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Relationship Between Weight Loss and Changes in Oral Function Test Results over 1 Year

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Abstract

Weight loss is an indicator of nutritional disorders, is associated with increased morbidity and mortality, and is more likely to be experienced by individuals with fewer teeth. In this study, we examined the relationship between 1-year body weight changes and variations in various oral function tests. In total, we examined 104 individuals aged 45–84 years (70 men and 34 women) who underwent health check-ups at our hospital in 2023 and 2024. Several oral function tests were performed, and changes over a 1-year period were compared using the Wilcoxon signed-rank test. The rate of change in oral function was compared between individuals who lost ≥5% of their body weight in 1 year and those who did not; no significant differences in body weight and oral function were observed between 2023 and 2024, and no significant differences in the rates of change in oral function or weight loss were observed based on sex and age. The rates of change in occlusal force and masticatory function were significantly correlated with weight loss rates, while no differences were observed in terms of sex or age between those who lost ≥5% of their body weight in 1 year and those who did not; the only significant difference was in occlusal force: weight loss was correlated with occlusal force over 1 year, with individuals who lost ≥5% of their body weight exhibiting significantly lower occlusal force, a risk factor for nutritional disorders.

Keywords: oral function; oral frailty; occlusal force; weight loss

1. Introduction

There have been several studies focused on weight loss in older populations due to its strong association with increased morbidity and mortality [1,2]. Weight loss is common among the older population, affecting approximately 15–20% of individuals aged ≥65 years [3]. Despite some observational studies defining clinically important weight loss as a reduction in body weight of 5% or more over 6–12 months, a universally accepted definition is lacking [4–6]. Freid et al. defined unintentional weight loss of 5% or more in the previous year as "shrinking," which is included in the Freid index of frailty [7] has been used as a criterion worldwide.

Another factor associated with weight loss is poor oral health, as suggested in recent cross-sectional and cohort studies. Nakamura et al. [8] reported that having fewer than 20 teeth and infrequent food intake were associated with weight loss and obesity; they defined weight loss among the older population (>65) as a loss of ≥2–3 kg over the previous 6 months using cross-sectional data obtained from the JAGES project in Japan. Ritchie

Academic Editor: Sara Baldassano

Received: 12 November 2025
Revised: 6 January 2026
Accepted: 15 January 2026
Published: 17 January 2026

et al. [9] analyzed cross-sectional data from the New England Elders Dental Study, revealing that edentulousness (absence of natural teeth) was a risk factor for ≥4% unintentional weight loss over 1 year among community-dwelling older adults aged ≥70 years. Weyant et al. analyzed data from the Health ABC study, a longitudinal cohort study among a community-dwelling population aged ≥65 years in Pennsylvania, and found that weight loss of ≥5% over 2 years was associated with compromised oral health status, including less natural teeth and increased gingival inflammation [10]. Kusama et al. reported that having fewer remaining teeth was associated with an increased risk of weight loss among older Japanese adults [11].

Recently, the concept of oral hypofunction has been introduced in Japan, with a decrease in remaining teeth considered to be one of its symptoms [12]. However, the relationship between oral function tests, other than the number of remaining teeth, and weight loss remains largely unexplored; therefore, it is unclear whether oral hypofunction truly leads to nutritional disorders.

In this study, we examined the relationship between the 1-year rate of change in body weight and the rate of change in various oral function tests.

2. Materials and Methods

This study was conducted with Fujita Health University Ethics Review Committee approval (Approval No. HM24-033). We examined a total of 104 individuals aged 45–84 years (70 men and 34 women) who underwent health check-ups in 2023 and 2024.

All patient information was extracted from this center's medical records, and several tests related to oral hypofunction were conducted in accordance with the Japanese Society of Gerodontology's position paper [8]: oral hypofunction was diagnosed when three or more items fell below the standard values in the tests detailed below.

