Development of an Odor Identification Test Kit for Thai Children

Odor Test for Children

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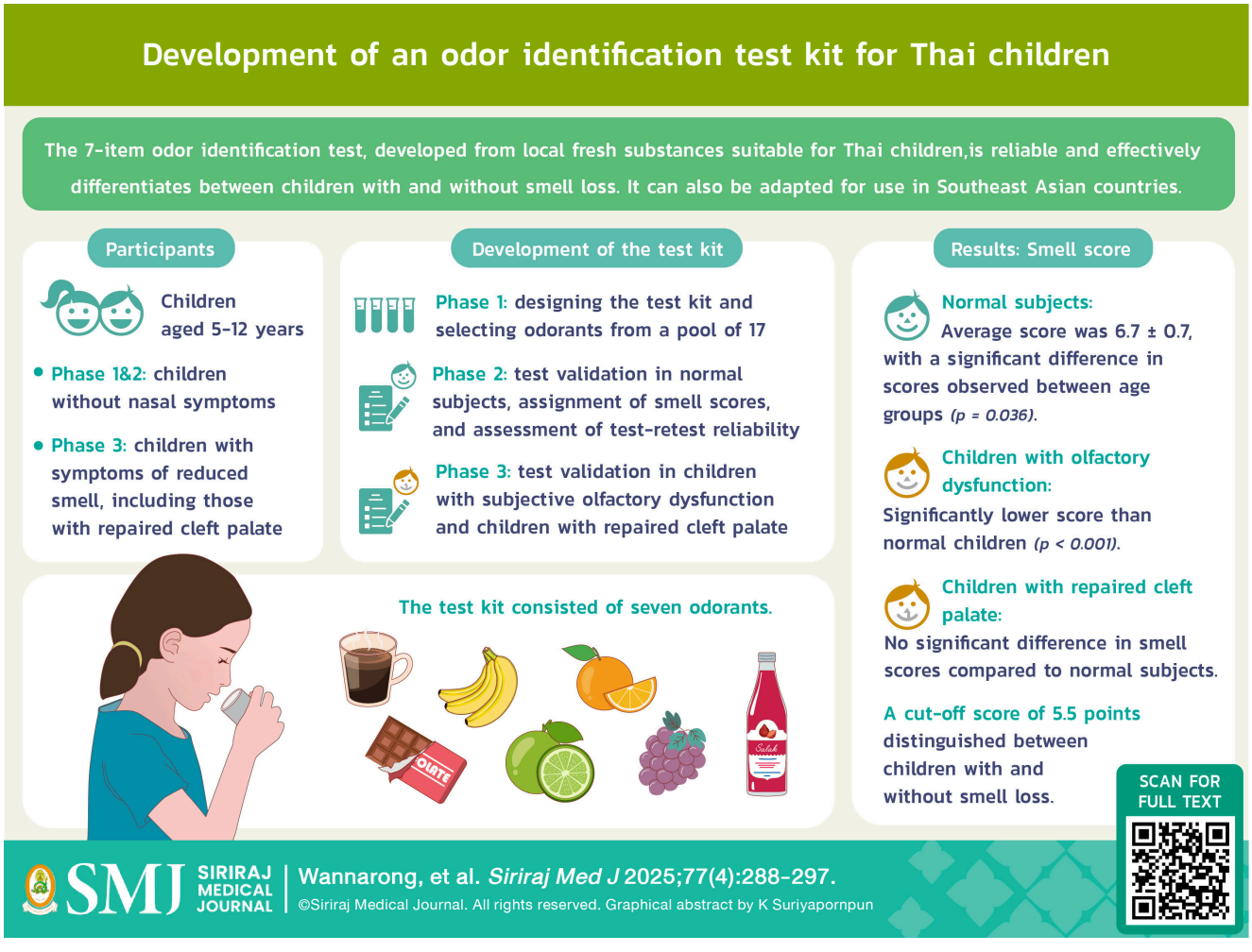

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ABSTRACT

Objective: To develop and validate an odor identification test kit for Thai children that can be adapted for use in Southeast Asian countries.

