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Effects of tongue cleaning on Ayurvedic digestive power and oral health-related quality of life: A randomized cross-over study

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ABSTRACT

Objectives: The effect of tongue cleaning on digestive power is mentioned in Ayurvedic information sources. However, no study has yet evaluated this. We aimed to evaluate the effects of tongue cleaning on digestive power from Ayurvedic viewpoint, and on oral health-related quality of life (OHRQoL) in healthy adults.
Design: Randomized cross-over.
Interventions: We recruited healthy adults aged 20–60 years. After randomization, the immediate intervention group started tongue cleaning with a tongue scraper every morning for 4 weeks, and then waited for 4 weeks. The delayed intervention group initially waited for 4 weeks, and then started tongue cleaning in the same way.
Main outcome measures: We assessed the outcomes using the questionnaire on digestive power from Ayurvedic viewpoint, and the General Oral Health Assessment Index for OHRQoL. We estimated the effects of tongue cleaning using generalized estimating equations (GEE). We also conducted a sensitivity analysis, by comparing the changes in outcomes during the first 4 weeks of both groups.
Results: Of 58 participants, 57 completed the study. In GEE analysis, tongue cleaning showed improvement in some components of Ayurvedic digestive power represented by fecal and body conditions. For example, the odds ratio for improvement of constipation was 2.80 (95% CI: 1.04–7.58). The General Oral Health Assessment Index score was significantly increased by 4.33 points (95% CI: 2.18–6.48) after tongue cleaning. In sensitivity analyses, the trends of the results were similar to the main GEE analyses.
Conclusions: Tongue cleaning may be an effective method to improve digestive power and OHRQoL.

1. Introduction

Ayurveda emphasizes the importance of personal hygiene to maintain and promote health. According to Ayurveda under the chapter of Dinacharya (daily regimen), tongue cleaning in the morning is one of the personal hygiene procedures that should be performed daily.[1] Tongue cleaning is an age-old custom practiced in countries like India as part of a daily routine for oral hygiene.[2] A classic Ayurveda textbook mentions that the root of the tongue should be scraped regularly to remove the dirt from the tongue that causes a foul smell and the obstruction of expiration.[1] Clinical studies in the dental and oral fields have supported this description of the effects of tongue cleaning, such as reducing halitosis,[3–6] coated tongue,[4,6] and bacterial flora in the tongue coating and dental plaque.[7,8] Websites that provide information on Ayurveda further state that tongue cleaning causes the improvement of digestive power.[9–12] This is reportedly because tongue cleaning thins the tongue coating that covers the taste buds, so the sense of taste and satisfaction with meals improves, and accordingly we will not eat more than necessary. By eating properly, digestive power is maintained and undigested food materials, commonly known as Ama in Ayurvedic terminology, are not accumulated in the body.

Previous intervention studies on tongue cleaning have mostly evaluated the effects on reducing halitosis,[3–6] coated tongue,[4,6] or bacterial flora in saliva and coated tongue.[7,8] To the best of our knowledge, no study has prospectively evaluated the effect of tongue cleaning on digestive power. We also assumed that when the oral environment is improved by tongue cleaning, the oral health-related quality of life (OHRQoL) will improve. However, we could not find any previous study that evaluated this. The objective of this randomized, cross-over, controlled trial was to prospectively evaluate the effects of tongue cleaning in healthy adults on digestive power from an Ayurvedic point of view and on OHRQoL.

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2. Methods

2.1. Study design and participants

We employed a randomized, cross-over, controlled design[13] to examine the effects of tongue cleaning on digestive power and OHRQoL. As this was an exploratory study, pre-calculation of the sample size was not done due to unavailability of information on effect size.

We recruited adult participants aged between 20 and 60 years at the time of recruitment who had experienced lassitude, tiredness, daytime sleepiness, and/or anorexia in the past month. The exclusion criteria were: taking treatment for any underlying disease like diabetes or hypertension; pregnancy; taking or planning to take oral treatment during the study period; history of artificial tooth or dental implant treatment within 6 months, or having any problem arising from such treatment even after 6 months; taking medicines, supplements and/or food continuously every day for at least 1 month that are considered to influence the digestive system by improving the intestinal environment (e.g., yogurt, lactic acid bacteria beverage); antibiotic treatment within the past month; already practicing tongue cleaning; pain or inflammation of the tongue; titanium allergy.

