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Validation of the clinical applicability of the brief self-administered waterless empirical taste test during the era of COVID-19

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Abstract

Background: This study was performed to test the clinical applicability of a new taste test, the Brief Self-Administered Waterless Empirical Taste Test (B-WETT) in the era of COVID-19.

Methods: Sixty healthy volunteers and 60 patients experiencing gustatory dysfunction were enrolled. All subjects received both the Self-Administered WETT and the new B-WETT which are comprised of disposable plastic strips containing sucrose, citric acid, sodium chloride, caffeine, and monosodium glutamate tastants to evaluate taste function. The healthy volunteers were re-tested with the WETT and B-WETT after an inter-test interval of at least 7 days to measure retest reliability.

Results: The sum scores of five tastants of the first test were 25.7 for males and 29.5 for females in WETT, and 12.4 for males and 15.2 for females in B-WETT. There were significant differences in the sum scores between males and females whether in WETT or B-WETT. The sum scores strongly correlated between WETT and B-WETT, whether in healthy volunteers or in patients with gustatory dysfunction (r >0.7). There was also a strong correlation between the first and second tests of B-WETT for the sum scores.

Conclusion: This study shows that B-WETT is a valid and reliable taste test, and is convenient for use in the era of COVID-19 to evaluate the taste function of patients.

Keywords: Brief Self-Administered Waterless Empirical Taste Test; COVID-19; Taste test; Validity; Waterless Empirical Taste Test

1. INTRODUCTION

Taste is an often overlooked sense.[1] According to the National Health and Nutrition Examination Survey 2013–2014, approximately 26.3 million subjects aged 40 years and older in the US population experienced taste problems.[2] These problems may cause anxiety, depression, or nutritional deficiencies in these patients.[1] To provide adequate management for patients with taste dysfunction, a comprehensive assessment of a person's taste function is necessary to make a correct diagnosis.[3] Traditionally, taste function has been evaluated using solution-based taste tests.[4,5] However, there are some drawbacks to these types of tests as they are usually time-consuming and commercially unavailable, and require assistance to be administered.[6]

Several taste tests using tablets, edible wafers, or taste strips have been developed to overcome the shortcomings of solution-based taste tests.[6] One such test named the Waterless Empirical Taste Test (WETT, Sensonics International, Haddon Heights, NJ, USA) is currently available on the market. The WETT is comprised of 53 disposable plastic strips, with sets of eight coated in one of five tastants (sucrose, citric acid, sodium chloride, caffeine, or monosodium glutamate) and 13 blank strips. The test has been validated in several studies.[7–9] Recently, a brief version of WETT (Brief Self-Administered Waterless Empirical Taste Test, B-WETT) has been developed with 27 disposable plastic strips, with sets of four coated in one of five tastants (sucrose, citric acid, sodium chloride, caffeine, or monosodium glutamate) and seven blank strips. B-WETT is designed for self-administration (Fig. 1). Currently, a self-administered WETT is also available commercially (Fig. 2).

The coronavirus disease 2019 (COVID-19) pandemic currently remains a major global health crisis. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection may affect both the olfactory and gustatory functions in COVID-19 patients.[10,11] Therefore, accurate, convenient, and self-administered olfactory and gustatory tests are needed to diagnose, prevent, and treat COVID-19 syndromes. The aim of this study was to test B-WETT's clinical applicability by comparing it with the original WETT.

2. METHODS

2.1. Participants

Thirty male and 30 female healthy volunteers with a normal self-rated taste function, along with 60 patients who had

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Fig. 1 Brief Self-Administered Waterless Empirical Taste Test.

complained of loss of taste function, were enrolled in this study from September 2021 to May 2022. Any healthy volunteer with a history of oral or middle ear surgery or having an acute oral infection was excluded. The patients who complained of loss of taste function were asked about their ability to taste sweet, sour, salty, bitter, and brothy tastants. If they responded that they still possessed a normal ability to differentiate between those five tastants, they were excluded from the study. At present, there is no standard test to evaluate the taste function in Taiwan. Therefore, we did not test the taste function of the healthy subjects and patients with olfactory dysfunction before enrollment. All eligible healthy volunteers and patients took both a WETT and B-WETT to assess their taste function. The healthy volunteers received another WETT and B-WETT no less than 7 days later for evaluation of retest reliability. This study was approved by the Institutional Review Board (II) of Taichung Veterans General Hospital (IRB number: CF19054B). Written informed consents were collected from all enrolled subjects.

2.2. Taste tests

In this study, each subject's taste function was measured through both a WETT and the new B-WETT. There was a minimum 10-minute break between the taste tests. In both groups, subjects received the WETT and B-WETT in random order.

