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SENPE

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ABSTRACT

Introduction: chronic kidney disease (CKD) is a major risk factor for end-stage renal disease, and owing to its increasing global prevalence, poses a serious public health challenge. Patients with CKD frequently experience protein-energy wasting, frailty, sarcopenia, and cachexia, necessitating complex dietary restrictions, including protein, salt, and potassium limitation. Although a nutrition support team (NST) can improve nutritional status in hospitalised patients, additional interventions such as swallowing evaluation, oral care, and medication adjustments are crucial for effective outcomes. CKD is also strongly correlated with periodontal disease and diabetes: tooth loss and oral frailty exacerbate low nutritional intake, especially in older individuals.

Objectives: to examine whether NST intervention combined with dental care would enhance nutritional and oral parameters in hospitalised patients referred for dental treatment.

Methods: twenty-seven patients were assigned to either an NST-intervention (*n* = 10) or non-NST (*n* = 17) groups. We assessed serum albumin, C-reactive protein (CRP), body mass index (BMI), Subjective Global Assessment scores, remaining teeth, periodontal pocket depth, and bleeding on probing.

Results: over a 1-month period, both groups showed significant decline in body weight and BMI, whereas albumin, CRP, and periodontal indices did not substantially change. The NST group demonstrated a higher proportion (50 %) of improved carbohydrate intake than the non-NST group (11 %), but this difference was not statistically significant. Reduced appetite was correlated with meal reduction, decreased body weight and meal reduction, and swallowing difficulties.

Conclusions: short-term periodontal or NST interventions are insufficient for achieving significant improvements in CKD-associated malnutrition or periodontal status; therefore, more specialised interventions are needed.

Keywords: Chronic kidney disease. Malnutrition. Nutritional status.

RESUMEN

Introducción: la enfermedad renal crónica (ERC) es un factor de riesgo importante para la enfermedad renal en etapa terminal y, debido a su creciente prevalencia mundial, representa un serio desafío de salud pública. Los pacientes con ERC suelen experimentar desgaste energético-proteico, fragilidad, sarcopenia y caquexia, lo que implica restricciones dietéticas complejas que abarcan proteína, sal y potasio. Aunque un equipo de soporte nutricional (ESN) puede mejorar el estado nutricional de los pacientes hospitalizados, intervenciones adicionales como la evaluación de la deglución, el cuidado bucal y el ajuste de la medicación son cruciales para lograr resultados efectivos. La ERC también se correlaciona fuertemente con la enfermedad periodontal y la diabetes: la pérdida de dientes y la fragilidad bucal empeoran la escasa ingesta nutricional, especialmente en personas mayores.

Objetivos: examinar si la intervención del ESN, combinada con el cuidado dental, mejoraría los parámetros nutricionales y orales en pacientes hospitalizados remitidos para tratamiento dental.

Métodos: se asignó a 27 pacientes a dos grupos: intervención con ESN (n = 10) o sin ESN (n = 17). Se evaluaron la albúmina sérica, la proteína C reactiva (PCR), el índice de masa corporal (IMC), la

puntuación de la Evaluación Global Subjetiva, los dientes remanentes, la profundidad de bolsa periodontal y el sangrado al sondeo.
Resultados: durante un período de un mes, ambos grupos mostraron disminuciones significativas en el peso corporal y el IMC, mientras que la albúmina, la PCR y los índices periodontales no cambiaron sustancialmente. El grupo con ESN presentó una mayor proporción (50 %) de aumento en la ingesta de carbohidratos en comparación con el grupo sin ESN (11 %), aunque la diferencia no fue estadísticamente significativa. Se observó que la reducción del apetito se correlacionaba con la disminución de la ingesta en las comidas, la pérdida de peso y las dificultades de deglución.
Conclusiones: las intervenciones a corto plazo de tipo periodontal o de ESN no son suficientes para lograr mejoras significativas en la malnutrición asociada a la ERC ni en el estado periodontal; por lo tanto, son necesarias intervenciones más especializadas.

