Parkinsonism and Related Disorders 113 (2023) 105494

Contents lists available at ScienceDirect

Parkinsonism and Related Disorders

journal homepage: www.elsevier.com/locate/parkreldis

Development and validation of the Vietnamese smell identification test

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ARTICLE INFO

Keywords:
Smell identification test
Validity
Reliability
Hyposmia

ABSTRACT

Background: Correct olfactory identification requires familiarity with the odor stimuli and is culturally dependent. Existing smell identification tests (SIT) are not culturally specific and may not be reliable in detecting hyposmia in all populations. This study aimed to develop a smell identification test suitable for Vietnamese patients (VSIT).

Methods: The study included 4 phases: 1) survey-based evaluation of the familiarity of 68 odors to identify 18 odors for subsequent testing (N = 1050); 2) smell identification test of 18 odors in healthy patients (N = 50) to determine which 12 should be included in the VSIT; 3) comparison of VSIT scores on 12 odors in patients with hyposmia (N = 60; Brief smell identification test (BSIT) score <8 and those with normosmia (N = 120; BSIT score ≥8) to establish the validity of the newly developed test; and 4) retest of the VSIT in 60 normosmic patients from phase 3 (N = 60) to determine test-retest reliability.

Results: As expected, the mean (SD) VSIT score was significantly higher in the healthy participants than in the hyposmic patients [10.28 (1.34) vs 4.57 (1.76); P < 0.001]. Using a cut-off score at 8, the sensitivity and specificity of the instrument in detecting hyposmia were 93.3% and 97.5% respectively. The test-retest reliability using the intra-class correlation coefficient was at 0.72 (P < 0.001).

Conclusion: The Vietnamese Smell Identification Test (VSIT) demonstrated favorable validity and reliability and will allow for assessment of olfactory function in Vietnamese patients.

1. Introduction

The olfactory system plays an important role in ingestive behaviors, awareness of environmental hazards, and social behaviors and communications [1]. As a result, olfactory dysfunction can have a significant negative impact on a patient's quality of life [2]. Various etiologies can lead to olfactory dysfunction, the most common being sinonasal diseases, upper respiratory tract infection and head trauma [3]. Olfactory dysfunction is also strongly associated with several neurodegenerative diseases [4], and has been demonstrated to be an early indicator for Parkinson's disease [5] and Alzheimer's disease [6]. Early olfactory deficits are imperceptible to the majority of patients until formal testing is conducted [7]. Thus, clinicians should not wait for patients to complain of changed sense of smell before testing, but rather initiate assessment based on other symptoms so it can be caught early and used in diagnosis. For that reason, an instrument for smell function assessment is critically important in clinical practice. Many psychophysical olfactory tests have been developed to evaluate major domains of olfaction including odor thresholds, discrimination and identification [8]. Among those three domains, previous findings have shown that

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https://doi.org/10.1016/j.parkreldis.2023.105494
Received 9 May 2023; Received in revised form 13 June 2023; Accepted 17 June 2023
Available online 1 July 2023

patients with Parkinson's disease or Alzheimer's disease seem to have a stronger association with dysfunctions in odor identification than in the other domains [9,10]. Smell identification testing is widely available and more practical for use in clinical settings than other methods for assessing olfactory dysfunction [8].

A limitation of available odor identification tests is that they rely on participants' familiarity with the odors being tested. However, familiarity with various odors is highly culturally dependent, rendering tests developed in one population or country invalid or less valid for those outside of that population or country [11,12]. As a result, numerous country-specific smell identification tests (SIT) have been developed since the introduction of the original University of Pennsylvania Smell Identification Test (UPSIT) in 1984 [13], including the Sniffin' Sticks identification test in Germany [14], the Scandinavian Odor Identification test [15] and more recently, the Chinese Odor Identification Test [16]. The goal of this study was to develop a Smell Identification Test (VSIT) suitable for use in the Vietnamese population (a Vietnamese SIT, or VSIT) and to evaluate the reliability and validity of the VSIT in detecting hyposmia in these individuals.

2. Materials and methods

2.1. Study design

This noninterventional study consisted of 4 phases designed to 1) identify appropriate odors for inclusion in a smell test assessment in a Vietnamese population based on an online survey; 2) further refine the list of odors based on a smell test in healthy volunteers; 3) establish the validity of the VSIT by determining its sensitivity and specificity in detecting hyposmia by comparing results in hyposmic and normosmic patients; and 4) assess the test-retest reliability of the VSIT by retesting a subset of normosmic patients from the previous study. Detailed methods are described below.

