4.5</td>
<td>33.2 ± 6.1</td>
<td>40.2 ± 0.5</td>
<td>32.8 ± 4.1</td>
<td>27.3 ± 3.6</td>
</tr>
<tr>
<td>10th percentile</td>
<td>28.8</td>
<td>25.0</td>
<td>39.5</td>
<td>27.5</td>
<td>22.75</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age &gt;55 y</th>
<th>Female</th>
<th>Male</th>
<th>Greece</th>
<th>Taiwan</th>
<th>Turkey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjects, No.</td>
<td>143-251</td>
<td>139-238</td>
<td>—</td>
<td>24</td>
<td>14</td>
</tr>
<tr>
<td>OT</td>
<td>7.4 ± 3.5</td>
<td>7.2 ± 3.6</td>
<td>6.9 ± 0.7</td>
<td>5.9 ± 2.0</td>
<td>3.3 ± 0.8</td>
</tr>
<tr>
<td>OD</td>
<td>10.7 ± 2.5</td>
<td>10.7 ± 2.8</td>
<td>13.8 ± 0.8</td>
<td>10.1 ± 2.9</td>
<td>9.8 ± 1.8</td>
</tr>
<tr>
<td>OI</td>
<td>12.16 ± 2.3</td>
<td>12.2 ± 2.6</td>
<td>13.0 ± 0.9</td>
<td>11.8 ± 2.2</td>
<td>10.3 ± 1.6</td>
</tr>
<tr>
<td>TDI</td>
<td>29.8 ± 6.8</td>
<td>29.8 ± 7.2</td>
<td>33.6 ± 1.4</td>
<td>27.7 ± 6.0</td>
<td>23.4 ± 3.4</td>
</tr>
<tr>
<td>10th percentile</td>
<td>19.1</td>
<td>19.8</td>
<td>30.8</td>
<td>16.9</td>
<td>18.1</td>
</tr>
</tbody>
</table>

Abbreviations: OD, odor discrimination; OI, odor identification; OT, odor threshold; TDI, threshold, discrimination, and identification.
It has been reported that smoking increases the risk of olfactory disorders. However, in our study, there was no relationship between smoking and olfactory scores. Danielides et al reported that smoking was not a major predictive factor after endoscopic sinus surgery in the early postoperative period, but it had an effect on OT scores at evaluation during the sixth postoperative month.

Identification of odors in the Sniffin’ Sticks test’s extended test battery may show variations due to cultural and local characteristics. For example, it was shown that Italians had problems in identifying the odor of clove in a screening test. In addition, in Taiwan and Greece, the subjects achieved better scores after some odors were changed because of local and cultural features. In our study, there was a significant decrease in the identification of turpentine, licorice, and apple odors. The main reason for the decrease in apple scores was the presence of a deceptive descriptor, such as peach. Seventy percent of subjects who gave wrong answers had problems in choosing between an apple and peach. If there had been another deceptive choice other than peach, the scores would have been even higher. Many of our volunteers had no idea about the turpentine, licorice, and anise, and correct answer were achieved by exclusion of other given choices. These 3 odors should be changed to others that Turkish people are more familiar with.

Conclusion

Our scores were lower than the scores of other countries. Scores decreased significantly with aging, and there was no relationship between olfaction and sex or smoking. Subjects with a lower educational status had lower scores compared with median and highly educated subjects. However, it is important to note that identification of odors in the Sniffin’ Sticks test battery may show variability because of local and cultural factors. Thus, more studies with the addition of familiar odors and a higher number of participants for the Turkish population are needed.

Author Contributions

Kadir Serkan Orhan, data collection, writing, statistical analysis; Burak Karabulut, data collection, writing, statistical analysis; Nesil Keleş, writing, literature review; Kemal Değer, writing, literature review.

Disclosures

Competing interests: None.

Sponsorships: None.

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