Materials and Methods: The test kit was developed in three phases, using local fresh substances. Phase 1 involved designing the test kit and selecting odorants from a pool of 17. Phase 2 focused on test validation in normal subjects, assignment of smell scores, and assessment of test-retest reliability. Phase 3 validated the test in children with subjective olfactory dysfunction and children with repaired cleft palate. Cut-off scores were determined using receiver operating curve analysis.

Results: The participants were children aged 5-12 years. Sample sizes in Phases 1, 2, and 3 were 53, 31, and 36, respectively. Seven odorants that met the selection criteria were chosen. The average score for normal subjects was 6.7 (SD 0.7), with a significant difference between age groups ($p = 0.036$). Children with olfactory dysfunction had an average score of 3.8 (SD 1.6), significantly lower than normal children ($p < 0.001$). Children with repaired cleft palate showed no significant difference in smell scores compared to normal subjects. A cut-off score of 5.5 points was used to distinguish between normal and abnormal olfactory function, with an area under the curve of 0.928.

Conclusion: Children aged 5-12 years were able to complete the 7-item odor identification test developed from local fresh substances. The test kit demonstrated good reliability and effectively distinguished between children with and without smell loss, using a cut-off score of 5.5.

Keywords: Smell loss; smell test; odor identification test; olfactory dysfunction (Siriraj Med J 2025; 77: 288-297)

INTRODUCTION

Olfaction plays a vital role in daily life. Without it, detecting specific dangers such as fire becomes challenging, and overall quality of life is impacted.[1] The perception of odors is essential for children's learning and development.[2] Common causes of olfactory dysfunction in children include sinonasal diseases, head trauma, and congenital conditions, although the prevalence differs from that in adult patients.[3] Congenital syndromic anomalies, such as Kallmann syndrome, can also cause anosmia in children.[4] Olfactory testing is crucial for evaluating olfactory function, with odor identification tests being commonly used in children due to their simple procedure, ease of understanding, and short duration.[3] Most tests for children incorporate pictures since some may not be able to read letters.[5] Descriptors with pictures and words are often included to assist children in completing the test.[5] The olfactory test for children should be engaging, culturally appropriate, and validated for the target age group.[3]

The Universal Sniff (U-sniff) test consists of 12 odors presented in pen-like Sniffin' Sticks for children aged 4-17 years.[6] The maximum score is 12 points. In children with normosmia, the mean score was 9.88 ±1.8, with different cut-off points for each age group.[6] The 10th percentile of normative data is used to distinguish between normosmia and hyposmia. The Pediatric Smell Wheel (PSW) consists of 11 odors delivered via micro-capsulated stickers for children aged 4-19 years.[7] The PSW was validated in Brazilian children aged 5-12, using the 10th percentile as the cut-off.[8] A score below 7 indicates hyposmia. Age-related cut-off points were set at 5 points for children under 8 years old, 6 points for those aged 8-10, and 7 points for those over 10 years old.[8]

Different cultures can impact odor familiarity.[6] Due to cultural differences and limited exposure to certain odors, existing tests using odorants are not suitable for Thai children. This makes it difficult to diagnose or assess odor dysfunction in this population. A cross-cultural study between Japanese and German women showed that culture-specific foods can significantly influence odor perception.[9] Some odor choices in current tests are unfamiliar to Thai children, such as peach in the U-sniff test, play-doh in the NIH Toolbox, mustard in the San Diego Odor Identification Test (SDOIT) and aniseed in Sniffin' Kids test.[6,7,10-13] These items are either not local products or unavailable in Thailand, so we cannot expect reliable familiarity from Thai children. Additionally, some odors in commercial test kits, such as gasoline, paint thinner, smoke, and turpentine, may cause irritation or discomfort in young children.[3,14-17]

The aim of this study was to develop an odor identification test kit suitable for Thai children, with potential applicability in other Southeast Asian countries. We selected local fruits, foods, and flavoring agents

familiar to target population. Additionally, we aimed to evaluate the kit's reliability in distinguishing between children with and without olfactory dysfunction.

