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Normative data for the Vietnamese smell identification test

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ABSTRACT

Introduction: The 12-item Vietnamese smell identification test (VSIT) has been developed to evaluate the olfactory function of the Vietnamese population. This study aimed to investigate the normative value of the VSIT in different age groups and sexes.

Methods: This cross-sectional study was conducted at Ho Chi Minh University Medical Center, Vietnam. All participants were evaluated for odor identification ability using the VSIT. We included healthy participants aged 18 years or older with no history of olfactory disturbances.

Results: A total of 391 healthy volunteers were recruited with a mean age of 45.80 years (SD: 17.62; range: 18–86; female: 63.4 %). The tenth percentile of scores on the 0–12 VSIT scale was 8.3 in participants aged 18–29 years, 9.0 in 30–39 years, 8.0 in 40–49 years, 7.8 in 50–59 years, 7.9 in 60–69 years and 6.0 in over 70 years. Young adults (18–39 years old) had better olfactory identification ability than older adults (over 50 years), $p < 0.001$. There was a significant main effect of sex on VSIT score ($p = 0.02$), suggesting that females outperformed males. Sensitivity to 8 odors were negatively correlated with age: lemon, garlic, banana, coffee, mango, guava, apple and watermelon ($p < 0.05$ in all cases) whereas four odors were age-independent including orange, fish sauce, soy sauce, and fish.

Conclusion: Normative data provide guidance for assessing individual olfactory function. However, there were significant sex and age effects on olfactory identification scores on the VSIT. Therefore, future studies should be conducted to better adjust for those confounders mentioned above.

1. Introduction

Olfaction plays an essential role in various aspects of human life, permitting the detection of environmental hazards and affecting taste perception and emotion. As a result, impaired olfactory function can greatly reduce quality of life [1]. However, olfactory disorders have been underestimated, as many patients are unaware of their smell impairment [2].

Many psychophysical tools for investigating olfactory function have been developed [3,4], among which odor identification tests are widely used because of their simplicity and availability [5]. However, familiarity with odors varies from country to country, and thus the results of odor identification tests depend on cultural factors [6]. For this reason, studies have been conducted to develop odor identification tests that are suitable for local populations [7–9]. Once these tests are introduced, it is crucial to determine the reference values for the diagnosis of hyposmia.

The influences of age and sex on odor identification have been frequently reported. Many studies have demonstrated an inverse

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correlation between aging and the ability to identify odors [10–12]. While a number of studies have found that women outperform men in odor identification [13–16], this finding is not universal [17]. Therefore, normative values of these tests in different age groups and sexes should be established to apply odor identification tests for the general population. Although normative data of the most commonly used odor identification tests, including the University of Pennsylvania Smell Identification Test (UPSIT), The Brief Smell Identification Test (BSIT), and the Sniffin's Stick test have been described [3,14,18], these might not be relevant for the different populations and cultures. Our previous study revealed that turpentine included in the BSIT and the UPSIT and clove included in the Sniffin's Stick test are not familiar to the Vietnamese population [19].

The Vietnamese smell identification test (VSIT) has been developed to permit the assessment of olfactory function in the Vietnamese population. The VSIT includes 12 odorants that are familiar and identifiable to Vietnamese. Our previous study demonstrated that using a cutoff of 8, the VSIT is highly sensitive (93.3 %) and specific (97.5 %) in distinguishing the normosmic group and the hyposmic group. The test retest reliability of VSIT was favorable (0.72, 95 % CI = 0.58–0.83). However, the number of healthy participants in the above mentioned study was 120 subjects, so normative data for the test has not been established [19].. This study aimed to investigate the normative values of the VSIT in different age groups and sexes and examine the influence of sex and age on the odor identification ability of Vietnamese people.

2. Materials and methods

This cross-sectional study was conducted at the University Medical Center, University of Medicine and Pharmacy Ho Chi Minh City, Vietnam.