The WETT is comprised of 40 disposable tastant plastic strips and 13 blank plastic strips.[8] The end of each tastant strip is lined with a monomer cellulose pad containing either sucrose, citric acid, sodium chloride, caffeine, or monosodium glutamate tastant. Each tastant has four different concentrations (sucrose: 0.20, 0.10. 0.05, 0.025 g/ml; citric acid: 0.20, 0.10. 0.05, 0.025 g/ml; sodium chloride: 0.25, 0.125. 0.0625, 0.0313 g/ml; caffeine: 0.088, 0.044. 0.022, 0.011 g/ml; and monosodium glutamate: 0.135, 0.068. 0.034, 0.017 g/ml). In each test, strips with the four different concentrations of all five tastants were presented twice in a counter-balanced order. The pads on the 13 blank strips are made only of monomer cellulose. These blank strips are interspersed throughout the whole test in a specific pattern to negate the need for rinsing with water between the ordinary tastant tests.

At the onset of the self-administered WETT, the tester held a strip, placed the pad situated at the end of the strip on the middle portion of the tongue, closed their mouth, and moved the strip slightly around.[7] The tester then selected one of the six options (sweet, sour, salty, bitter, brothy, or no taste at all). One point was scored if a correct answer was made, thus generating a potential 8 score maximum for the correct identification of each of the five tastants, and a 13 score maximum for correctly identifying all 13 of the blank strips. Each patient required about 10 to 15 minutes to complete a WETT.

The B-WETT is comprised of 20 disposable tastant plastic strips and seven blank plastic strips. The end of each tastant strip is also lined with a monomer cellulose pad containing either sucrose, citric acid, sodium chloride, caffeine, or monosodium glutamate tastant. Each tastant has four different concentrations,

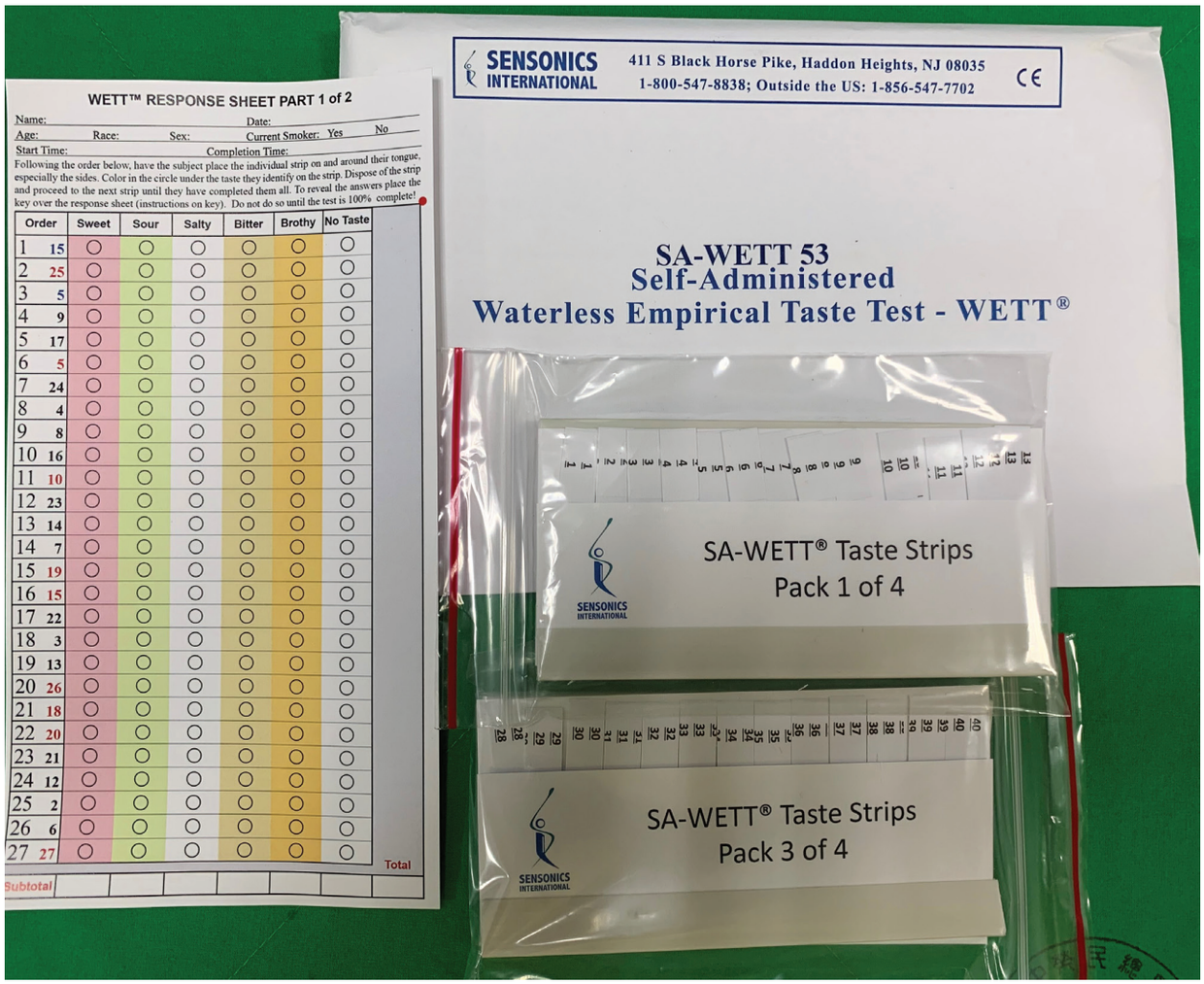

Fig. 2 Self-Administered Waterless Empirical Taste Test.