MATERIALS AND METHODS

The study was divided into three phases. Phase 1 involved picture identification and odor selection for designing the test kit. Phase 2 focused on validating the test kit with subjects who had no reported smell dysfunction. In Phase 3, the test was used to differentiate between children with and without olfactory dysfunction. Participants were children aged 5 to 12 years. Children above 12 years old were not recruited because a previous study found no significant differences in smell scores among children aged 9-11, 12-14, and 15-17 years.[18] The study was approved by The Institutional Review Board of Siriraj Hospital, Faculty of Medicine Siriraj Hospital, Mahidol University (COA Si 148/2021). Informed consent was obtained from parents or legal guardians, and informed assent was obtained from the children. The research was conducted in accordance with the World Medical Association's Code of Ethics (Helsinki Declaration).

Power analysis

The sample size for Phase 1 was calculated based on the study by Dżaman, which reported that 76% of children aged 5-7 years and 90% of children over 7 years could correctly identify odors.[19] The total sample size for Phase 1 was 53 participants.

For Phases 2 and 3, the sample sizes were calculated using the study by *Grossman et al*[20], which compared olfactory function between patients with repaired cleft palate (CP) and a control group. With 80% power for a two-sided test and a 1:1 ratio, the required number of participants per group was 31.

Phase 1: Picture identification and Odor selection

Fifty-three children, divided into three age groups — 5 to 7 years, over 7 to 10 years, and over 10 to 12 years — were recruited after a thorough history-taking and complete ear, nose and throat (ENT) examination. History was obtained from both the children and their guardians regarding nasal symptoms and the child's ability to smell food. The inclusion criteria for Phases 1 and 2 were children without nasal symptoms, such as rhinorrhea, nasal congestion, or loss of smell. Exclusion criteria included children with: (1) structural lesions in the nasal cavity, such as nasal polyps or sinonasal tumors; (2) a history of head trauma; (3) previous sinonasal surgery; (4) recent upper respiratory tract infection within the past week; and (5) speech or language impairment.

We selected 11 common odorants from previous studies, including banana, orange, lime, grape, strawberry, cinnamon, garlic, chocolate, coffee, mint, and rose.[5-7,10-12,19,21-24] To these, we added six new odorants familiar to Thai children, including dried squid, cheese, tomato sauce, caramel, jasmine and salak-flavored syrup. Salak, a tropical fruit native to Southeast Asia, is used in the concentrated syrup. In total, 17 odorants were selected from categories such as fruit, food, beverage, and flavoring agents.

The odor-producing substances in the study were chosen from synthetic materials or commercial form of the natural products, as well as from fresh preparations, depending on the strong smell, resemblance of the odor to the natural products, and the convenience for use. For example, the smell of grape juice and strawberry jam were stronger, easier to be recognized and more convenient for use than fresh grapes or strawberries. The same consideration was applied for the use of salak-flavored syrup instead of fresh salak. Finally, ten odorants from synthetic materials and seven odorants from fresh preparations were used in this study. We controlled the consistency of the odor quality by using fresh preparations from the same source or commercial brands, with meticulous measurement of the substance and the weight was recorded before use in every session of the test. The source materials included the following: banana (Cavendish banana), 0.7 g of both peel and flesh from the brand Dole; orange (Mandarin orange), 0.3 g of peel from the brand 2.P.H.; lime (Key Lime), 0.6 g of peel from the brand Pakbangpun; strawberries (strawberry jam), 0.9 g from the brand Best Foods; mint (mint powder), 0.1 g from the brand Royal Project; rose (Wine & Roses Anti-Aging Body Oil), 0.1 g from the brand Erb; jasmine, 0.2 g from jasmine flowers; caramel (Vanilla Flavour), 0.2 g from the brand Winner's; tomato sauce, 0.5 g from the brand Prego; garlic (peeled garlic), 0.2 g from the brand My Choice; cinnamon (Chinese Five-Spice or Pae-Lo powder), 0.1 g from the brand Home Fresh Mart; dried squid, 0.2 g from the brand Taotong; cheese (Parmesan cheese), 0.2 g from the brand Imperial; chocolate, 0.2 g from the brand Van Houten; coffee, 0.2 g from the brand Nescafe Red Cup; salak-flavored syrup, 0.8 g from the brand Hale's Blue Boy; and grape (red grape juice), 0.8 g from the brand Tipco. Each odorant was placed in an opaque bottle and covered with an aluminum lid featuring small holes punched in it to release the odor without revealing the contents. The pattern for the holes was designed on the aluminum foil, and the same template was used for every bottle (Fig 1). The lid was disposed of after each use. The entire