2.1. Tongue Coating Index (TCI)

The tongue surface was divided into nine areas and the tongue coating degree in each was evaluated using a three-point scale (0, tongue coating not visible; 1, thin tongue coating with visible papillae; and 2, thick tongue coating with no visible papillae). The TCI was calculated as the total score percentage out of 100 points for the nine areas on the three-point scale [13].

2.2. Oral Dryness (ODN)

With the tongue protruding, oral dryness was measured by pressing the Oral Moisture Meter Mucus (manufactured by Life Co., Ltd., Saitama, Japan) 10 mm behind the tip of the dorsal surface of the tongue for 2 s at a constant pressure of 200 g or more [14].

2.3. Occlusal Force (OF)

The OF of the entire dentition was measured for 3 s during clenching in the intercuspal position using a pressure-indicating film (Dental Prescale II; GC Corp., Tokyo, Japan) [15]. The measurement was taken while the participants wore their dentures.

2.4. Remaining Tooth Number (RTN)

The number of functional teeth (natural teeth and fixed prostheses) present was counted, while the remaining roots, wisdom teeth, and artificial teeth from denture prostheses were excluded [16].

2.5. Oral Diadochokinesis (OD)

Comprehensive measurements of the motor speed and dexterity of the tongue and lips were taken to determine the OD. The participant was instructed to repeat each syllable

(/pa/,/ta/, and/ka/) for 5 s, and the number of respective syllables produced per second was determined using an automatic counter (Kenkokun Handy, Takei Scientific Instruments Co., Ltd., Niigata, Japan), as described previously [17].

2.6. Maximum Tongue Pressure (MTP)

The maximum tongue pressure was measured using the JMS tongue pressure measuring instrument (TPM-01, JMS Co., Ltd., Hiroshima, Japan), which recorded the pressure exerted when the participant compressed a balloon attached to the tongue pressure probe against the anterior palate for a few seconds using their maximum voluntary tongue force [18]. The participant was instructed to practice the procedure in advance. Measurements were taken several times, allowing the participant to rest during every interval, and the mean value was used for assessment.

2.7. Masticatory Function (MFN)

The glucose concentration obtained from chewing gummy jelly was measured to assess the masticatory function. The participant was asked to chew 2 g of gummy jelly, and the amount of eluted glucose was measured using a masticatory ability testing system (Gluco Sensor GS-II, GC Corporation, Tokyo, Japan) [19].

2.8. EAT-10

Deterioration of swallowing function was assessed using a self-administered questionnaire (10-item Eating Assessment Tool [EAT-10]), where a score of 3 or higher indicates whether there is a deterioration in swallowing function or not [20].

2.9. Statistical Analysis

The body weight and oral function test results over a 1-year period were compared using the Wilcoxon signed-rank test. The 1-year rate of change was calculated as $\Delta = (2024 - 2023)/2023 \times 100$, and the relationship between weight loss and changes in oral function tests over 1 year was analyzed using Spearman's test. Then, the rate of change in oral function was compared between those who had lost 5% or more of their body weight in 1 year and those who had not, using the Mann–Whitney U test. Nonparametric statistical methods were used; however, the data are presented as mean $\pm$ standard deviation for convenience. The threshold for statistical significance was set at 0.05, and all statistical analyses were conducted using SPSS version 25 (IBM, Tokyo, Japan).

3. Results

No significant differences in body weight and oral function test results were observed between 2023 and 2024 (Table 1). Five (4.8%) and three (2.9%) patients were diagnosed with oral hypofunction in 2023 and 2024, respectively, and one was diagnosed with the condition during both years. There was no significant difference in weight change rate between individuals with and without oral hypofunction.

TCI and swallowing function were excluded from the results because their rates of decrease could not be calculated due to the high number of patients scoring 0 in the 2023 examination results. The rate of change in oral function test results that significantly correlated with the weight loss rate was observed in OF and masticatory ability (Table 2).