similar to that in the WETT. In each test, strips with four different concentrations of all five tastants were presented once in a counter-balanced order. The pads on the seven blank strips were comprised only of monomer cellulose. These blank strips were interspersed throughout the whole test in a specific pattern to negate the need for rinsing with water between the ordinary tastant tests, as was done in the WETT.

The administration procedures for the self-administered B-WETT were the same as the WETT. The tester then selected one answer from six options (sweet, sour, salty, bitter, brothy, or no taste at all). One point was scored if a correct answer was made, thus generating a potential 4 score maximum for the correct identification of each of the 5 tastants, and a 7 score maximum for correctly identifying all 7 of the blank strips. It usually required less than 10 minutes for each patient to complete a B-WETT.

2.3. Statistical analysis

Descriptive data are presented as means ± SD. The ages, scores recorded for the tastant and blank strips, and the sum scores of the five tastants for the healthy male and female volunteers were compared using the Mann-Whitney U test. The scores were recorded for the tastant and blank strips, and the sum scores of the five tastants were compared between the first and the second WETT and B-WETT tests, and between the first 27 items of the WETT and B-WETT tests using the Wilcoxon Signed Ranks test. Split-half reliabilities of the WETT were computed using Spearman-Brown coefficients. The sum scores of the five tastants were compared between the healthy volunteers and the patients with gustatory dysfunction using the Mann-Whitney U test. The scores recorded for the tastant and blank strips, and the sum scores of the 5 tastants were correlated between the WETT and B-WETT using Spearman's correlation coefficients and the Bland–Altman plots, in both the healthy volunteers and patients with gustatory dysfunction. Spearman's correlation coefficients were used to measure the strength and direction of the association between the WETT and B-WETT and to evaluate the validity of the test, whereas the Bland–Altman plot is a method of data plotting used in analyzing the agreement between two different tests. Retest reliability of both the WETT and B-WETT were determined using Spearman's correlation coefficients and intraclass correlation coefficients (ICC) in the healthy male and female volunteers. Normative values of the WETT and B-WETT were defined by tenth percentile values. The minimal detectable change was determined by a 95% confidence interval. All computations were performed using SPSS (version 22.0, SPSS, Inc., Chicago, IL, USA). Two-tailed p-values <0.05 were considered statistically significant.

3. RESULTS

3.1. Participants

The ages of the 30 healthy male volunteers ranged from 22 to 71, with a mean of 36.4 years, while the ages of the 30 healthy female volunteers ranged from 22 to 69, with a mean of 34.1 years. There was no significant difference in age between the healthy male and female volunteers. There were 25 male and 35 female patients experiencing gustatory dysfunction, with ages ranging from 20 to 83 and having a mean of 47.1 years. All patients with gustatory dysfunction have been reviewed with detailed history-taking and examined by routine ENT check-ups. Their etiologies and taste test results are shown in Table 1. None of them had acquired COVID infection at the time of the taste test.

3.2. Taste test scores and administration times

Table 2 shows the scores of WETT, the first 27 items of WETT and B-WETT of healthy volunteers, and patients with gustatory dysfunction. Among the five tastants, monosodium glutamate was the most difficult to detect. The sum scores of the five tastants and scores recorded for the tastant and blank strips were not significantly different between the first 27 items of the WETT and B-WETT except for the sweet tastant at the first round of tests in the healthy volunteers. Table 3 shows the comparison of taste test scores between healthy male and female volunteers. In the first round of tests in the healthy volunteers, females performed better than males whether it was in WETT or B-WETT. However, in the second round of tests, the sum scores of the five tastants in the male volunteers became

Table 1

Etiology and taste test results of patients with gustatory dysfunctions

Etiology	No.	M/F	Age	WETT score	B-WETT score
CNS disease	2	1/1	39&72	1&10	3&3
Chronic kidney disease	1	0/1	67	23	8
Chronic rhinosinusitis	4	2/2	49.3 (26–62)[a]	27.75 (19–32)	13.25 (11–16)
Iatrogenic	6	3/3	56.2 (31–82)	13.67 (2–26)	5.33 (0–11)
Idiopathic	16	7/9	53.4 (26–83)	19.75 (3–31)	10.94 (2–18)
Traumatic brain injury	29	12/17	40.9 (20–66)	16.24 (0–32)	8.48 (0–18)
Upper respiratory infection	2	0/2	35&36	29&27	13&12
Total	60	25/35	47.1 (20–83)	17.83 (0–32)	9.08 (0–18)

B-WETT = Brief Self-Administered Waterless Empirical Taste Test; CNS = central nervous system; F = female; M = male; WETT = Self-Administered Waterless Empirical Taste Test.
[a]Mean (range).