Fig 1. An odorant presented in an opaque bottle, covered with an aluminum foil lid with holes. The bottles were placed 1 cm below and parallel to the child's nostril.

set was replaced every three days, and the odorants made from fresh substances were stored at 5-7°C to prevent deodorization.[25]

We selected pictures that were easy for children to clearly identify. These pictures were validated by children during a preliminary phase to ensure their suitability. For picture identification, the researcher showed a picture of each substance and asked the child to identify it. A score of 1 or 0 was assigned for each item. After showing each picture, two bottles with different odorants were presented — one containing the same substance as in the picture and the other containing an odor from a different category, including fruit, food, beverage, and flavoring agents. The bottles were placed 1 cm below and parallel to the child's nostril, and the child smelled both, choosing the one that matched the picture. The child could smell as many times or for as long as needed until they answered the question. This approach was consistent across all phases. The number and percentage of correct picture identifications and odor selections were recorded.

We planned to select 6-8 odorants for the test kit based on their high ranking and correct identification, both by picture and odor, in more than 90% of participants. A 4-alternative forced-choice (AFC) paradigm was designed for each odorant to help children recognize the correct scent and reduce guessing. In the 4-AFC, four labelled pictures were presented: one for the target odorant and three for distractors. Two distractors were "related", belonging to the same category as the target odor, such as fruits, while one distractor was unrelated, from a different category of odor source.

Phase 2: Validation of the odor identification test and Test-retest reliability

Thirty-one children without nasal symptoms were recruited and divided into three age groups as in Phase 1. Each child was tested using the odor identification test kit from Phase 1, and smell scores were recorded. For each item from the test kit, only one bottle was presented, and the children responded using the 4-AFC method. A correct answer was scored as 1, while an incorrect answer as 0. To assess test-retest reliability, the same participants were tested again at least one week later, following the protocol of previous studies.[6,7,18]

Phase 3: Odor identification test in children with olfactory dysfunction or repaired CP

Participants in Phase 3 included children with symptoms of reduced smell due to upper respiratory tract infection or congenital anosmia, such as Kallmann syndrome. Children with repaired CP were also recruited, as evidence suggests factors like anatomical abnormalities, reduced nasal airflow, and smaller nasal volume may contribute to olfactory dysfunction.[20,26,27] History of subjective olfactory issues and ENT examinations were conducted for all participants. The odor identification test was administered as in Phase 2, and smell scores were recorded.

Outcome measure and statistical analyses

The outcomes for Phase 1 included demographic data and the results of picture identification and odor selection, which were analyzed using descriptive statistics. Ranking of the results was used to select the odorants for the test kit.

In Phases 2 and 3, the outcomes were the smell scores and the time taken to complete the test kit. Analysis of variance (ANOVA) or Kruskal-Wallis tests were used to compare the outcomes among the three age groups. Test-retest reliability was analyzed using paired T-tests or Wilcoxon's test. A receiver operator characteristic curve (ROC) and the Youden index were used to determine the cut-off score that could differentiate between normal and abnormal olfactory function. Additionally, the 10th percentile of smell scores across all age groups was used as an alternative cut-off point between normal and abnormal olfactory function. Statistical analyses were performed using SPSS version 22.0.

RESULTS

The demographic data and time taken for all tests are presented in Table 1. The mean age across all phases was approximately 8 years. In Phase 1, the mean test

TABLE 1. Demographic data.