Eight patients experienced more than 5% weight loss, three of whom were undergoing treatment for diabetes; however, none had an acute illness that caused rapid weight loss during this period. No differences in sex or age were observed between patients with $\geq$5% and <5% weight loss, and the only significant difference was observed in OF (Table 3).

Table 1. Comparisons of the patient characteristics between 2023 and 2024.

	2023		2024		Change Rate (%)		*p*-Value
					Δ = (2024 − 2023)/2023 × 100		2023 vs. 2024
	Mean	SD	Mean	SD	Mean	SD	
Body weight (kg)	65.7	12.4	65.7	11.9	0.2	3.4	0.525
BMI (kg/m^2)	24.0	3.3	24.0	3.1	0.1	3.6	0.887
TCI (%)	1.0	4.7	2.7	7.1	–	–	0.066
ODN (unit)	27.9	1.2	28.2	1.6	1.2	6.7	0.090
OF (N)	1023.0	512.4	1045.8	573.2	9.6	49.6	0.952
RTN (teeth)	25.4	5.5	25.3	5.6	−0.3	5.0	0.137
OD/pa/(/s)	6.7	0.6	6.7	0.7	0.4	7.9	0.514
OD/ta/(/s)	6.7	0.8	6.7	0.8	0.6	7.1	0.722
OD/ka/(/s)	6.1	0.9	6.2	0.8	1.5	12.7	0.900
MTP (kPa)	37.5	8.3	37.2	8.3	−0.2	11.9	0.742
MFN (g/mL)	232.2	69.6	234.2	68.8	6.5	38.6	0.647
EAT-10 (point)	0.3	1.1	0.3	1.5	–	–	0.750

–: The calculation could not be performed due to an excessive number of zeros in the denominator (data for 2023). SD, standard deviation; BMI, body mass index; TCI, tongue coating index; ODN, oral dryness; OF, occlusal force; RTN, remaining teeth number; OD, oral diadochokinesis; MTP, maximum tongue pressure; MFN, masticatory function; and EAT-10, the 10-item Eating Assessment Tool.

Table 2. Correlation between the weight loss rate and the rate of change in oral function.

	ΔBody Weight (%)	
Spearman's ρ	Correlation Coefficient	*p*-Value
ΔODN (%)	−0.092	0.354
ΔOF (%)	0.239 *	0.015 *
ΔOD/pa/(%)	−0.049	0.625
ΔOD/ta/(%)	0.02	0.842
ΔOD/ka/(%)	−0.068	0.49
ΔMTP (%)	0.116	0.242
ΔMFN (%)	0.200 *	0.043 *

* $p < 0.05$. ODN, oral dryness; OF, occlusal force; OD, oral diadochokinesis; MTP, maximum tongue pressure; and MFN, masticatory function.

Table 3. Comparison between patients with ≥5% and <5% weight loss.

	Body Weight Change				*p*-Value
	≥5%		<5%		χ^2 Test
	M = 5, F = 3		M = 65, F = 31		0.714
	Mean	SD	Mean	SD	Mann–Whitney U Test
Age (y)	64.6	10.3	66.0	10.8	0.674
ΔODN (%)	−0.4	6.1	1.4	6.7	0.468
ΔOF (%)	−17.7	11.9	11.9	50.9	0.017 *
ΔOD/pa/(%)	4.0	7.0	0.1	8.0	0.167
ΔOD/ta/(%)	−0.3	7.0	0.7	7.1	0.976
ΔOD/ka/(%)	−0.1	10.1	1.6	13.0	0.801
ΔMTP (%)	0.1	15.4	−0.2	11.7	0.981
ΔMFN (%)	−7.9	15.9	7.7	39.7	0.200

* $p < 0.05$. SD, standard deviation; ODN, oral dryness; OF, occlusal force; OD, oral diadochokinesis; MTP, maximum tongue pressure; and MFN, masticatory function.

4. Discussion

In this study, a correlation was found between weight loss over 1 year and OF, revealing significantly lower OF in those who had lost ≥5% body weight within a year, which is considered a risk for nutritional disorders. The number of teeth remaining did not change during this period; hence, the decrease in OF may be attributed to reduced muscle strength from weight loss.