2.2. Participants

2.2.1. Phase 1

In Phase 1, 350 volunteers from each of the three main regions of Vietnam participated in the online survey. Respondents were classified into one of five age groups (18–29, 30–39, 40–49, 50–59 and over 60 years old), with 210 subjects recruited in each group. A total of 1050 participants (mean age ± SD = 44.04 ± 15.34 years; range: 18–90 years; female/male: 541/509) completed the form in Phase 1. 64.7% of participants were living in urban areas and 35.3% in the countryside.

2.2.2. Phases 2–4

All participants in Phase 2 and Phase 3 were examined by a neurologist and an otolaryngologist. Healthy volunteers were recruited from hospital staff or caregivers who were greater than or equal to 18 years old, had no evidence of olfactory dysfunction and had a score of at least 8 on the BSIT (Brief Smell Identification Test). The exclusion criteria for the healthy control group included a medical history of neurodegenerative disorders, neuropsychiatric disorders, chronic ENT diseases, diabetes mellitus, the presence of cognitive impairment (MMSE of 24 or less) or pregnancy, a past history of nasal surgery, severe head trauma, exposure to medications known to cause reduced olfaction, including, some antibiotics, antiepileptics, antithyroid or benzodiazepines, a record of upper respiratory tract infection within the prior two weeks.

The subjects with decreased sense of smell were recruited from otorhinolaryngology clinics or Parkinson's disease and movement disorder clinics, University Medical Center, Ho Chi Minh City, Vietnam. Inclusion criteria for participants with hyposmia were: 18 years old or older, confirmed current or past medical history of olfactory disorder, BSIT score <8, and MMSE score >24.

Fifty healthy volunteers (mean age ± SD = 30.54 ± 7.66 years; range: 20–60 years; female/male: 29/21) participated in Phase 2. A total of 120 individuals with reported normal olfaction (mean age ± SD = 41.19 ± 13.02 years; range: 18–72 years; female/male: 74/46) and 60 patients with olfactory dysfunction (mean age ± SD = 56.57 ± 12.55 years; range: 21–78 years; female/male: 39/21) took part in Phase 3. Sixty hyposmic patients included 53 with Parkinson's disease, 3 with chronic sinusitis, 3 with history of nasal trauma, and 1 with history of head trauma. The group of 60 healthy subjects that continued participating in Phase 4 recorded a mean age ±SD: 32.5 ± 8.83.

2.3. Methods

In phase 1, we aimed to determine the odors that were most familiar to the Vietnamese population from a list of 68 odors tested. The odors tested comprised all items from the UPSIT and BSIT as well as a variety of smells familiar to Vietnamese people. Through an online survey, participants were asked to rate their familiarity with each of the odors (based on the name) using a Likert-type scale ranging from 1 to 5 (1 = unfamiliar, 2 = less familiar, 3 = familiar, 4 = quite familiar, 5 = highly familiar). The average value of ratings for each item was subsequently calculated and converted to percentage. This methodology was used by Ribeiro et al. [17] and Delgado-Losada et al. [18]. At the end of this phase, 18 smells with familiarity rates greater than or equal to 70% and readily available in Vietnam were moved into Phase 2.

Phase 2 evaluated whether odorants corresponding to the selected odors could be correctly identified by healthy people. Like the widely used smell identification tests, the test was designed as a multiple-choice format. The goal of this phase is to build a VSIT set of 12 odors that were familiar, well-recognized and pleasant to the participants. In Phase 2, 50 participants with confirmed intact olfaction were presented with the 18 odorants from Phase 1 and were asked to make a forced choice of each odorant's name from a list of four descriptors. They also were asked to rate the intensity, pleasantness and irritability of each odorant on a 5-point Likert scale, with 5 representing very strong, very pleasant and very irritating. All selected distractors had the familiarity rates greater than 60%. Like UPSIT, we selected response alternatives to be as distinct from one another as possible [13]. Any testing odorants correctly identified less than 70% were excluded from inclusion in the VSIT.

In Phase 3, we evaluated the validity of the newly developed VSIT. We compared olfactory identification in 120 normosmic participants and 60 hyposmic patients using the VSIT and BSIT. In this phase, the BSIT was used to calculate the concurrent validity of the VSIT. We also defined the cut-off for the diagnosis of hyposmia based on the Youden index value.