Palabras clave: Enfermedad renal crónica. Malnutrición. Estado nutricional.

INTRODUCTION

Chronic kidney disease (CKD) is a major risk factor for end-stage renal failure; its prevalence is increasing globally owing to population aging (1). CKD leads to serious health issues such as renal failure, cardiovascular disease, and premature death if it progresses (2,3).

CKD is evaluated based on the presence of chronic proteinuria or estimated glomerular filtration rate (eGFR) (2). eGFR indicates the kidney's ability to excrete waste products into the urine, with lower values indicating poorer kidney function. CKD is classified into five stages based on severity (3).

Patients with CKD face numerous nutritional challenges, including protein-energy wasting (PEW), sarcopenia, and cachexia, associated with worse clinical outcomes and increased mortality (4). Owing to decreased renal function, metabolic waste products and excess electrolytes accumulate, compromising health (1). Therefore, nutritional management is critical for patients with CKD. High-protein diets exacerbate renal dysfunction; thus, protein restriction or low-protein diets are recommended for patients with CKD (1). Moreover, excessive sodium intake has been associated with CKD progression and mortality; hence, salt restriction is advised (1). Appropriate potassium levels are crucial, as hypokalaemia is linked to muscle weakness, hypertension, and arrhythmias (1). Consequently, patients with CKD have multiple dietary restrictions that necessitate appropriate nutritional management.

Recent guidelines recommend individualised dietary potassium adjustments. For patients with stage G3 or G4 CKD, maintaining calcium balance through adequate dietary calcium intake is recommended (1). Given the numerous dietary considerations of patients with CKD, effective nutritional management is challenging.

The concept of a nutrition support team (NST) began with total parenteral nutrition promoted by Dudrick et al. in 1968 (5). NST interventions have been reported to improve the nutritional status of hospitalised patients, particularly those with decreased renal function (6,7). Appropriate NST interventions are crucial for addressing malnutrition (8) and improving electrolyte abnormalities (9,10).

CKD is associated with several diseases such as diabetes (3) and periodontal disease (11,12). CKD and periodontal disease share common factors related to the prevalence and severity of both conditions, with a higher prevalence of periodontitis observed among patients with CKD (13). Moreover, patients with periodontitis are 60 % more likely to develop CKD than those without periodontitis (14). Most patients with decreased renal function are elderly patients with few remaining teeth, resulting in oral frailty (decline in oral function), which increases the risk of malnutrition. Therefore, the evaluation of oral function may be effective in improving malnutrition (15). The oral function and nutritional status of patients with decreased renal function must be properly managed to address renal dysfunction (16,17).

Despite growing recognition that both nutritional support and oral health maintenance are key to preventing malnutrition in CKD, few studies have thoroughly evaluated how combining NST interventions with dental treatment could enhance outcomes in this population. Although NST strategies have been broadly examined, evidence specifically addressing how oral care—ranging from periodontal management to functional dental interventions—might synergise with NST to optimise patients' nutritional and systemic status is sparse.

Moreover, the direct implications of oral frailty for CKD progression and malnutrition underscore the need to elucidate whether concurrent dental approaches can mitigate the diet-related limitations unique to CKD. Therefore, this study aimed to determine the impact of NST interventions and dental treatment on the nutritional and systemic status of patients with CKD and comprehensively evaluate the usefulness and challenges of a comprehensive approach for patients with CKD, using multidimensional data.

MATERIAL AND METHODS

Ethical considerations

This study was approved by the Ethics Committee of Sendai Hospital, Regional Health Care Organisation (Approval No: 2023-18).

Patient selection and grouping

This retrospective observational study included patients who received dental treatment during hospitalisation at Sendai Hospital between January 2020 and December 2021. The patients were divided into two groups according to whether they received NST intervention during their hospital stay.

The NST group consisted of patients who were referred to and managed by the hospital's NST, which includes a multidisciplinary team of physicians, dietitians, nurses, pharmacists, and dental professionals. NST involvement was determined according to the attending physician's referral based on clinical indicators of malnutrition, electrolyte imbalance, or need for nutritional rehabilitation.