Participants were recruited through posters placed on the noticeboards of Okayama University, flyer distribution in nearby areas, and an announcement placed on our homepage. The participants were fully informed about the study, and all participants provided written informed consent.

After enrollment, participants were randomly allocated to either the immediate intervention group (IIG) or the delayed intervention group (DIG). Allocation was done by block randomization with four participants per block,[14] using a random number table,[15] to enable equal allocation as far as possible. The IIG immediately started the tongue cleaning intervention for 4 weeks, and then stopped performing tongue cleaning for the subsequent 4 weeks. The DIG initially waited for 4 weeks, and then performed the intervention for 4 weeks (Fig. 1). We did not set a washout period. The study period was from July 2016 to March 2017.

Approval for this study was obtained from the institutional ethics committee of Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences and Okayama University Hospital (R1606-005).

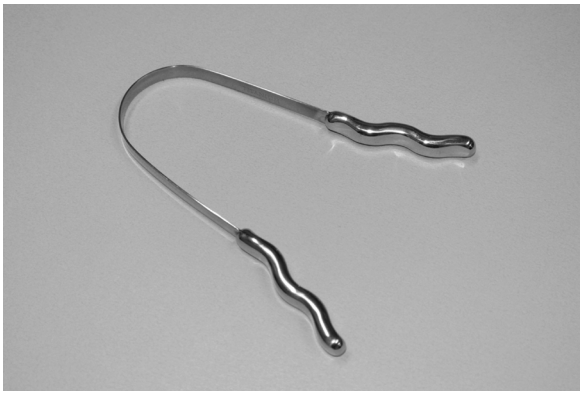

Fig. 2. Photograph of the titanium tongue scraper. The U-shaped center of the scraper was placed on the dorsum of the tongue and pulled forward to the tip of the tongue with gentle force; this was repeated five times to cover the whole tongue surface.

2.2. Tongue cleaning procedure

We asked participants to perform tongue cleaning at their home once daily before breakfast (or before tooth brushing if they did not eat breakfast) for 4 weeks. Tongue cleaning was done using a U-shaped titanium tongue scraper (Centrea Inc., Niigata, Japan) (Fig. 2). Although silver or stainless steel tongue scrapers are conventionally commonly used, we selected a titanium one that is considered more biocompatible,[16] taking into account the possibility of allergy to other metals.

We instructed participants to perform tongue cleaning as follows: 1. grasp both handles at the ends; 2. put the tongue out and place the center of the scraper on the dorsum of the tongue, as far posteriorly as possible, but not to the point that would induce gagging; 3. pull the scraper slowly forward to the tip of the tongue with very gentle force on