	Phase 1 (n=53)	Phase 2 (n=31)	Phase 3 (n=36)	
			Cleft palate	Olfactory dysfunction
Sex				
Male	27 (50.9%)	16 (51.6%)	18 (72.0%)	7 (63.6%)
Female	26 (49.1%)	15 (48.4%)	7 (28.0%)	4 (36.4%)
Age (year, mean ± SD)	8.4 ± 2.3	8.4 ± 2.2	8.0 ± 2.3	8.0 ± 2.1
Age stratification				
5-7 yrs.	18 (34.0%)	10 (32.3%)	10 (40.0%)	5 (45.5%)
7.01-10 yrs.	17 (32.1%)	11 (35.3%)	10 (40.0%)	4 (36.4%)
10.01-12 yrs.	18 (34.0%)	10 (32.3%)	5 (20.0%)	2 (18.2%)
Duration of the test (minute, mean ± SD)	8.9 ± 3.5	3.2 ± 1.4	3.3 ± 1.7	5.0 ± 1.8

Abbreviation: SD, standard deviation

duration was 8.9 minutes (SD 3.5), which included both picture identification and odor selection. The odor identification test kit was developed by integrating these two components, as shown in Table 2. The top seven odorants that met the criteria were lime, orange, banana, grape, salak-flavored syrup, coffee, and chocolate. The total score ranged from 0 to 7.

The results of Phase 2 are shown in Table 3. The mean test duration for normal subjects was 3.2 ± 1.4 minutes, with no significant difference in the amount of time spent across all three age groups ($p = 0.066$). The overall mean smell score for children was 6.7 (SD 0.7), with no significant difference between males and females ($p = 0.143$). However, there was a significant difference in scores among the three age groups, with the youngest group scoring the lowest ($p = 0.036$). A significant positive correlation was found between smell scores and the age of the children ($r = 0.512$, $p = 0.003$). Coffee was the only odor with a significant difference in identification between age groups ($p = 0.03$). We tested the effect of the season by performing the test with fresh fruit in different seasons, the results showed no difference of the mean scores ($p = 0.868$). Test-retest reliability showed a strong correlation ($r = 0.932$, $p < 0.001$).

In Phase 3, we conducted the test on children with smell loss or those at risk for olfactory dysfunction. This group included 11 children with complaints of smell loss, consisting of 10 cases of acute rhinosinusitis (ARS) and one case of Kallmann syndrome. Additionally, 25 children with repaired CP participated, however, none of the CP group reported subjective olfactory dysfunction prior to the test.

The mean duration to complete the test for the 11 children with olfactory dysfunction was 5.0 minutes (SD 1.8), which was significantly longer than the time taken by normal subjects in phase 2 ($p = 0.005$). The mean score for children with olfactory dysfunction was 3.8 (SD 1.6), which was significantly lower than that of the normal subjects in Phase 2 ($p < 0.001$). The smell scores for all groups are presented in Table 4. There was no significant difference between the CP group and the normal group in either time spent ($p = 0.991$) or smell scores ($p = 0.946$). Therefore, the children with repaired CP were excluded from the validation and ROC analysis.

Finally, we validated the test by including 31 children with normal olfaction from Phase 2 and 11 children with olfactory dysfunction from Phase 3. The test demonstrated a sensitivity of 90.32%, specificity of 90.91%, and accuracy of 90.5% in detecting smell loss. The positive predictive value was 96.6%, with a negative predictive value of 76.9%, a positive likelihood ratio (LR) of 9.93, a negative LR of 0.1, and a diagnostic odds ratio of 93.3. The ROC curve, shown in Fig 2, indicated a cut-off score of 5.5 for diagnosing normal odor identification. The area under curve (AUC) was 0.928. The mean score at the 10^{th} percentile in normal subjects was 5.2.

TABLE 2. Phase 1: Picture identification and Odor selection.