Table 2

Test scores of WETT, the first 27 items of WETT and B-WETT

	Score						
Tastant	Five[a]	Sweet	Sour	Salty	Bitter	Brothy	No
Healthy volunteers (60[b])							
WETT							
First test	27.58 ± 7.05	4.93 ± 2.16	6.65 ± 2.07	5.80 ± 1.76	6.03 ± 2.37	4.17 ± 2.66	11.02 ± 2.31
Second test	29.27 ± 6.67	5.22 ± 1.91	6.90 ± 1.60	5.94 ± 1.83	5.90 ± 2.56	5.28 ± 2.66	10.97 ± 2.04
P	0.014	0.304	0.336	0.576	0.774	<0.001	0.934
B-WETT							
First test	13.82 ± 3.74	2.70 ± 1.11	3.20 ± 1.01	2.95 ± 1.02	3.00 ± 1.21	1.97 ± 1.61	5.62 ± 1.51
Second test	14.75 ± 3.87	2.68 ± 1.02	3.48 ± 0.85	3.10 ± 1.12	2.97 ± 1.40	2.52 ± 1.51	5.76 ± 1.59
P	0.005	0.896	0.006	0.414	0.737	0.001	0.412
Patients with gustatory dysfunction (60[b])							
WETT	17.83 ± 9.06	2.90 ± 2.60	4.70 ± 2.69	5.00 ± 2.78	2.78 ± 2.58	2.45 ± 2.59	11.23 ± 2.85
B-WETT	9.08 ± 5.06	1.57 ± 1.35	2.18 ± 1.41	2.67 ± 1.48	1.37 ± 1.40	1.30 ± 1.44	6.02 ± 1.59
Healthy volunteers (60[b])							
First test							
First half of WETT	13.63 ± 3.65	2.32 ± 1.20	3.25 ± 1.08	2.95 ± 1.05	3.07 ± 1.19	2.05 ± 1.58	5.95 ± 1.33
B-WETT	13.82 ± 3.74	2.70 ± 1.11	3.20 ± 1.01	2.95 ± 1.02	3.00 ± 1.21	1.97 ± 1.61	5.62 ± 1.51
P	0.572	0.005	0.596	0.988	0.621	0.544	0.051
Second test							
First half of WETT	14.48 ± 3.81	2.57 ± 1.11	3.38 ± 0.85	2.90 ± 1.13	2.98 ± 1.36	2.65 ± 1.49	5.82 ± 1.36
B-WETT	14.75 ± 3.87	2.68 ± 1.02	3.48 ± 0.85	3.10 ± 1.12	2.97 ± 1.40	2.52 ± 1.51	5.76 ± 1.59
P	0.347	0.270	0.375	0.105	0.867	0.213	0.854
Patients with gustatory dysfunction (60[b])							
First half of WETT	8.98 ± 4.58	1.52 ± 1.28	2.30 ± 1.41	2.50 ± 1.48	1.47 ± 1.43	1.20 ± 1.29	6.12 ± 1.53
B-WETT	9.08 ± 5.06	1.57 ± 1.35	2.18 ± 1.41	2.67 ± 1.48	1.37 ± 1.40	1.30 ± 1.44	6.02 ± 1.59
P	0.700	0.669	0.366	0.194	0.629	0.522	0.542

B-WETT = Brief Self-Administered Waterless Empirical Taste Test; WETT = Self-Administered Waterless Empirical Taste Test.
[a]Sum score of 5 tastants.
[b]Number of subjects.

higher than those in the first round (p = 0.011 for WETT and p = 0.003 for B-WETT). When the sum scores of the five tastants were compared between the healthy volunteers and the patients with gustatory dysfunction, there were significant differences, whether it be in WETT (p < 0.001 for both males and females) or B-WETT (p = 0.004 for males and p < 0.001 for females). The mean time interval spent to complete a test was 20.3 minutes for the first test of WETT in healthy volunteers, 14.9 minutes for their second test of WETT, and 20.5 minutes in patients with gustatory dysfunction. For B-WETT, times were 13.1 minutes for the first test in healthy volunteers, 8.1 minutes for their second test, and 12.4 minutes in patients with gustatory dysfunction.