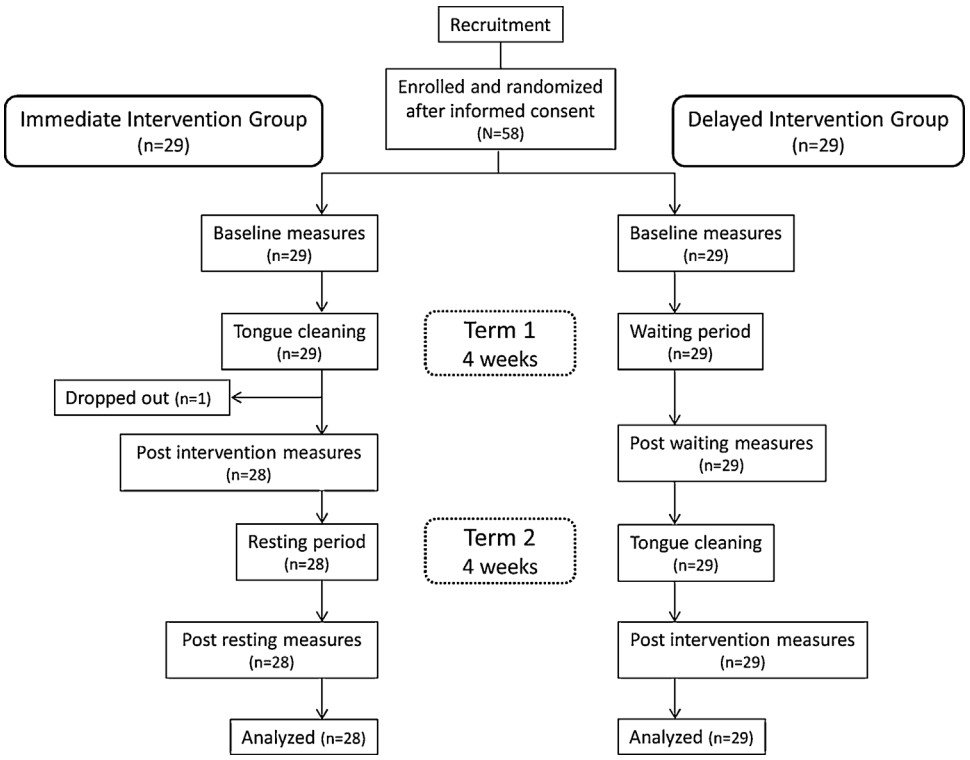

Fig. 1. Flow chart of the 58 participants throughout the trial.

the surface of the tongue; 4. repeat the procedure five times to cover the whole tongue surface; 5. if necessary, remove the debris accumulated on the scraper with running water in between scrapes.

We asked IIG participants to return the tongue scraper at the next visit after the intervention period to prevent them from using it during the resting period.

2.3. Outcome measures

We used the following evaluation tools as outcome measures: a questionnaire for assessing the Ayurvedic digestive power, and the General Oral Health Assessment Index (GOHAI) for OHRQoL. The outcome data were collected when participants visited our office at baseline and during two follow-up visits.

2.3.1. Primary outcome

Ayurvedic digestive power: we prepared a self-rating questionnaire with 5-point Likert scaling on physical condition in the past 2 weeks to evaluate digestive power from an Ayurvedic point of view. It included 17 questions related to Ama and functional dyspepsia (Table 2).

2.3.2. Secondary outcomes

OHRQoL: we used the Japanese version of the GOHAI. This self-rating questionnaire is widely used in various populations for assessing OHRQoL, and its validity has been verified.[17] It consists of 12 questions with 5-point Likert scaling related to oral health. The total score is called the GOHAI score. Higher scores indicate greater OHRQoL (maximum score: 60 points; minimum score: 12 points).[18–20] We asked the participants to rate the conditions over the past 2 weeks.

We also collected the following information for analyses.

1. Demographic questionnaire: this included birth date; sex; height; weight; marital, occupational, smoking, alcohol, and exercise status; medical history; and eating habits. Regarding eating habits, we extracted relevant 17 questions with 4-point Likert scaling from a dietary habit questionnaire that originally included 50 questions.[21] Out of four choices (no, sometimes, usually, or always), we categorized the answers of 'usually' and 'always' as an indication of an unwholesome dietary habits, and counted the total number of unwholesome dietary habits of each participant. This questionnaire was completed only once at baseline.
2. Implementation status of tongue cleaning: we asked participants to keep a record in a table of whether they performed tongue cleaning each morning during the 4-week intervention period, and to submit this record at the next visit after the intervention period. This was to exclude participants who failed to perform tongue cleaning for 14 or more days during the intervention period. We assumed that the effects of tongue cleaning would not appear properly if participants failed to perform tongue cleaning for more than half of the specified period.

2.4. Statistical analysis

We primarily assessed the effects of tongue cleaning using generalized estimating equations (GEE),[22] taking into account the within-individual correlation in the cross-over study design. In the analysis, the effects of tongue cleaning on all outcomes during the intervention periods were estimated compared with non-intervention periods. We assumed within-individual exchangeable correlation and did not adjust for covariates because of the randomized cross-over design.

To assess the effects of tongue cleaning on Ayurvedic digestive power, we used logistic regression with binary variables. In each question, when the follow-up answer was more favorable than the baseline value for each term, it was regarded as 'improved'; otherwise, it was counted as 'unchanged or deteriorated.' We estimated the odds ratio (OR) in each question for improvement caused by tongue cleaning. In each question, we excluded from the analysis those who gave the most favorable answers at baseline as well as at follow-up, and treated these as missing values. Although these participants might have had improvement at follow-up, there was no option in the 5-point Likert scaling that would indicate this, and therefore their answers might have been counted as 'unchanged' even though they actually had experienced improvement. We used linear regression to assess the effects on the GOHAI, treating the GOHAI score as the continuous variable.