Substance	Percent of correct picture identification					Percent of correct odor selection				
	All age (n=53)	5-7 yrs. (n=18)	7.01-10 yrs. (n=17)	10.01-12 yrs. (n=18)	Age group comparison (*p*-value)**	All age (n=53)	5-7 yrs. (n=18)	7.01-10 yrs. (n=17)	10.01-12 yrs. (n=18)	Age group comparison (*p*-value)**
Cheese	96.2%	88.9%	100%	100%	0.321	96.2%	94.4%	100%	94.4%	1.0
Squid	75.5%	50.0%	82.4%	94.4%	0.010*	98.1%	94.4%	100%	100%	1.0
Strawberry	100%	100%	100%	100%	-	96.2%	100%	100%	88.9%	0.321
Cinnamon	81.1%	72.2%	76.5%	94.4%	0.211	92.5%	88.9%	100%	88.9%	0.530
Lime	**98.1%**	100%	94.1%	100%	**0.321**	**98.1%**	94.4%	100%	100%	**1.0**
Garlic	79.2%	55.6%	82.4%	100%	0.002*	94.3%	88.9%	94.1%	100%	0.530
Orange	**98.1%**	100%	94.1%	100%	**0.321**	**98.1%**	94.4%	100%	100%	**1.0**
Tomato sauce	100%	100%	100%	100%	-	96.2%	88.9%	100%	100%	0.321
Banana	**100%**	100%	100%	100%	-	**100%**	100%	100%	100%	-
Grape	**98.1%**	94.4%	100%	100%	**1.0**	**100%**	100%	100%	100%	-
Caramel	90.6%	88.9%	82.4%	100%	0.185	86.8%	83.3%	82.4%	94.4%	0.603
Salak flavored syrup	**98.1%**	94.4%	100%	100%	**1.0**	**100%**	100%	100%	100%	-
Jasmine	81.1%	55.6%	88.2%	100%	0.001*	100%	100%	100%	100%	-
Coffee	**100%**	100%	100%	100%	-	**98.1%**	94.4%	100%	100%	**1.0**
Rose	86.8%	66.7%	94.1%	100%	0.008*	94.3%	88.9%	94.1%	100%	0.530
Chocolate	**100%**	100%	100%	100%	-	**98.1%**	94.4%	100%	100%	**1.0**
Mint	84.9%	72.2%	88.2%	94.4%	0.190	92.5%	83.3%	94.1%	100%	0.207

Note: Level of significant *$p < 0.05$; ** By the chi-square test; The selected odors in the odor identification test kit are presented in bold.
Abbreviation: yrs, years

TABLE 3. Phase 2: Odor identification scores and duration of the test in normal subjects.

	All age (n=31)	5-7 years (n=10)	7.01-10 years (n=11)	10.01-12 years (n=10)	Age group comparison (p-value)
Duration of the test** (minute, mean ± SD)	3.2 ± 1.4	4.0 ± 1.2	3.1 ± 1.8	2.6 ± 0.5	0.066
Score** (mean ± SD)	6.7 ± 0.7	6.2 ± 1.1	6.8 ± 0.4	7.0 ± 0.0	0.036*
Target odor***					
Chocolate	96.8%	90.0%	100%	100%	0.913
Orange	96.8%	100%	90.9%	100%	0.639
Salak flavored syrup	93.5%	90.0%	90.9%	100%	0.588
Banana	96.8%	90.0%	100%	100%	0.053
Coffee	93.5%	80.0%	100%	100%	0.030*
Lime	93.5%	80.0%	100%	100%	0.375
Grape	96.8%	90.0%	100%	100%	0.576

Note: Level of significant *$p < 0.05$; ** By the one-way ANOVA; *** By the chi-square test or Fisher's exact test
Abbreviation: SD, standard deviation

TABLE 4. Comparison of odor identification scores among 3 groups.