2.1. Participants

From March 2022 to March 2023, hospital staff members and caregivers aged 18 years or older with no history of olfactory disturbances were eligible and were invited to participate in this study. The following exclusion criteria were applied: 1/ history of neurodegenerative disorders, neuropsychiatric disorders, chronic ear/nose/throat (ENT) diseases or diabetes mellitus; 2/ history of nasal surgery or severe head trauma, 3/ medication use that might affect olfactory function, 4/ history of upper respiratory tract infection within the past two weeks, 5/ the presence of cognitive impairment (Mini Mental State Exam [MMSE] scores of 24 or less) and 6/ pregnancy. All participants provided informed written consent. The protocol was approved by the Ethics Committee of the University Medical Center, University of Medicine and Pharmacy at Ho Chi Minh City, Vietnam (122/GCN-HĐĐĐ).

2.2. Measures

Participants' olfactory performance was assessed using the VSIT. This test includes 12 odorants presented in cotton buds. These cotton buds are dipped in diluted odor solution and packaged in sterile, non-volatile sachets. To perform the test, the investigator tears the cotton swab-containing sachet in the direction of the arrow to reveal the bud of the cotton swab and places it approximately 2 cm from the nostrils for 2–3 s. The interval between odor presentations was at least 20 s. The participants were requested to sniff and identify the smell by indicating the correct odor from four descriptors, including one answer and three distractors on a questionnaire presented in multiple forced choice design. Each correctly recognized odorant was given one mark, resulting in a total score ranging from 0 to 12 [19].

2.3. Statistical analysis

Data analysis was performed using SPSS 20.0 software. Participants were divided into six age groups: (A) 18–29 years; (B) 30–39 years; (C) 40–49 years; (D) 50–59 years; (E) 60–69 years and (F) ≥ 70 years. Normative data of the VSIT scores were recorded as means, standard deviations (SDs), medians, ranges, and percentiles, stratified for sex and age groups. The 10th percentile values in each age group and each sex were established to separate the normosmic from the hyposmic subjects [16,20,21]. Percentile ranks for olfactory function by age group and sex were also described. We also evaluated the relative influences of age and sex on VSIT scores using analysis of variance (two-way ANOVA). Post-hoc pairwise comparisons using Tukey honestly significant difference (HSD)-corrected multiple comparisons between the six age groups. A recent *meta*-analysis suggests a sex difference was concentrated in the age group 50 years and below [22]. Therefore, we also planned to examine the effect of sex on patients 18 to 50 years and 51 years old or older using *t* tests. Chi-square tests were also conducted to examine the relationship between sex and specific VSIT items. To examine the influence of age on the identifiability across the specific odor items, a series of point-biserial correlations were performed. The level of significance was set at 0.05.

3. Results

A total of 391 participants, with a mean age of 45.80 years, (SD: 17.62; range: 18–86) were enrolled and females accounted for the majority of the study sample (63.4 %).

The mean VSIT scores, median, and percentiles in the different age and sex groupings are shown in Table 1. With pooled sex, the VSIT scores at the tenth percentile value of group A (18–29 years) was 8.3 points; group B (30–39 years) 9 points; group C (40–49 years) 8 points; group D (50–59 years) 7.9 points; group E (60–69 years) 7.8 points; and group F (≥70 years) 6 points (Table 1). Percentile ranks for olfactory function by age group and sex are presented in Table 2.

3.1. Effects of sex and age on VSIT score

In this study, age had a main effect on the VSIT score, $F(5,379) = 13.36$, $p < 0.001$. Post-hoc testing indicated differences (all $p < 0.005$) between groups A and C, A and D, A and E, A and F, B and D, B and E, B and F, and C and F. The analyses pointed out that people of 50 to 59, 60 to 69, and 70 and above age groups had lower identification scores than those of 18 to 29 and 30 to 39 age groups ($p < 0.001$ in all cases). No significant differences were found between groups A and B, B and C, C and D, C and E, D and E, D and F, and E and F (Table 3). There was also a significant main effect of sex on VSIT score ($F(1,379) = 9.39$, $p = 0.02$), suggesting that on average, female participants ($M = 9.86 \pm 1.60$) outperformed their male counterparts ($M = 9.53 \pm 1.57$). The two factors of interest (sex and age) did not interact with each other ($p = 0.53$). Significant differences in odor identification between the two sexes were exclusively noted in adults aged 18 to 50 years (student's *t*-test, p=<0.001), but not in those 51 years old or older (student's *t*-test, $p = 0.43$).