We conducted sensitivity analyses by comparing the changes in the above two outcomes during the first term for both groups, i.e., the intervention period of the IIG with the waiting period of the DIG (Fig. 1). This sensitivity analysis was done as we did not set a washout period between terms, and there was the possibility of a carryover effect. We used logistic regression for the Ayurvedic digestive power analysis, and linear regression for the GOHAI analysis.

All confidence intervals (CIs) were calculated at the 95% level. All analyses were performed using Stata statistical software (Stata SE version 12.1, Stata Corp LP, TX, USA).

3. Results

Fig. 1 shows the participant flow chart. The 58 participants were randomly allocated equally into groups. One participant allocated to the IIG dropped out due to urticaria during the intervention period. All other participants completed both the periods (retention rate: 98.3%), and provided all required data. Furthermore, all participants conducted tongue cleaning for 22 or more days during the intervention period. Therefore, 57 participants (IIG: n = 28, DIG: n = 29) were included in the analyses.

Baseline characteristics of the participants are shown in Table 1. The proportion of female participants was 84.2% (n = 48), and the mean age of all participants was 37.5 ± 9.4 years.

Table 2 shows the results of GEE analysis of the effects of tongue cleaning on the primary outcome, i.e., Ayurvedic digestive power. After tongue cleaning, there were significant improvements in four out of 17 question items; i.e., constipation (2.80, 95% CI: 1.04–7.58), watery/loose motions (2.61, 95% CI: 1.07–6.39), malodor of stools (3.39, 95% CI: 1.21–9.53), and lassitude or fatigue in the limbs and/or whole body

Table 1
Participant characteristics.

	IIG (n = 28)	DIG (n = 29)	Total (n = 57)
Sex, n (%)			
Female	22 (78.6)	26 (89.7)	48 (84.2)
Male	6 (21.4)	3 (10.3)	9 (15.8)
Age (y)	37.1 ± 8.8	38 ± 10.0	37.5 ± 9.4
BMI	19.6 ± 2.0	21.4 ± 2.7	20.5 ± 2.5
Marital status, n (%)			
Married	16 (57.1)	18 (62.1)	34 (59.7)
Not married	12 (42.9)	11 (37.9)	23 (40.4)
Smoking behavior, n (%)			
Never smoked	26 (92.9)	27 (93.1)	53 (93.0)
Current smoker	1 (3.6)	1 (3.5)	2 (3.5)
Ex-smoker	1 (3.6)	1 (3.5)	2 (3.5)
Alcohol consumption, n (%)			
No/rarely	12 (42.9)	12 (41.4)	24 (42.1)
1 to 3 times per week	8 (28.6)	10 (34.5)	18 (31.6)
≥4 times per week	8 (28.6)	7 (24.1)	15 (26.3)
Exercise, n (%)			
No	9 (32.1)	15 (51.7)	25 (42.1)
1 to 4 times per week	13 (46.4)	12 (41.4)	25 (43.9)
≥5 times per week	6 (21.4)	2 (6.9)	8 (14.0)
Unwholesome dietary habit (n)	4.4 ± 3.1	4.4 ± 2.8	4.4 ± 2.9

Values expressed with a plus/minus sign are the mean ± standard deviation.
BMI, body mass index; IIG, immediate intervention group; DIG, delayed intervention group.

Table 2
Generalized estimating equations analysis of the effects of tongue cleaning on Ayurvedic digestive power.

Questions[a]	ORs (95% CI)
1. Do you have a good appetite?	0.87 (0.34–2.19)
2. Do you enjoy the taste of food?	1.19 (0.38–3.73)
3. Do you feel food remaining in your stomach for long time after meal?	1.31 (0.52–3.27)
4. Do you experience any increased salivation?	2.46 (0.89– 6.81)
5. Do you have constipation?	2.80 (1.04– 7.58)
6. Do you have watery/loose motion?	2.61 (1.07–6.39)
7. Does your stool smell badly?	3.39 (1.21–9.53)
8. Is your stool sticky to the toilet bowl?	2.91 (0.96–8.82)
9. Does your stool sink in water?	0.59 (0.22–1.62)
10. Do you feel lassitude or fatigue in your limbs and/or whole body?	4.11 (1.50–11.24)
11. Do you feel sleepy during the daytime?	2.36 (0.96–5.76)
12. Do you have joint pain?	2.61 (0.78–8.81)
13. Do you have body ache (other than joint pain)?	2.64 (0.89–7.77)
14. Do you have stiffness in the body?	1.70 (0.74–3.88)
15. Do you feel burning sensation around the pit of the stomach?	-[b]
16. Do you have rashes on face and/or around mouth?	1.39 (0.50–3.84)
17. Do you feel gloomy?	1.09 (0.43–2.75)