The non-NST group included patients who received routine medical and dental care but were not referred to the NST during their admission. This grouping allowed for comparison of outcomes between patients who did and did not receive coordinated nutritional support interventions.

Classification of target patients

This study encompassed patients diagnosed with chronic kidney disease (CKD) who were referred for dental treatment to the Department of Oral and Maxillofacial Surgery at the Sendai Hospital for Japan Community Health Care Organization (hereafter referred to as Sendai Hospital) from April 2019 to June 2024.

Patients for whom NST intervention was selected were determined on the basis of Subjective Global Assessment (SGA) on admission, which assesses patients' appetite, changes in food intake and weight, gastrointestinal symptoms, Activities of Daily Living (ADL), and BMI. SGA scores were classified as A (score 0-2, good nutritional status), B (score 3-4, possibly undernourished) and C (score ≥ 5, undernourished).

Patients who had no oral intake during the intervention period were excluded from the study; these patients were not considered eligible for the intervention (dental response and NST assessment) because they were started on parenteral nutrition (gastrostomy and tube feeding) owing to severe disorders of the tongue, pharynx, larynx, and oesophagus. Furthermore, patients who received only one NST intervention in 1 month were excluded: they could not be included in the non-NST intervention observation group because they were not considered to have had a fully effective NST.

Assessed variables

CKD stage, eGFR, age, sex, serum albumin level, CRP, body mass index (BMI), number of remaining teeth (excluding remaining roots), progression of periodontal pocket depth (probing pocket depth, PPD), and bleeding on probing (BOP) were used to assess periodontal disease. PPD and BOP measurements were performed by dental hygienists with at least 5 years of experience.

Professional oral hygiene care (scaling, removal of calculus and plaque) was conducted by dental hygienists. Oral hygiene instructions (daily brushing techniques, oral self-care methods) were provided to the patients. Basic periodontal management, including localised periodontal scaling and root planing, was conducted, if necessary. Assessment and management of oral function and dental status in collaboration with the NST, including necessary modifications to dietary textures according to dental condition. Eating patterns were investigated before and after the intervention in the NST-intervention and non-NST intervention observation groups.

NST-intervention observations

NST-intervention observations were conducted for a minimum of 1 month. Electronic medical record information and patient interviews were conducted, and clinical problems and dietary details were reviewed. As a result, an intervention policy was determined. Advice was provided to the attending physician if a drug prescription was required.

Statistical analysis

Fisher's exact probability test was used to assess the sex distribution. The Mann-Whitney U-test was used to compare the NST-intervention and non-NST intervention observation groups. Wilcoxon's signed rank test was performed for the pre- and post-intervention assessment of the groups. Owing to the small sample size of this study, Spearman's rank correlation coefficient was used to assess correlations between SGA measurement items. Correlation analysis was also performed to compare each item before and after intervention observation. Fisher's direct probability calculation method was used to compare the change in intake between the NST-intervention observation group and non-NST intervention observation group. The significance level was set at a p-value < 0.05. All statistical analyses were performed using IBM SPSS Statistics for Windows, version 27.0 (Armonk, NY: IBM Corp.).

RESULTS

The study included 27 participants (female, 15 [55.6 %]; male, 12 [44.4 %]), with 10 participants in the NST-intervention observation group and 17 in the non-NST intervention observation group.

Basic attributes and SGA scores of each group

The total SGA scores ranged from 0 to 9 for both groups, with a mean±standard deviation of 4.0 ± 2.1 and 3.5 ± 1.9 for the NST-intervention observation group and non-NST intervention observation group, respectively, with no significant difference between the two groups as assessed by the Mann-Whitney U-test (*p* = 0.68). A cross-tabulation table of ordinal scale items for each SGA item showed no significant differences (Tables I and II).