3.2. Effects of sex and age on items of VSIT

The smell identification rates are presented in Table 4. Nearly all (93 %) of the participants correctly identified onion, while only 66 % correctly identified watermelon. The percentage of the women in the study sample correctly recognizing the scent of banana and guava were significantly higher relative to men ($p < 0.05$). Age had a negative influence on identification for some odorants, whereas others were unaffected by age. Specifically, eight odors demonstrated to be sensitive to aging were lemon ($r = -0.14$), garlic ($r = -0.14$), banana ($r = -0.20$), coffee ($r = -0.25$), mango ($r = -0.26$), guava ($r = -0.30$), apple ($r = -0.15$) and watermelon ($r = -0.16$) ($p < 0.05$ in all cases), whereas four age-independent odors were orange, fish sauce, soy sauce and fish.

Table 1
Normative values for the VSIT (N = 391).

	Age groups																				
	18–29 years			30–39 years			40–49 years			50–59 years			60–69 years			≥70 years			Overall		
	Male	Female	All	Male	Female	All	Male	Female	All	Male	Female	All	Male	Female	All	Male	Female	All	Male	Female	All
N	43	49	92	25	49	74	26	34	60	18	40	58	19	38	57	12	38	50	143	248	391
Mean	10.3	10.6	10.5	9.9	10.6	10.4	9.2	10.2	9.7	8.9	9.6	9.4	9.1	9.3	9.2	8.5	8.6	8.6	9.5	9.9	9.7
SD	1.4	1.1	1.2	1.4	1.2	1.3	1.3	1.6	1.5	1.8	1.2	1.4	1.4	1.7	1.6	1.8	1.9	1.9	1.6	1.6	1.6
Min	7	8	7	5	8	5	7	7	7	6	7	6	6	4	4	6	5	5	5	4	4
Max	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	11	12	12	12	12	12
Median	10	11	11	10	11	10	9	11	10	8.5	9.5	9	9	9	9	8.5	9	9	10	10	10
Percentiles																					
5	8.0	8.0	8.0	5.9	8.0	8.0	7.0	7.0	7.0	6.0	7.1	7.0	6.0	5.9	6.0	6.0	6.0	6.0	7.0	7.0	7.0
10	8.0	9.0	8.3	8.6	9.0	9.0	7.7	7.5	8.0	6.9	8.0	7.9	7.0	7.9	7.8	6.0	6.0	6.0	8.0	8.0	8.0
25	9.0	10.0	10.0	9.0	10.0	10.0	8.0	9.0	9.0	8.0	9.0	8.0	8.0	8.0	8.0	7.0	7.0	7.0	8.0	9.0	9.0
50	10.0	11.0	11.0	10.0	11.0	10.0	9.0	11.0	10.0	8.5	9.5	9.0	9.0	9.0	9.0	8.5	9.0	9.0	10.0	10.0	10.0
75	11.0	11.0	11.0	11.0	12.0	11.0	10.0	11.0	11.0	10.3	10.0	10.0	10.0	10.3	10.0	10.5	10.0	10.0	11.0	11.0	11.0
90	12.0	12.0	12.0	11.4	12.0	12.0	11.0	12.0	12.0	12.0	11.0	11.1	11.0	12.0	11.2	11.0	11.0	11.0	12.0	12.0	12.0
95	12.0	12.0	12.0	12.0	12.0	12.0	11.7	12.0	12.0		12.0	12.0		12.0	12.0		12.0	11.5	12.0	12.0	12.0

4. Discussion

The current study provides normative data for the VSIT based on a sufficient sample size. Significant differences in VSIT performance were revealed between men and women and among different age groups, with worse olfactory performance associated with male sex and older age.

Normative data of the VSIT can be used to estimate individual smell identification ability in relation to the subject's age. The 10th percentile of the BSIT in the age group 70–74 years was 5 for male and 7 for female [18], whereas that of the VSIT in the age group over 70 years was 6 for both sexes. Numerous prior studies have used the 10th percentile of the normative data as the threshold to differentiate between healthy subjects and those with olfactory dysfunction [14,16,21]. With regards to the group of subjects aged 18 to 29 years, the normative cut-off VSIT scores were 9 for female and 8 for male.