In Phase 4, we assessed the test-retest reliability of the 12-item VSIT using interclass correlations. Sixty of the normosmic participants from Phase 3 performed the VSIT a second time after a one-month interval.

2.3.1. Olfactory testing

The test stimuli used in VSIT were odorous solutions commercially available in Vietnam. These test solutions were prepared by diluting industrial chemical compounds to a concentration that generated clear and pleasant smells to a normosmic individual. Liquid odorants were diluted with water at a ratio of 1:20, except for fish sauce and soy sauce with a ratio of 1:40 to ensure quite similar odor intensity. Cotton buds were dipped into each diluted odorous solution and used as test materials. The cotton swabs were then wrapped in a separate sterile and non-volatile sachet. To present the odors, participants tore the outer package to reveal the bud of the cotton swab and placed it approximately 2 cm in front of both their nostrils for 2–3 s (Fig. 1). The test administration was conducted in a quiet and properly ventilated room. All participants were instructed not to eat, drink (except for purified water), smoke, chew gum or brush their teeth for 1 h before the olfactory assessment.

After smelling each cotton swab, participants were asked to identify the odor and to answer a series of multiple-choice questions on the answer sheet. The time interval between odor presentations was 20 s.

A

B

Fig. 1. Fig 1. Vietnamese Smell Identification Test, VSIT (A) and how to test olfactory function: To present the odors, participants tore the outer package to reveal the bud of the cotton swab and placed it approximately 2 cm in front of both their nostrils for 2-3 seconds (B).

Using a multiple forced-choice paradigm, participants had to choose one option from a list of four descriptors that included one correct answer and three distractors. Odor identification performance was scored from 0 to 12 based on the number of odorants that were correctly identified. The BSIT was supplied by the Sensonics company, and the test administration was carried out according to the manufacturer's instructions. The 12 odorants in the BSIT test are cinnamon, turpentine, lemon, smoke, chocolate, rose, thinner, banana, pineapple, onion, gasoline, and soap. Odorants are microencapsulated on the paper and odors are released when the subject uses a pencil to scratch the microcapsule coating. Odorants were placed 2 cm from both nostrils and participants selected the smell from the answer card containing four options for each odorant. The score based on the number of correct answers ranges from 0 to 12.

2.3.2. Statistical analysis

Data analysis was performed using SPSS 20.0 software. Means ± SDs were calculated for all continuous variables. The Kolmogorov-Smimov test was used to check the normality distribution of data. VSIT mean scores for the normosmic and hyposmic participants were compared using the Mann-Whitney *U* test. A receiver operating characteristic (ROC) curve was used to evaluate the performance of the VSIT in detecting individuals with decreased olfactory function. The sensitivity, and specificity of the VSIT were calculated at each cut-off point. The Youden Index was also calculated to choose the best cut-point. Test-retest reliability was assessed using the intra-class correlation coefficient (ICC) and the Bland-Altman plots. The level of significance was set at 0.05.

2.3.3. Ethics statement

All study participants from phase 2 onwards provided informed written consent. The study was approved by the Ethics Committee of the University Medical Center of Ho Chi Minh city, Vietnam (122/GCN-HDĐĐ).

3. Results

3.1. Phase 1: Odor familiarity

The odors were ranked by familiarity as shown in Table 1. A total of 29 smells had a familiarity percentage above 70%, 20 of which were >75%. Eight odors were considered most familiar to the Vietnamese study population: lemon (familiarity percentage: 85.2%), fish sauce (84.2%), garlic (83.2%), soap (82.6%), ginger (82.4%), banana (80.2%), coffee (79.8%), and orange (79.6%). Seven items from the BSIT yielded familiarity rates more than 70%, namely lemon, soap, banana, pineapple (75.8%), gasoline (74.8%), onion (74.4%), and cinnamon (71.4%). The least familiar smells were anise (49.7%), cherry (48.2%), turpentine (46.7%), clove (43.5%), cedar (40.7%), lilac (33.6%), and wintergreen (30.4%). From these 29 smell items, considering commercial availability in Vietnam, we selected a total of 18 smells including orange, banana, soy sauce, fish sauce, garlic, coffee, lemon, apple, guava, mango, fish, watermelon, green tea, shrimp, pineapple, honey, durian, and ginger (Table 2).