	Normal children (n = 31)	Repaired CP (n = 25)	Olfactory dysfunction (n = 11)	*p*-value
Score**	6.7 ± 0.7	6.6 ± 0.6	3.8 ± 1.6	<0.001*
Post Hoc Tests***				
	6.7 ± 0.7	6.6 ± 0.6		0.946
	6.7 ± 0.7		3.8 ± 1.6	<0.001*
		6.6 ± 0.6	3.8 ± 1.6	<0.001*

Note: Level of significant *$p < 0.05$; ** By the one-way ANOVA; *** By the Tukey Post Hoc Tests
Abbreviation: CP, cleft palate

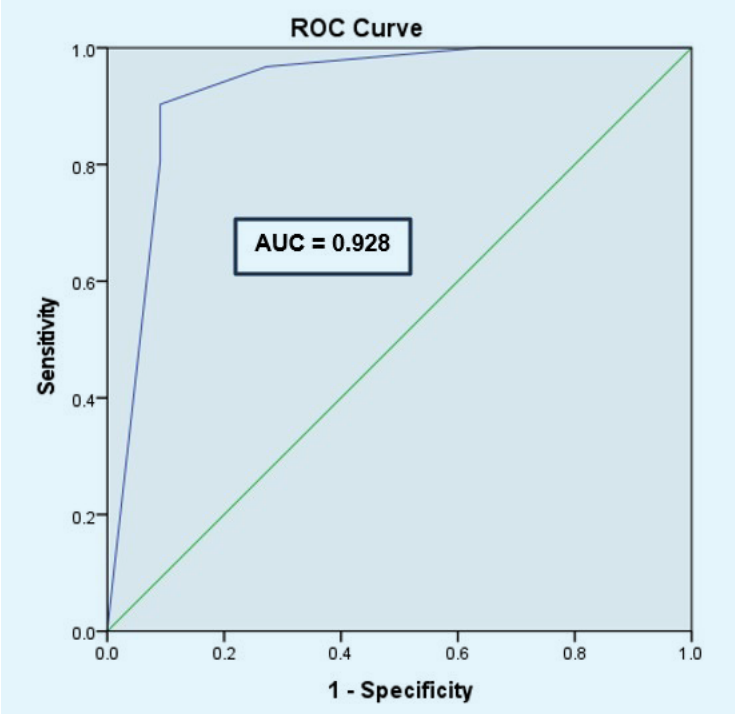

Fig 2. Receiver operator characteristic (ROC) curve showing the cut-off smell score at 5.5 for children across all age groups. The area under curve (AUC) is 0.928.

DISCUSSION

Olfactory dysfunction can lead to decreased appetite, malnutrition and a reduced quality of life.[1,28,29] Smell tests may be beneficial for children with low appetite or poor weight gain. We developed an odor identification test kit using food and flavoring agents because they are closely associated with appetite. Some of the odorants in this study were used in previous studies,[5-7,10-13,19,21-24] combined with new substances commonly found local foods and desserts. Children aged 5-12 years should be familiar with these common fruits and flavoring agents. However, studies have also been conducted on children below 5 years old.[7,10,11,23] *Schriever et al.*[10] found that U-sniff test was reliable and valid for children aged ≥ 4 years. *Cavazzana et al.*[23] reported that children aged 3-4.99 years could successfully complete the Sniffin' Kids test using 11 odors instead of 14. In our study, four substances (squid, garlic, jasmine, and rose) showed that picture identification was influenced by age ($p < 0.05$). However, age did not affect odor selection for any of the 17 odorants in Phase 1. Odor identification performance improves with age, likely due to enhanced cognitive function and verbal abilities[7,30,31] In our study, all children in the 10.01 to 12-year-old group correctly identified all seven odorants in the test kit. *Schriever et al.*[13] also found a positive correlation scores on the Sniffin' Kids test and age ($p < 0.001$; $r = 0.29$). *Dżaman et al.*[19] reported a statistically significant influence of age on odor identification ability ($r = 0.676$, $p < 0.001$). The average time taken to complete the test for seven odors

was 3 to 5 minutes. The longest duration recorded for a correct answer to a single odor test was 30 seconds. Participants who took more than 30 seconds either failed to provide an answer or gave an incorrect one. The test-retest reliability of our test ($r = 0.932$, $p < 0.001$) was comparable to other smell tests for children.[6,7,11,13,32,33]