Several studies have shown that human olfactory function declines with age [3,8,16,23]. Our data found that the VSIT scores of the two youngest age groups (18- to 29-year-old age group and 30- to 39-year-old age group) were significantly higher than those of the 50–59, 60–69, and over 70-year-old age groups. This suggests that olfactory identification ability decreased from the age of 50 onward. Oleszkiewicz et al. also found similar results: the 21- to 30 years- and 31- to 40-years age groups had a higher score on the identification test than other groups over 51 years old [14]. There have been conflicting findings from studies evaluating the relation between age and olfactory performance. While several studies reported decreased olfactory ability in age groups over 55 years [16,24,25], one study conducted in Malaysia revealed a different result whereby middle-aged adults (41–60 years) identified odors better than other age groups [20]. Evidence suggests that age-related olfactory impairments arise from a multitude of factors, such as anatomical and physiological changes, loss of selectivity of receptor cells to odorants, and changes in neurotransmitter and neuromodulator systems [26,27].

Women in our population had significantly better smell identification ability than men. However, the difference in the mean VSIT scores between the two groups was 0.33 points. Regarding this issue, the results of previous studies are inconclusive, with some finding a significant difference between the two sexes in favor of women [14,20] and others failing to confirm this difference [16]. Recently, a *meta*-analysis with a large sample demonstrated weak but significant sex differences in olfactory performance [13]. Furthermore, in our data significant sex differences for odor identification existed only in younger adults aged 18–50 but not in older adults aged more than 50 years. A similar result was also noted in a *meta*-analytic review in 2019 [22]. Differences in gonadal steroid levels may explain why females outperformed males in young adults [28].

Regarding the influence of age on specific odor, we found a negative relationship between age and identification of lemon, garlic, banana, coffee, mango, guava, apple, and watermelon. However, age did not affect the recognition of the remaining four odors consisting of orange, fish sauce, soy sauce and fish. Iordanis Konstantinidis et al also revealed that the effects of age were not uniform across the various smell items [29]. Specifically, seven odors that proved sensitive to aging were pineapple, apple, anise, banana, peppermint, lemon, and cinnamon, whereas seven odors were equally well identified across all age cohorts, including rose, cloves, coffee, garlic, turpentine, fish, and shoe-leather [29]. Another study showed a negative correlation between age and identification of five items: gasoline, paint thinner, chocolate, smoke, and lemon [30]. Iordanis Konstantinidis et al suggested that odor sensitivity or resistance to aging may be differentiated based on the hedonics [29]. Odors perceived as unpleasant were age-independent, whereas odors considered as pleasant exhibited age sensitivity [29]. Therefore, some specific odors, such as fish could be used to develop odor identification tests because they effectively screen hyposmia irrespective of age.

Our findings showed that the effects of sex were also inconsistent

Table 2
Percentile ranks for VSIT score by age groups (N = 391).

Age group (Years)	18–29			30–39			40–49			50–59			60–69			≥70		
	Male	Female	All	Male	Female	All	Male	Female	All	Male	Female	All	Male	Female	All	Male	Female	All
12	90	90	90	98	88	91	99	93	95	95	99	97	99	96	97	.	99	99
11	66	63	64	82	60	67	94	63	76	83	88	85	95	84	87	92	91	90
10	40	30	34	52	32	38	75	40	54	78	65	68	79	70	72	.	76	76
9	21	10	15	22	10	15	48	26	35	64	34	42	47	46	47	67	53	56
8	10	4	6	8	4	5	23	13	17	36	10	18	21	20	19	46	37	38
7	2	.	1	.	.	.	6	6	5	14	4	6	10	8	8	29	28	27
6	.	.	.	.	.	.	.	.		6	.	2	6	5	4	10	10	12
5	.	.	.	4	.	2	.	.		.	.		.	.	.	.	3	2
4	.	.	.	.	.		.	.		.	.		.	3	2	.	.	.
3	.	.	.	.	.		.	.		.	.		.	.	.	.	.	.
2	.	.	.	.	.		.	.		.	.		.	.	.	.	.	.
1	.	.	.	.	.		.	.		.	.		.	.	.	.	.	.
0	.	.	.	.	.		.	.		.	.		.	.	.	.	.	.

Table 3
Mean VSIT difference between age groups.