3.2. Phase 2: Odor identification

Of the 18 selected odors from Phase 1, the 12 items that had identification rates >70% were orange (100%), banana (98%), soy sauce (98%), fish sauce (96%), garlic (96%), coffee (92%), lemon (88%), apple (86%), guava (84%), mango (78%), fish (76%) and watermelon (72%).

Table 1
Survey results for familiarity of odors (N = 1050). After using a Likert-type scale ranging from 1 to 5, average results are presented in a percentage scale.

Odor Item	Familarity (%)	Odor Item	Familarity (%)
1 Lemon	85.2	35 Popcorn	67.6
2 Fish sauce	84.2	36 Chocolate	67.5
3 Garlic	83.2	37 Vinegar	67.1
4 Soap	82.6	38 Fruit Punch	66.9
5 Ginger	82.4	39 Menthol	66.8
6 Banana	80.2	40 Bubble gum	65.6
7 Coffee	79.8	41 Cumin	65.3
8 Orange	79.6	42 Motor oil	64.6
9 Pomelo	78.6	43 Beer	64.3
10 Bread	77.8	44 Strawberry	64.2
11 Mandarin	77.4	45 Grape	63.8
12 Fish	77.2	46 Jasmine	63.4
13 Pepper	76.6	47 Grass	62.7
14 Mango	76.2	48 Coconut	62.3
15 Soy sauce	76.1	49 Paint Thinner	62.1
16 Durian	75.9	50 Vanilla	62.0
17 Pineaple	75.8	51 Natural Gas	61.7
18 Honey	75.1	52 Baby Powder	60.7
19 Guava	75.1	53 Charcoal	60.6
20 Gasoline	74.8	54 Peach	59.4
21 Onion	74.4	55 Cheese	58.9
22 Shrimp	74.2	56 Mustard	58.8
23 Green tea	73.6	57 Pizza	58.0
24 Watermelon	73.5	58 Sesame oil	57.3
25 Longan	73.0	59 Rubber Tire	56.5
26 Cinnamon	71.4	60 Licorice	56.1
27 Soybean milk	70.5	61 Pine	54.3
28 Peanut	70.2	62 Anise	49.7
29 Apple	70.0	63 Cherry	48.2
30 Cola	68.6	64 Turpentine	46.7
31 Rose	68.0	65 Clove	43.5
32 Smoke	68.0	66 Cedar	40.7
33 Eucalyptus oil	67.8	67 Lilac	33.6
34 Mint	67.8	68 Wintergreen	30.4

Table 2
Characterization of the 18 odorants in Phase 2 (the correct identification rate of odorants, intensity, irritation, and pleasantness) that was investigated in 50 healthy subjects.

Number	Odors	Correct identification rating, %	Intensity Mean ± SD	Irritation Mean ± SD	Pleasantness Mean ± SD
1	Orange	100%	3.74 ± 1.10	1.44 ± 0.79	4.12 ± 1.20
2	Banana	98%	3.58 ± 1.13	1.66 ± 1.00	4.00 ± 1.12
3	Soy Sauce	98%	3.86 ± 1.16	2.46 ± 1.13	2.76 ± 1.21
4	Fish Sauce	96%	3.70 ± 1.30	2.92 ± 1.26	2.12 ± 1.12
5	Garlic	96%	3.38 ± 1.10	2.90 ± 1.15	2.16 ± 1.04
6	Coffee	92%	3.70 ± 1.07	1.90 ± 1.13	3.40 ± 1.26
7	Lemon	88%	2.54 ± 1.18	1.32 ± 0.74	3.80 ± 1.18
8	Apple	86%	3.32 ± 1.15	1.68 ± 0.94	3.50 ± 1.31
9	Guava	84%	3.78 ± 1.11	1.56 ± 0.81	4.14 ± 0.99
10	Mango	78%	3.52 ± 1.21	1.56 ± 1.01	3.78 ± 1.04
11	Fish	76%	2.88 ± 1.22	2.56 ± 1.46	2.56 ± 1.23
12	Watermelon	72%	2.80 ± 1.07	1.48 ± 0.71	3.72 ± 1.07
13	Green Tea	68%	3.26 ± 1.10	1.86 ± 0.99	3.58 ± 1.03
14	Shrimp	66%	2.80 ± 1.25	2.50 ± 1.16	2.66 ± 1.01
15	Pineapple	64%	2.38 ± 1.05	1.40 ± 0.73	3.72 ± 1.07
16	Honey	62%	2.94 ± 1.19	1.66 ± 0.92	3.48 ± 1.23
17	Durian	56%	2.68 ± 1.38	1.58 ± 0.84	3.26 ± 1.26
18	Ginger	24%	2.68 ± 1.06	1.56 ± 0.81	3.68 ± 1.18