Odds ratio for improvement caused by tongue cleaning.
OR, odds ratio; CI, confidence interval.
[a] Question no. 1 and 2: positive answers indicate improvement; question no. 3–17: negative answers indicate improvement.
[b] Calculation was not possible, as 95 observations were deleted from the analysis.

(4.11, 95% CI: 1.50–11.24). Although not statistically significant, tongue cleaning also showed a tendency for beneficial effects in 10 other question items, indicating positive point estimates.

The GOHAI score was significantly increased by 4.33 points (95% CI: 2.18–6.48); that is, OHRQoL as measured by the GOHAI was improved by tongue cleaning.

Sensitivity analysis comparing the IIG with the DIG in the first term showed that the overall trend of the effects on Ayurvedic digestive power was similar to that of the main GEE analysis (Table 3). Tongue cleaning showed significant improvements in the same four question items with the main GEE analysis with different ORs and 95% CIs: constipation (5.92, 95% CI: 1.39–25.30), watery/loose motions (3.83, 95% CI: 1.2–12.28), malodor of stools (5.80, 95% CI: 1.59–21.25), and lassitude or fatigue in the limbs and/or whole body (3.40, 95% CI: 1.05 − 11.04). The GOHAI score was significantly improved by tongue cleaning; i.e., the regression coefficient in the IIG was 4.59 (95% CI: 1.87–7.30). This result was similar to the GEE analysis.

Table 3
The effects of tongue cleaning on Ayurvedic digestive power.

Questions[a]	ORs (95% CI)
1. Do you have a good appetite?	0.75 (0.24–2.39)
2. Do you enjoy the taste of food?	0.50 (0.11–2.30)
3. Do you feel food remaining in your stomach for long time after meal?	2.40 (0.76–7.53)
4. Do you experience any increased salivation?	2.95 (0.77–11.34)
5. Do you have constipation?	5.92 (1.39–25.30)
6. Do you have watery/loose motion?	3.83 (1.2–12.28)
7. Does your stool smell badly?	5.80 (1.59–21.25)
8. Is your stool sticky to the toilet bowl?	4.67 (0.86–25.19)
9. Does your stool sink in water?	0.68 (0.20–2.31)
10. Do you feel lassitude or fatigue in your limbs and/or whole body?	3.40 (1.05–11.04)
11. Do you feel sleepy during the daytime?	1.00 (0.34–2.92)
12. Do you have joint pain?	2.25 (0.44–11.52)
13. Do you have body ache (other than joint pain)?	2.95 (0.82–10.58)
14. Do you have stiffness in the body?	1.33 (0.43–4.09)
15. Do you feel burning sensation around the pit of the stomach?	-[b]
16. Do you have rashes on face and/or around mouth?	0.95 (0.28–3.23)
17. Do you feel gloomy?	0.76 (0.25–2.33)

Odds ratios for improvement caused by tongue cleaning (comparison between the IIG and the DIG in term 1).
IIG, immediate intervention group; DIG, delayed intervention group; OR, odds ratio; CI, confidence interval.
[a] Question no. 1 and 2: positive answers indicate improvement; question no. 3–17: negative answers indicate improvement.
[b] Calculation was not possible, as 46 observations were deleted from the analysis.

No serious adverse event was reported. However, one participant was diagnosed with urticaria during the intervention period and dropped out from the study.

4. Discussion

We used a randomized cross-over control design to prospectively evaluate the effects of tongue cleaning, a personal hygiene method suggested in Ayurveda, on Ayurvedic digestive power and OHRQoL in healthy adults. To our knowledge, this is the first study to evaluate the effects of tongue cleaning on digestive power from an Ayurvedic point of view and on OHRQoL. Although there have been descriptions about the effect of tongue cleaning on digestive power in books and on internet websites, there was no scientific evidence. The present study demonstrated the effects of tongue cleaning on digestive power from an Ayurvedic point of view and on OHRQoL, although exploratively and partially.