Eleven children who were able to express their loss of smell had either ARS or Kallmann syndrome. These children took longer to complete the test and had significantly lower smell scores. ARS causes mucosal swelling, impaired mucociliary transport, and increased secretion, all of which prevent odors from reaching the olfactory epithelium.[34,35] Kallmann syndrome is a genetic disease characterized by hypogonadotropic hypogonadism and anosmia.[36] Magnetic resonance imaging of patients with Kallmann syndrome reveals aplasia or hypoplasia of the olfactory bulbs and tracts.[37]

Children with CP have anatomical abnormalities that can contribute to olfactory dysfunction. *Grossmann et al.*[20] found that patients with unilateral CP had a higher smell threshold on the cleft side. In their study, the mean number of identified odors was 1.8 in the cleft group and 2.7 in the control group, though the subjective sense of smell was similar in both groups.[20] *Mani et al.*[26] demonstrated a significant reduction in smell scores in unilateral CP patients when compared to participants without cleft ($p = 0.005$). Despite this evidence, the results of our study showed no difference between children with and without CP in terms of smell scores or the time taken to complete the test. *Roosenboom et al.*[38] also reported no significant difference in Sniffin' Sticks scores between participants with non-syndromic cleft lip and/or CP and participants without cleft.

In our study, the discriminant scores between normal and abnormal olfactory function were determined using the ROC curve and the 10th percentile of the smell score, with both methods yielding similar results. Since the scores were recorded as integers, a smell score of 6 and 7 was considered indicative of normal olfactory function based on both approaches.

The limitations of our study were the small number of children with olfactory dysfunction. Kallmann syndrome is a rare genetic disorder, and we had only one case in this study. Additionally, there were 31 participants with normal smell in Phase 2, but we were unable to provide normative data for subgroup due to the limited number of participants within each subgroup. Furthermore, we did not use a tool to measure the concentration of the odors, which might be the limitation of the study. However, we had normal adult subjects who smelled the substance at the concentrations used in the test kit before using them for the first time to ensure the optimal level of the odor. After that, we controlled the amount of the substance in every use with precise measurements. For future development, an odor meter should be used to test the consistency of odors, ensuring a uniform scent every time a test is conducted.

We developed the test kit using odor sources from widely available food products that can be found in convenience stores across Thailand and countries in Southeast Asia. With only seven items, the test kit is easy to prepare, accurate regardless of the season, and suitable for use in a variety of hospital settings. The test duration was no more than 5 minutes, making it suitable for incorporation into regular outpatient visits. The selection of odors could be applied to children in other Southeast Asian countries where commercial test kits are either unavailable or unfamiliar. In the future, we plan to transform these odorants into pen-like sticks to enhance their clinical use and facilitate future research. Further studies are needed to evaluate the test in children with specific causes of smell loss and those with failure to thrive, where olfactory dysfunction may be a cause.

CONCLUSION

The odor identification test kit consisted of seven odorants derived from fresh fruit, food and flavoring agents that are familiar to Thai children. Children aged 5-12 years with no symptoms of smell loss were able to complete the test in an average of 3.2 minutes. The test effectively distinguished children with reported smell loss from those with normal olfactory function. The cut-off scores were 5.5 based on the ROC analysis and 5.2 from the 10th percentile. Children with repaired CP showed no significant difference in smell scores compared to children without cleft.

Data Availability Statement

The data that support the findings of this study are available upon request from the corresponding author, [K.U.]. The data are not publicly available due to containing information that could compromise the privacy of research participants.

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DECLARATION

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Conflict of Interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Author Contributions

T.W: Conceptualization, Methodology, Validation, Investigation, Resources, Writing – Original Draft, Visualization, Supervision; S.W.: Validation, Investigation, Resources, Writing – Original Draft.; T.S.: Methodology, Formal analysis.; A.T.: Investigation, Resources, Writing – Original Draft.; V.V.: Investigation, Resources, Writing – Original Draft.; K.U.: Conceptualization, Methodology, Validation, Formal analysis, Data Curation, Writing – Review & Editing, Project administration.

Use of Artificial Intelligence

None

Ethics Approval

This study was approved by the Institutional Review Board of Siriraj Hospital, Faculty of Medicine Siriraj Hospital, Mahidol University (COA Si 148/2021).

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