Association between SGA and weight change and BMI change

The associations of SGA scores with weight loss and BMI change were assessed using Spearman's rank correlation coefficients. The participants with no appetite tended to eat less (correlation coefficient 0.469, *p* = 0.014), those who lost weight tended to eat less (correlation coefficient 0.440, *p* = 0.022) and tended to choke when eating (correlation coefficient 0.596, *p* = 0.001), those requiring increased assistance with meal intake tended to eat less (correlation coefficient 0.382, *p* = 0.049), and those who requiring increased assistance with ADL tended to have a higher BMI (correlation coefficient -0.431, *p* = 0.025) (Table III).

Comparison before and after NST intervention

Comparison of parameters between the NST-intervention (*n* = 10) and non-NST intervention observation group (*n* = 17) showed no significant differences at baseline (before intervention) (Table IV). Furthermore, when examining the amount of change before and after the intervention, both groups showed a significant decrease in weight and BMI (Table V and VI). When comparing the changes between the two groups, the mean difference was greater in the non-NST intervention observation group, but the Mann-Whitney U-test showed no significant difference. No significant changes were observed in serum albumin and CRP levels.

Dental interventions and oral indicators

No significant changes were found in the number of remaining teeth and maximum PPD and BOP between the intervention and non-intervention groups in the pre/post comparisons (Tables IV, V, and VI) Although PPD and BOP are common indicators to assess periodontitis, short-term interventions of around 1 month did not result in significant improvements.

Change in intake

We examined changes in the intake of staple and side meals in the NST-intervention and non-NST intervention observation groups (Table VII). Intake of rice was evaluated because it is the main staple food in Japan, where this study was conducted. In Japan, rice intake is an important determinant of total caloric intake and has a significant impact on nutritional status, especially for hospitalised elderly patients. Fisher's exact probability test showed no significant difference in the improvement in rice intake between groups (p = 0.664), but a significant difference in the improvement in staple food intake was observed (p = 0.041).

DISCUSSION

In this study, SGA was used to assess the nutritional status of hospitalised patients to determine the presence or absence of NST intervention. The NST-intervention observation group was characterised by a higher mean age (75.5 ± 8.1 years) than the non-NST intervention observation group (71.9 ± 11.2). Early NST intervention was considered important because older people are more likely to have a reduced appetite, poor swallowing function, and underlying diseases, which can lead to nutritional disorders. Furthermore, a significant positive correlation was found between age and ‘swallowing’ when eating. In particular, the total scores of patient Nos. 3 and 25 in table II were particularly high at 9 points, indicating a high risk of undernutrition.

These results were consistent with a significant and positive correlation among reduced food intake, lack of appetite, and weight loss. When swallowing shows a significant positive correlation with weight loss, indicating reduced swallowing function, the surrounding muscles involved in swallowing, swallowing reflex capacity, and appetite in future research should be investigated.

The participants with a greater degree of assistance showed not only a significant and positive correlation with reduced food intake but also a positive association with BMI. The reasons for this observation are not clear, future studies should determine whether being overweight increases the burden of caregiving or whether some confounding factors are involved. Whether there was a difference in BMI reduction before and after NST between non-NST intervention observation groups was difficult to verify by statistical tests owing to the small number of participants.

In contrast, there were cases with high SGA scores (No. 7 = 6, No. 26 = 9) in the non-NST intervention observation group, but no intervention was conducted if the patients themselves were able to maintain some ADLs and were able to feed themselves or if general nutritional management by medical staff was judged to be sufficient for follow-up. The SGA is only a screening tool; in some cases, NST is required owing to severe illness or dysphagia even if the score is low, while in other cases intervention may be postponed even if the score is high, e.g., if ADLs are maintained.

Early intervention with NST is important for reducing the risk of complications such as pressure ulcers, infections, and extended hospital admissions in elderly patients and patients with multiple medical conditions who are undernourished. Multi-professional collaboration between doctors, nurses, dietitians, pharmacists, rehabilitation staff, and other professionals to provide comprehensive support, including the optimisation of oral, enteral, and intravenous nutrition, swallowing assessment and rehabilitation, could improve patient prognosis and reduce hospital stay. Patients should be monitored regularly for the presence of dysphagia (e.g., frequency of 'swallowing'), weight changes (decrease or increase in BMI), and oedema, and nutrition screening using tools other than SGA (e.g., Mini Nutritional Assessment; Malnutrition Universal Screening Tool), physical measurements and biochemical tests are recommended for early intervention.