The participants in this study had strong health awareness and paid a high fee to receive yearly health check-ups, similar to Kanie et al. [21]'s study participants. Some patients in the current study were being treated for chronic diseases, such as hypertension and diabetes; however, all of these conditions were well-controlled through treatment. Consequently, none of the participants were excessively obese, and none appeared to be on a diet. Under these conditions, the participants' weight loss may have been due to aging. However, skeletal muscle mass measurements were not taken; hence, a sarcopenia diagnosis was not established. Therefore, it is unknown whether this weight loss indicates the onset of sarcopenia [22]. Low nutrition and a lack of exercise also contribute to sarcopenia, highlighting its connection to oral function.

The current study's results showed a significant relationship between OF and weight loss, rather than the number of remaining teeth, as was found in previous studies [8–11]. Remaining teeth cannot be restored once lost; however, occlusion can be restored through prosthetic treatments, such as dentures. Differences in food intake and nutritional status have been reported between denture wearers and nonwearers [23,24]. All participants in the present study had undergone prosthetic treatment; therefore, it is likely that the oral functions that had declined due to tooth loss had improved, while the decrease in bite strength was due to muscle weakness.

Less than 5% of the subjects presented with oral dysfunction, as defined by the Japanese Society of Gerodontology. In Hatanaka et al. [25]'s study, oral hypofunction was observed in approximately half of the patients who visited the dental outpatient clinic at a university hospital. Likewise, in our previous study, oral hypofunction was observed in more than half of the older people living in the community [26]. However, the findings of the current study differ significantly from those of the abovementioned studies.

Regular dental visits are essential for maintaining oral health, and socioeconomic factors such as education and income may be confounding factors in maintaining oral function. In this study, we targeted individuals with high social status, such as those who pay relatively high fees for annual health examinations, in order to minimize the influence of socioeconomic confounding factors. Our results indicate that a decline in OF can be a risk factor for weight loss, even among patients with high levels of health awareness. This study's results may be difficult to generalize, as it was conducted on a specific population within a single institution. It also cannot demonstrate the causal relationship between occlusal force and weight loss; the decrease in bite force is thought to be due to muscle weakness, and this is thought to be due to nutritional impairment caused by reduced oral function. Future studies with larger, community-based samples are likely to clarify this relationship further.

5. Conclusions

This study's findings indicate a correlation between ≥5% weight loss over 1 year and OF, an indicator of oral hypofunction. We believe that implementing oral function tests during health check-ups could enhance health promotion.

Author Contributions: Study conception and design, M.Y. (Mitsuyoshi Yoshida) and M.Y. (Miyuki Yokoi); data acquisition, R.I., M.Y. (Miyuki Yokoi) and M.O.; data analysis and interpretation, M.Y.

(Mitsuyoshi Yoshida) and M.O.; drafting of the manuscript, R.I. and M.Y. (Miyuki Yokoi); critical review of the manuscript, H.S. and M.Y. (Mitsuyoshi Yoshida). All authors have read and agreed to the published version of the manuscript.

Funding: This study was supported by the Foundation Nakao for Worldwide Oral Health.

Institutional Review Board Statement: This study was conducted in accordance with the Declaration of Helsinki and approved by the Fujita Health University Ethics Review Committee (Approval No. HM24-033), 1 May 2024.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data supporting the findings of this study can be obtained from the corresponding author upon reasonable request.

Acknowledgments: We would like to express our deepest gratitude to all our colleague dental hygienist colleagues.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

BMI	Body mass index
EAT-10	10-item Eating Assessment Tool
MFN	Masticatory function
MTP	Maximum tongue pressure
OD	Oral diadochokinesis
ODN	Oral dryness
OF	Occlusal force
RTN	Remaining teeth number
SD	Standard deviation
TCI	Tongue coating index

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