3.3. Correlation between WETT and B-WETT

Table 4 shows the Spearman's correlation coefficients of the scores of each tastant and the blank strips, and the sum scores of the five tastants between WETT and B-WETT in healthy volunteers and the patients with gustatory dysfunction. There was a strong correlation between the sum scores

Table 3

Comparison of taste test scores between healthy male and female volunteers

	Score						
Tastant	Five[a]	Sweet	Sour	Salty	Bitter	Brothy	No
WETT							
First test							
M (30[b])	25.70 ± 7.32	4.87 ± 2.37	6.20 ± 2.27	5.60 ± 1.67	5.50 ± 2.80	3.53 ± 2.95	10.50 ± 2.54
F (30[b])	29.47 ± 6.35	5.00 ± 1.97	7.10 ± 1.79	6.00 ± 1.86	6.57 ± 1.74	4.80 ± 2.22	11.53 ± 1.96
P	0.045	0.893	0.017	0.332	0.186	0.095	0.038
Second test							
M (30[b])	28.03 ± 7.14	5.10 ± 2.12	6.73 ± 1.76	5.80 ± 1.86	5.40 ± 2.82	5.00 ± 2.73	10.63 ± 2.08
F (30[b])	30.50 ± 6.04	5.33 ± 1.71	7.07 ± 1.44	6.13 ± 1.81	6.40 ± 2.21	5.57 ± 2.61	11.30 ± 1.99
P	0.133	0.994	0.477	0.433	0.143	0.410	0.133
B-WETT							
First test							
M (30[b])	12.43 ± 3.72	2.70 ± 1.26	2.90 ± 1.13	2.47 ± 1.04	2.80 ± 1.38	1.57 ± 1.55	5.47 ± 1.66
F (30[b])	15.20 ± 3.26	2.70 ± 0.95	3.50 ± 0.78	3.43 ± 0.73	3.20 ± 1.00	2.37 ± 1.59	5.77 ± 1.36
P	0.005	0.706	0.022	0.000	0.365	0.061	0.549
Second test							
M (30[b])	14.03 ± 3.83	2.67 ± 1.16	3.37 ± 0.89	3.27 ± 1.11	2.53 ± 1.53	2.20 ± 1.61	5.57 ± 1.79
F (30[b])	15.47 ± 3.85	2.70 ± 0.88	3.60 ± 0.81	2.93 ± 1.11	3.40 ± 1.13	2.83 ± 1.37	5.93 ± 1.36
P	0.105	0.756	0.227	0.134	0.015	0.127	0.390

B-WETT = Brief Self-Administered Waterless Empirical Taste Test; F = female; M = male; WETT = Self-Administered Waterless Empirical Taste Test.
[a]Sum score of 5 tastants.
[b]Number of subjects.

Table 4

Correlation between WETT and B-WETT

Tastant	Five[a]	Sweet	Sour	Salty	Bitter	Brothy	No
Healthy volunteers							
M: 1st test							
Rho[b]	0.698	0.827	0.573	0.309	0.636	0.788	0.539
P	<0.001	<0.001	0.001	0.096	<0.001	<0.001	0.002
F: 1st test							
Rho	0.723	0.446	0.627	0.581	0.436	0.703	0.816
P	<0.001	0.013	<0.001	0.001	0.016	<0.001	<0.001
M: 2nd test							
Rho	0.767	0.609	0.227	0.532	0.905	0.795	0.481
P	<0.001	<0.001	0.228	0.002	<0.001	<0.001	0.007
F: 2nd test							
Rho	0.817	0.705	0.285	0.712	0.605	0.626	0.815
P	<0.001	<0.001	0.127	<0.001	<0.001	<0.001	<0.001
Patients with gustatory dysfunction							
M							
Rho	0.946	0.819	0.705	0.774	0.819	0.814	0.688
P	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
F							
Rho	0.854	0.708	0.731	0.732	0.700	0.783	0.498
P	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002

B-WETT = Brief Self-Administered Waterless Empirical Taste Test; F = female; M = male; WETT = Self-Administered Waterless Empirical Taste Test.
[a]Sum score of 5 tastants.
[b]Spearman's correlation coefficient.

of the five tastants between WETT and B-WETT, whether it be in healthy volunteers or the patients with gustatory dysfunction. Bland–Altman plot scores of WETT and B-WETT are shown in Fig. 3 for healthy volunteers, and in Fig. 4 for patients with gustatory dysfunction. For example, there were 3 (5%) healthy subjects whose sum scores of five tastants