Age group (Years)	18–29	30–39	40–49	50–59	60–69	>70
30–39[#]	0.094					
40–49[#]	0.712*	0.618				
50–59[#]	1.066***	0.972**	0.354			
60–69[#]	1.235***	1.141***	0.523	0.169		
≥70[#]	1.866***	1.771***	1.153**	0.799	0.631	
Overall[$]	0.921***	0.752***	−0.10*	−0.425	−0.622**	−1.332***

*** < 0.001, ** < 0.01, * < 0.05.
[#] Turkey HSD is used as a pairwise post hoc ANOVA test.
[$] Each age group is compared with the remaining groups using Student's *t*-test.

Table 4
Item identification rates and effect of sex and age (N = 391).

Odor	Correct Identification Rates (%)	Gender Differencesp (chi square)	Correlation with age r
Orange	93	0.34	−0.10, p = 0.06
Fish sauce	91	0.10	−0.01, p = 0.77
Garlic	91	0.13	−0.14, p = 0.004**
Soy sauce	90	0.41	−0.06, p = 0.21
Banana	86	0.04*	−0.20, p < 0.001***
Guava	84	0.02*	−0.30, p < 0.001***
Mango	79	0.93	−0.26, p < 0.001***
Coffee	75	0.85	−0.25, p < 0.001***
Fish	74	0.20	0.03, p = 0.66
Lemon	72	0.62	−0.14, p = 0.005**
Apple	72	0.86	−0.15, p < 0.001***
Watermelon	66	0.23	−0.16, p = 0.001***

across various odorants. Identification rates for two items (banana and guava) were significantly higher for women than men. Chloe Menon et al also found that identification rates for four items (soap, gasoline, paint thinner, rose) were significantly different between sexes [30]. Studies found that women are more prone to increased sensitivity to certain odorants due to repeated exposure to these smells [31,32].

This study has some limitations. The sample size in each age group was relatively low compared to previous studies. Therefore, future studies on VIST should be conducted with larger samples. Also, the female population accounted for the majority of the study sample (63.4 %), which could be a confounder for our study. Additionally, healthy subjects in our study were defined based on history and clinical examination without any further diagnostic tests. Therefore, we could have included underdiagnosed hyposmia patients in our study population. Future studies could based on our mentioned limitation to design their research on the VSIT.

5. Conclusion

Our VSIT normative data provides guidance for assessing individual olfactory function in relation to subject's age and sex. Hyposmia was defined at less than 9 points for females and less than 8 points for males on the VSIT for the group aged 18–29 years. A significant sex difference for odor identification was found in adults aged 18–50 years. Olfactory identification ability significantly decreased in subjects over 70 years. A study with a larger sample size in the future should be performed to confirm and extend these results.

CRediT authorship contribution statement

Tai Ngoc Tran: Conceptualization, Methodology, Resources, Data curation, Validation, Visualization, Supervision, Project administration, Formal analysis, Writing – original draft, Writing – review & editing. **Thuong Huyen Thi Dang:** Conceptualization, Methodology, Resources, Data curation, Validation, Visualization, Supervision, Project administration, Formal analysis, Writing – original draft. **Truc Thanh Thai:** Conceptualization, Methodology, Resources, Data curation, Validation, Visualization, Supervision, Project administration, Formal analysis, Writing – review & editing. **Uyen Le Ngoc Ha:** Conceptualization, Methodology, Resources, Data curation, Validation, Visualization, Supervision, Project administration, Formal analysis, Writing – review & editing. **Hien Thi Le:** Investigation, Writing – review & editing. **Thuy Thu Thi Nguyen:** Investigation, Writing – review & editing. **Hai Thi Nguyen:** Investigation, Writing – review & editing. **Anh Ngoc Thi**

Nguyen: Investigation, Writing – review & editing. **Khang Chung Ngoc Vo:** Formal analysis, Writing – review & editing. **Thanh Vinh Nguyen:** Investigation, Writing – review & editing. **Thanh van Nguyen:** Conceptualization, Investigation, Methodology, Resources, Data curation, Validation, Visualization, Supervision, Project administration, Formal analysis, Writing – review & editing. **Quang Xuan Ly:** Conceptualization, Methodology, Resources, Data curation, Validation, Visualization, Supervision, Project administration, Formal analysis, Writing – review & editing. **Khang Vinh Nguyen:** Investigation, Writing – review & editing. **Daniel Truong:** Conceptualization, Methodology, Resources, Data curation, Validation, Visualization, Supervision, Project administration, Formal analysis, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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