Moreover, these 12 odorants were perceived as moderate intensity (means range from 2.38 to 3.86 on a 5-point Likert scale with 5 signifying very strong), acceptable irritating (all means are less than 3 on a 5-point Likert scale with 5 signifying very irritating) (Table 2). Among them, some odors were perceived as quite pleasant including lemon, banana, coffee, orange, mango, guava, watermelon, apple (all means are greater than 3 on a 5-point Likert scale with 5 signifying very pleasant) (Table 2). Therefore, these 12 odorants were chosen for VSIT development (Table 3).

3.3. Phase 3: Validity of the VSIT

The mean (SD) VSIT score was more than twice as high in the normosmic group than in the hyposmic group [10.28 (1.34) vs 4.57 (1.76); $p < 0.001$]. The area under the ROC curve was 0.992 (0.984–1.000), $P < 0.001$ for normal olfactory function vs olfactory dysfunction (Fig. 2). At a cut-off value of 8 (<8 indicate indicates hyposmia), the VSIT showed 93.3% sensitivity and 97.5% specificity in detecting hyposmia. When the cut-off value was set at 9, the reported sensitivity of the VSIT increased from 93.3% to 100% but the specificity decreased from 97.5% to 90%. The cut-off value at 8 had the highest Youden index value (0.91). Therefore, the VSIT score of 8 was the most appropriate cut-off value for clinical diagnosis of hyposmia in the Vietnamese population. The correlation coefficient between VSIT scores and BSIT scores of participants in Phase 3 was $r_{S=}0.68$ ($p < 0.0001$).

3.4. Phase 4: Test-retest reliability

Fig. 3 shows a Bland Altman agreement plot for the VSIT. The test-retest reliability was 0.72 (95% CI = 0.58–0.83) ($P < 0.001$).

Table 3
Odor items in the VSIT, *: correct option.

Number	Odor, Options
1	Orange*, Strawberry, Onion, Smoke
2	Longan, Soap, Pomelo, Banana*
3	Soy Sauce*, Gasoline, Chocolate, Pepper
4	Coffee, Fish Sauce*, Pepper, Gasoline
5	Banana, Pepper, Garlic*, Smoke
6	Soy sauce, Coffee*, Grape, Motor Oil
7	Lemon*, Apple, Rose, Grape
8	Coconut, Apple*, Orange, Grape
9	Guava*, Coconut, Onion, Orange
10	Garlic, Mango*, Mandarin, Fish
11	Durian, Lemon, Fish*, Mango
12	Fish, Pomelo, Watermelon*, Onion

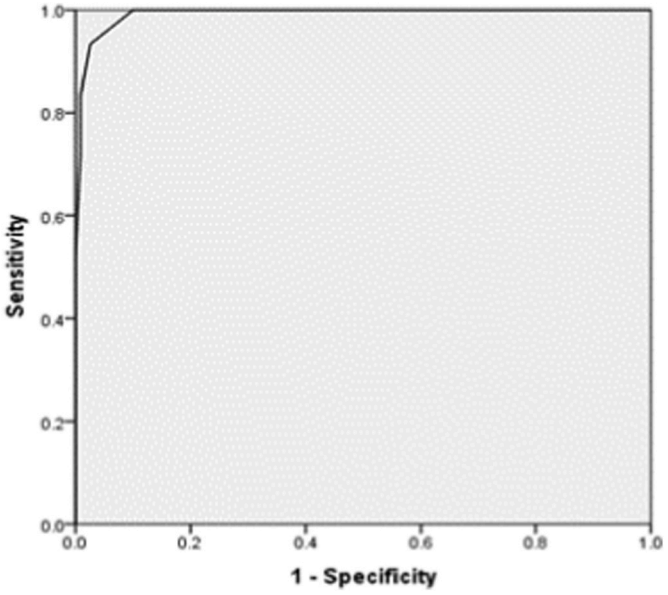

Fig. 2. Fig 2. Area under the curve for VSIT 0.992 (95% CI: 0.984-1.000), P< 0.001.