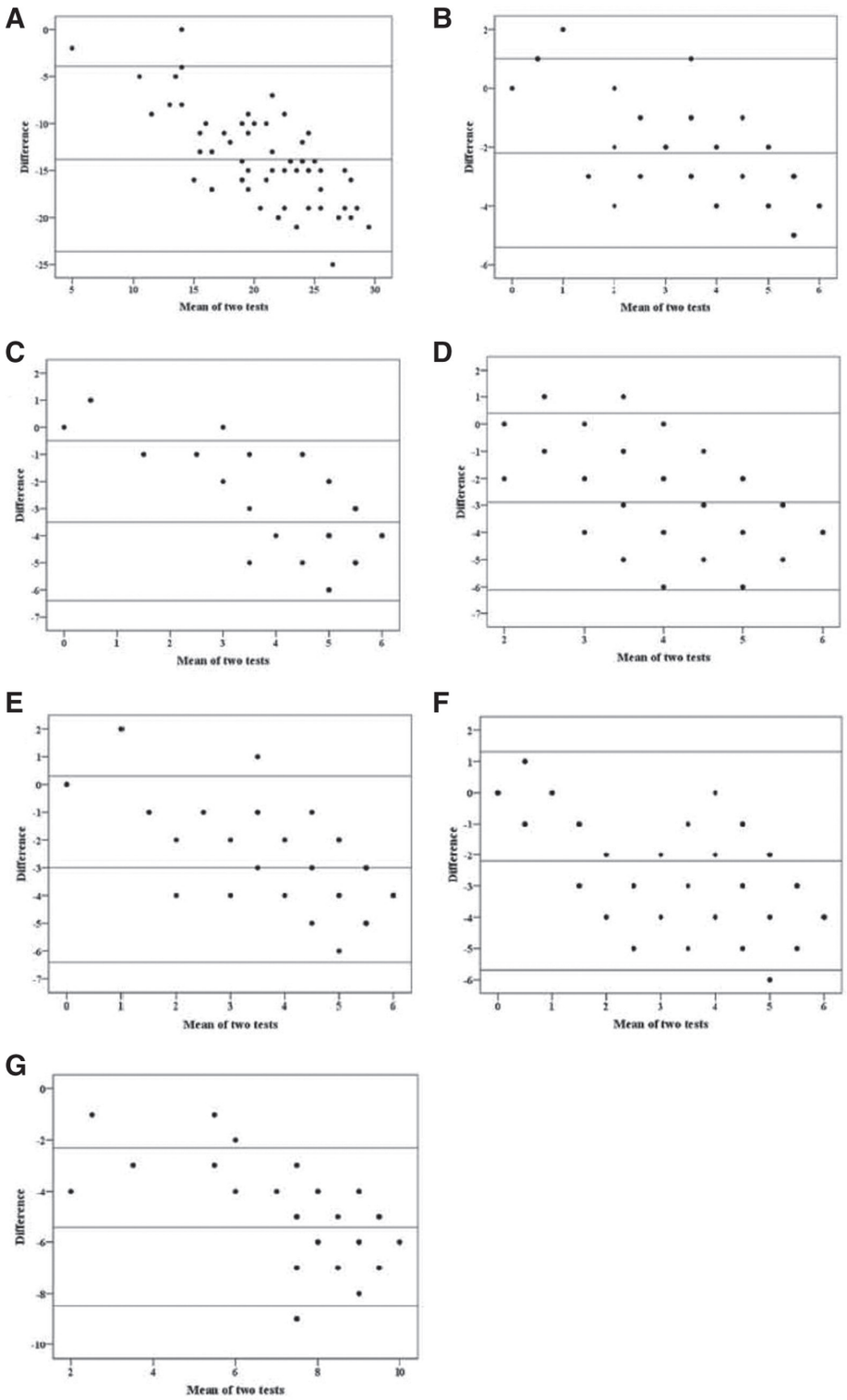

Fig. 3 The Bland–Altman plots of scores of healthy subjects. A, sum score of five tastants; B, sweet tastant; C, sour tastant; D, salty tastant; E, bitter tastant; F, brothy tastant; G, no tastant.