Tongue cleaning improved most components of the questionnaire on Ayurvedic digestive power. Specifically, significant improvement was observed in constipation, watery/loose motions, malodor of stools, and lassitude or fatigue in the limbs and/or whole body. According to Ayurveda, when the digestive power is strong enough, consumed food materials get digested properly and separated into nutrients and waste products.[23] In contrast, when digestive power is weak, consumed food materials are not digested well and remain as undigested or partially digested materials in the body known as Ama.[24] The conditions that were asked about in the questionnaire are the indices used to indicate the presence of Ama.[25] After tongue cleaning for 4 weeks, most of these conditions were improved. Therefore, we can interpret from an Ayurvedic point of view that tongue cleaning resulted in an increase in digestive power and a reduction in Ama. This interpretation is consistent with Ayurvedic information sources.[9–12] In analysis of each question, we excluded those who gave the most favorable answers at baseline as well as at follow-up. If some of these participants had experienced further improvement after tongue cleaning, but could not indicate this in the questionnaire due to its answering structure, this could not have been reflected in the analysis and would have led to possible underestimation of effect.

Tongue cleaning resulted in a significantly improved GOHAI score, indicating better OHRQoL. As we could not find previous studies that evaluated the effect of tongue cleaning on the GOHAI score nor on OHRQoL, we could not compare our results with other studies. The GOHAI was originally developed for use in elderly or diseased people, and was then found useful for younger people as well.[20] Although we set the inclusion criteria for participation as experiencing lassitude, tiredness, daytime sleepiness, and/or anorexia in the past month, the participants were healthy and relatively young, and had a low possibility of having oral problems. In fact, the baseline GOHAI score of both groups was about 55 points out of 60. The average GOHAI score of people in their seventies (both male and female) is reportedly around 50 points, and the score decreases with age.[19] In the present study, as the average baseline GOHAI score was already high at around 55 points, the effect of tongue cleaning might be underestimated.

We conducted the sensitivity analysis because there was no washout period between the two terms. The overall trend of the effect on Ayurvedic digestive power was similar in both analyses. However, we observed a difference in the estimated values specifically in fecal conditions, which might suggest a carry-over effect. The result regarding the GOHAI score was similar in both analyses.

The retention rate of participants was quite high (98.3%). All participants remained until the end of the study period, except for one who dropped out due to urticaria. The average number of days that tongue cleaning was performed was 26.75 ± 1.73 out of 28, and half of all participants performed tongue cleaning on all 28 days. The post-study questionnaire revealed that tongue cleaning was not at all bothersome for most participants, and they stated that they would like to continue it. This suggests the feasibility and comfortableness of tongue cleaning, and indicates that it would be acceptable among Japanese people. The cross-over control design adopted in the present study might also have contributed to maintaining the high motivation of participants in the DIG during the study, which would reflect the high retention rate.

There are some limitations in our study. First, as this was an exploratory study, we did not pre-calculate the sample size due to unavailability of information of effect size, and the actual number of participants was relatively small. This might have caused broad CIs and made the effect estimates unstable. Second, again as this was an exploratory study, the duration of the tongue cleaning intervention might have been too short to generate beneficial changes. In real practice, tongue cleaning is intended to be conducted as a daily routine, and it may need to be conducted for longer periods to obtain more clear improvements. Third, the participants were healthy, although they had experienced lassitude, tiredness, daytime sleepiness, and/or anorexia in the past month, and the inclusion criteria were not very restrictive. Hence, the changes in digestive power and OHRQoL might have been lessened compared with diseased subjects. Fourth, the questionnaire on Ayurvedic digestive power was prepared for this study by us. This questionnaire has not yet been evaluated for validity; however, we estimated the OR in each question and made individual interpretation possible. Finally, the participants were not blinded to the treatment assignment, as blinding was difficult due to the nature of the intervention (i.e., nonpharmacological treatment). Therefore, there was a possibility of performance bias, which might influence the effect estimates.[26]

5. Conclusions

This study demonstrated that tongue cleaning may be a safe and easy personal hygiene method that can potentially improve digestive power and OHRQoL.

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Author disclosure statement

No competing financial interests exist.

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