4. Discussion

Despite the importance of olfactory dysfunction in the early identification of neurodegenerative diseases, there is no universal test. Although several countries have developed culturally specific assessments, there is still significant unmet need in several countries around the world. The goal of this study was to address that need in Vietnam by developing and testing a VSIT. This study developed the VSIT in a systematic fashion beginning with healthy volunteers and then evaluating sensitivity, specificity and test-retest reliability in hyposmic patients. The VSIT includes odorants that are familiar and identifiable to the Vietnamese population (Phases 1 and 2) and was effective in diagnosing hyposmia in Vietnamese patients (Phase 3). Moreover, VSIT is also a reliable instrument with an acceptable test-retest reliability (Phase 4).

The UPSIT is one of the most popular smell identification test kits. However, as demonstrated in several previous studies, the UPSIT is not suitable for use in some countries due to the unfamiliarity of some of the test stimuli to the local populations [11,19,20]. Our study confirmed those findings by demonstrating that some of the most readily

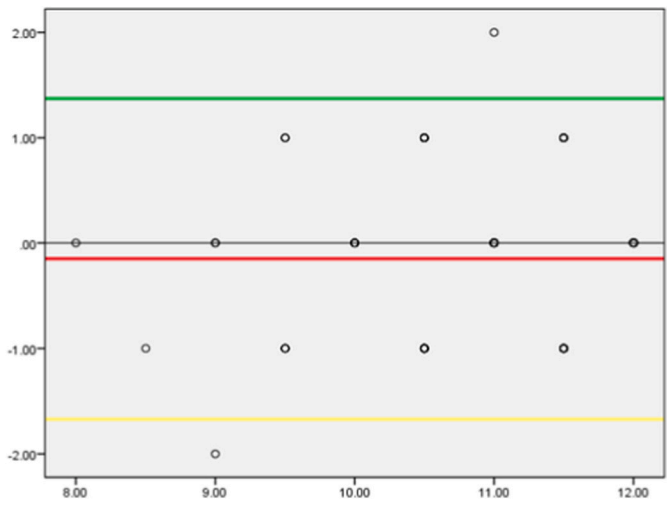

Fig. 3. **Fig 3.** A Bland Altman agreement plot for VSIT scores for test and retest (N=60). The middle horizontal line represents the mean difference, and the upper and lower lines are the 95% confidence limits of the mean difference. A flat horizontal line indicates VSIT average of test and re-test. A flat vertical indicates VSIT difference between test and retest.

identifiable items on the UPSIT such as lilac and wintergreen were unfamiliar to our Vietnamese population. Similarly, only seven smells from the BSIT, including lemon, soap, banana, pineapple, gasoline, onion, and cinnamon, had a familiarity percentage above 70% in our participants. There were also seven smells in the Sniffin' Sticks 12-identification test (Burghart Messtechnik GmbH, Wedel, Germany) and its modified versions, including orange, lemon, banana, pineapple, fish, coffee, and cinnamon, with a familiarity percentage over 70% in our subjects [21,22].

Northern Vietnam, Central Vietnam and Southern Vietnam are the three main historical, geographical and cultural regions within Vietnam and each has distinct cultures and dialects that make them unique. In consideration of those differences, we made every effort to recruit participants equally from all three regions. Our study participants were also diverse in terms of age and geographical regions, which gives us confidence that our findings are generalizable to the Vietnamese population.