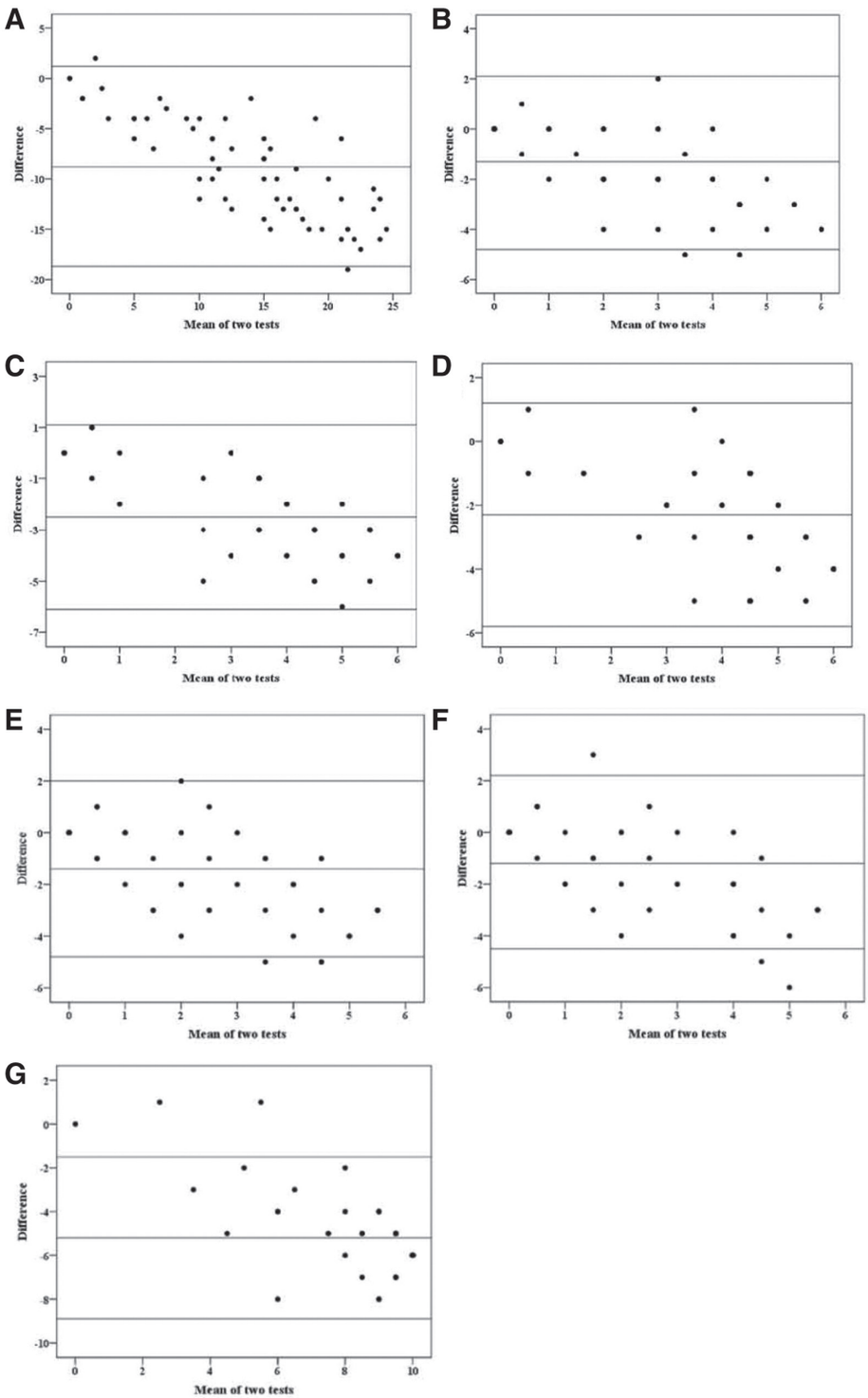

Fig. 4 The Bland–Altman plots of scores of patients with olfactory dysfunction. A, sum score of five tastants; B, sweet tastant; C, sour tastant; D, salty tastant; E, bitter tastant; F, brothy tastant; G, no tastant.

were outside the 95% of differences (95% limits of agreement: –23.6 to –3.9), and there were 2 (3.33%) patients with gustatory dysfunction whose sum scores of five tastants were outside the 95% of differences (95% limits of agreement: –18.7 to 1.2).

3.4. Test-retest reliability

When split-half reliabilities of the WETT were computed using Spearman-Brown coefficients, the coefficients were 0.85 for the sum scores of the five tastants, 0.77 for the sweety tastant, 0.85 for the sour tastant, 0.45 for the salty tastant, 0.90 for the bitter

tastant, and 0.75 for the brothy tastant at the first round of tests in the healthy volunteers. Spearman–Brown coefficients were 0.92 for the sum scores of the five tastants, 0.89 for the sweety tastant, 0.84 for the sour tastant, 0.89 for the salty tastant, 0.76 for the bitter tastant, and 0.87 for the brothy tastant in patients with gustatory dysfunction. Eleven of the 12 Spearman–Brown coefficients were above 0.70, with two-thirds (8/12) being above 0.80, a value considered to be very strong.[8] Table 5 shows the Spearman's correlation coefficients and ICC of the scores of each tastant and the blank strips, as well as the sum scores of the five tastants between the first and second tests of WETT and B-WETT in the healthy volunteers. There was strong correlation between the first and second tests of B-WETT in the sum scores of the five tastants. ICC showed a moderate correlation for B-WETT.[12]

3.5. Normative values and minimal detectable change

Table 6 shows the tenth percentile values and the minimal detectable change of the scores of each tastant and the blank strips, as well as the sum scores of the five tastants of WETT and B-WETT. The normative values of the sum scores of the five tastants were set at 16 for male adults and 23 for female adults in WETT, and at 10 for male adults and 10 for female adults in B-WETT. The minimal detectable change is the minimal amount of change that a measurement must show to be greater than the within-subject variability and measurement error.[13] The minimal detectable change in the sum scores of the five tastants was set at 8 for male adults and 6 for female adults in WETT, and at 4 for male adults and 4 for female adults in B-WETT.

4. DISCUSSION

The WETT is a valid taste test.[7–9] It employs neither liquid tastants nor liquid rinses between tests, making it convenient to use at a medical clinic to evaluate the taste function of COVID-19 patients. Moreover, it includes a test for umami, which makes the test more comprehensive when compared with traditional taste tests.[14,15] As the WETT uses a blank taste test, it does not employ the multiple forced-choice methods to produce an answer as most taste tests do.[16] It has been found that forced-choice and non-forced-choice procedures produce differences in the results of taste tests.[17]

Table 5

Test-retest reliability and intraclass correlation coefficients of WETT and B-WETT

Tastant	Five[a]	Sweet	Sour	Salty	Bitter	Brothy	No
Male healthy volunteers							
WETT							
Rho[b]	0.687	0.347	0.590	0.580	0.627	0.647	0.452
ICC	0.717	0.431	0.650	0.567	0.702	0.693	0.490
B-WETT							
Rho	0.740	0.508	0.590	0.176	0.694	0.784	0.392
ICC	0.744	0.683	0.640	0.305	0.723	0.771	0.487
Female healthy volunteers							
WETT							
Rho	0.671	0.559	0.501	0.179	0.486	0.650	0.478
ICC	0.713	0.712	0.758	0.235	0.553	0.661	0.489
B-WETT							
Rho	0.746	0.416	0.577	0.318	0.499	0.600	0.561
ICC	0.705	0.424	0.708	0.307	0.442	0.564	0.532

B-WETT = Brief Self-Administered Waterless Empirical Taste Test; F = female; M = male; WETT = Self-Administered Waterless Empirical Taste Test.
[a]Sum score of 5 tastants.
[b]Spearman's correlation coefficient.

Table 6

The tenth percentile value and minimal detectable change

Tastant	Five[a]	Sweet	Sour	Salty	Bitter	Brothy	No
Male healthy volunteers							
WETT							
10th%	16	2.1	3.6	3.1	0.2	0.5	7.6
MDC	8	3	3	2	3	4	3
B-WETT							
10th%	9.1	0.6	1.1	1.2	0.5	0	4
MDC	4	1	2	2	2	2	2
Female healthy volunteers							
WETT							
10th%	22.1	3.1	5.1	3.6	3.6	2.5	8.6
MDC	6	2	2	3	3	3	3
B-WETT							
10th%	9.6	1.5	3	2.1	1.6	0.5	4
MDC	4	1	1	2	2	2	2

B-WETT = Brief Self-Administered Waterless Empirical Taste Test; F = female; M = male; MDC = minimal detectable change; WETT = Self-Administered Waterless Empirical Taste Test.
[a]Sum score of 5 tastants.

In a previous study,[8] it had been demonstrated that women produced higher WETT scores for all five tastants than men and that the sweet, sour, and bitter scores decreased with age, but the salty and brothy scores did not. Therefore, gender affects WETT results, although the effect of age on WETT results still requires further investigation. In another study,[9] it was also discovered that females performed better than males, but that the salty WETT® score did not decrease with age. Therefore, we divided our subjects into male and female groups. Our results show that women tended to perform better than men in WETT.

Chen et al.[9] have compared the test results of WETT between Chinese and American healthy adult subjects. The mean total WETT scores (the sum scores of the five tastants and blank strips) were 33.24 for Chinese males and 33.85 for female Chinese females as compared with 31.83 for American males and 38.19 for American females. The mean total WETT scores of the first test were 36.2 for our male healthy subjects and 41 for our female healthy subjects. Although the total, sweet, and salty scores were not significantly different between the Chinese and American healthy subjects, the brothy scores were 28.40% higher for the Chinese than for the American subjects, and the bitter and sour scores were 24.12 and 21.79% higher for the American than for the Chinese subjects. The sour, salty, bitter, and brothy scores were higher for our subjects than for the Chinese subjects (Table 2). The reasons for the differences in performance on the WETT between Taiwanese and Chinese subjects are difficult to explain, although environmental, genetic, and cultural factors have been mentioned.[9]

B-WETT is a brief version of WETT. It is comprised of 20 disposable tastant plastic strips and seven blank plastic strips which are used in the first half of the WETT. Our results show that the test offers solid validity. The sum scores of the five tastants and scores recorded for the tastant and blank strips were not significantly different between the first 27 items of the WETT and B-WETT except for the sweet tastant at the first round of tests in the healthy volunteers. The correlation between B-WETT and WETT was strong for the sum scores of the five tastants and each tastant score, particularly in patients with gustatory dysfunction. The sum scores of the five tastants were significantly higher in the healthy volunteers than in the patients with gustatory dysfunction. This indicated that B-WETT possessed a strong ability to differentiate the taste functions between healthy subjects and patients with gustatory dysfunction. The test-retest reliability coefficients showed

that B-WETT was highly reliable. Obviously, B-WETT is more convenient to administer than WETT. It took approximately 12 minutes to complete a B-WETT test, as compared with 20 minutes to complete a WETT test in patients with gustatory dysfunction. In this study, we did not investigate the effect of age on B-WETT results due to a limited number of enrolled subjects.

In conclusion, our study has shown that B-WETT is a valid and highly reliable taste test. It is convenient, self-administered, and suitable for use in the era of COVID-19 to evaluate and follow-up the gustatory function of patients. In the future, it is necessary to determine its normative values based on age and sex before it can be more accurate to evaluate the taste function of patients.

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