Regarding odorant presentation, several methods have been described in the literature. Among them, the two most popular means to deliver stimuli are microcapsules and felt-tip pens. The stimuli used to administer the UPSIT and the BSIT are microencapsulated on paper and delivered by scratching the microcapsule coating [11,13]. With this mean, the UPSIT and the BSIT are disposable tests, easy to use but quite expensive. The high price can prevent it from being widely used in Vietnam, In contrast, the Sniffin' Sticks odorants are presented in felt-tip pens [23]. Sniffin' sticks can be reused so it is cheaper than the BSIT but at a risk of viral and bacterial contamination. In the Scandinavian Odor-Identification Test kit, 5 mL of the odorants were placed in a 10 ml glass jar and presented 1–2 cm below the nostrils of subjects [15]. This way is simple and convenient but it has the same disadvantage as Sniffin' sticks. The Odor Stick Identification Test for Japanese (OSITJ) is made from odorants that are microencapsulated in a melamine resin and then mix with melted base material to form a semisolid odor stick that is encased like a lipstick. To present the odorants, the cream from the odor stick is applied on paraffin paper within a circle of 2 cm in diameter [24]. This single test kit is capable of testing about 250 subjects but can't be performed in various clinics at the same time. In our study, the odorants were presented in the form of cotton buds dipped in the odorous solutions and delivered in tear-away sachets. This convenient method was also employed in the Indian smell identification test [25]. However, in that test, the cotton buds were used directly after being dipped in the odorants and that makes the Indian test unable to be sent by post. In the VSIT kit, cotton swabs are packaged in a sterile and non-volatile sachet. This packaging makes the VSIT transportable. As the VSIT kit was disposable, the production cost was considerably less expensive. Therefore, it might be more suitable for the resource limitations in Vietnam.

Our study demonstrated that using a cutoff of 8, the VSIT is highly sensitive (93.3%) and specific (97.5%) in detecting olfactory dysfunction as evidenced by significantly lower mean scores in the hyposmic compared with the normosmic group. Furthermore, the AUC for the VSIT of 0.992 showed that the VSIT identified individuals with olfactory impairments with a high degree of accuracy. The cut-off point at 8 was also suggested by the developers of the BSIT [11]. The BSIT score less than 8 typically exists below the 5th percentile of the normative distribution [11]. Finally, our results indicate that the VSIT is a clinically stable test with a test-retest correlation coefficient of 0.72, similar to that reported for the BSIT ($r = 0.71$) [11] and the Sniffin' Sticks ($r = 0.73$) tests [14]. However, various odor identification tests achieved stronger coefficients of correlation between the test and retest. For instance, the UPSIT and the Chinese Smell Identification Test (CSIT) obtained test-retest reliability of 0.92 [13,26]. The test-retest correlation coefficient of the Scandinavian Odor Identification Test (SOIT) is 0.79 [15]. Some studies suggested that higher test-retest reliability may be related to the larger number of odorants used for odor identification [11,14]. While the UPSIT and the CSIT include 40 odorants, the Sniffin's Sticks and SOIT have 16 and the VSIT and the BSIT have 12 smell items. However, we preferred to develop the VSIT with 12 items in order to reduce the length of time required for testing.

Besides that, this study had some limitations. First, although soap, pomelo, bread, mandarin, pepper, and gasoline were familiar to Vietnamese people, these odorants were unavailable in Vietnam. As a consequence, we had to select several smells with lower familiarity percentages. Second, normative data for the VSIT was not established in this study. This is a preliminary cut-off, based on a reasonable but small sample (120 controls and 60 hyposmic subjects). The influences of age and gender on odor identification function have been demonstrated. Larger studies may be needed to define age and gender appropriate cut-offs. Finally, like the BSIT, the VSIT with a limited number of items was not able to detect olfactory malingering, while the UPSIT can do that [11].

5. Conclusion

The VSIT demonstrates favorable validity and reliability, making it a useful clinical tool for identifying early olfactory dysfunction that may indicate risk for neurodegenerative disease in Vietnamese patients. The VSIT also can be used to evaluate olfactory disorders in other conditions. In the future, studies should be conducted to assess the validation of VSIT in diagnosing Parkinson's disease.

Funding details

This study is supported by Research Grant of University Medical Center, University of Medicine and Pharmacy at Ho Chi Minh City, Vietnam.

Declaration of competing interest

Tai Ngoc Tran: has received consultation and/or honoraria/lecture fees from Boehringer-Ingelheim, Ipsen Pharmaceuticals, and Medtronic, and research funding from University Medical Center, University of Medicine and Pharmacy at Ho Chi Minh City.

Daniel Truong: has received consultation and/or honoraria/lecture fees from Neurocrine Inc., Teva Pharmaceutical Inc., He received research funding from AbbVie, Acadia Cynapsus, Daiichi Sankyo Pharma, Intec, Ipsen, Kyowa, Merz, National Institute of Neurological Disorders and Stroke, Neurocrine, Neuroderm Ltd, Sunovion, Acorda

Sage, Takeda, Cerevel Therapeutics, UCB Pharma, Pharmather, Inc., Teva, Aeon Biopharma, Bukwang Pharmaceuticals, Lundbeck Pharmaceuticals.

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