Unlike a randomised controlled trial (RCT), this study was an observational approach contrasting 'intervention targets' and 'non-targets' as envisaged in the field. The balance between groups was checked by considering background factors such as sex, eGFR, number of remaining teeth, periodontal indices, and serum albumin levels, suggesting the absence of major confounding factors. Therefore, the observational comparisons in this study were considered to have a certain degree of reliability.

No significant differences in sex distribution were found between the NST-intervention and non-NST intervention observation groups (Table II), suggesting that the observed results can be attributed to the intervention rather than sex differences. As shown in table V, no significant differences were present in the baseline parameters such as number of days of dental intervention, number of remaining teeth, periodontal measurements (PPD and BOP), measurement data (weight, BMI), eGFR, and biochemical markers (serum albumin level and CRP) between the groups. These findings suggest that the differences in intervention effects were not caused by sex or initial condition differences.

In pre- and post-intervention comparisons, significant reductions in body weight and BMI were observed in the NST-intervention observation group (Table VI). Weight and BMI were also significantly lower in the non-NST intervention observation group (Table VII). These findings suggest that the nutritional status of both groups declined during the intervention period. Albumin levels did not significantly decrease before and after the intervention in both groups. Serum albumin level is an indicator of nutritional status (18), and steps were taken to prevent a decline.

The prevalence of malnutrition in patients with CKD and the importance of nutritional interventions have been highlighted in previous studies (1,11). PEW occurs commonly in patients with CKD and is associated with poor outcomes such as increased morbidity (19). Previous studies have suggested that NST interventions contribute to improved nutritional status and clinical outcomes in hospitalised patients. However, a reduction in weight and BMI was observed as a result. In the present study, the effects of both the NST and dental interventions were not as pronounced as originally planned, which was seen as a negative result in comparison with previous studies. Multiple factors may have contributed to this outcome. First, dietary restrictions for the management of CKD involve limitations in protein, sodium, potassium, and phosphorus intake. NSTs may have prioritised kidney disease-specific dietary restrictions, leading to an overall inadequate energy and protein intake. Second, in the NST-intervention observation group, the short intervention period of 1 month may not have been sufficient for achieving nutritional improvement or showing improvements after an initial adjustment of dietary restrictions worsened the nutritional status. Compared with previous studies, where the intervention periods were often longer than 3 months, the intervention duration, patient background (e.g., CKD severity and comorbidities), and interventions provided by the NST members (e.g., swallowing rehabilitation, type of oral supplements, frequency of collaboration with dentists) were different in this study. These differences in intervention duration and patient conditions may have led to differences in effect sizes.

Regarding the lack of significant improvement in PPD and BOP despite dental interventions, periodontal disease indicators such as periodontal pockets and bleeding are unlikely to show significant improvement without multiple professional care sessions and long-term plaque control. Significant differences may not have been evident owing to the short intervention period of 1 month in this study and the diversity of periodontitis severity at the time of intervention. In addition, although PPD/BOP is effective as a comprehensive indicator of periodontitis, it may not be suitable for capturing minute changes over a short period of time. The effectiveness of dental interventions shown in previous studies is often based on comprehensive programmes that include continuous plaque control instruction and regular tartar removal for 3 months or longer, different from the usual short-term observation during hospitalisation, as in the present study. Therefore, the validity of the periodontal assessment and endpoints should be re-examined.

Our results showed that NST interventions in patients with CKD may not lead to adequate improvement of nutritional status. Improving undernutrition is an important issue for patients with CKD, and a more careful and balanced intervention strategy was considered necessary, as malnutrition is linked to increased hospital admissions and mortality. In addition, the social context in which patients live should be considered, and a comprehensive approach including support for economic and family circumstances should be considered. In some cases, such as in areas with large economic disparities, it is difficult to obtain fresh food, and it is important to develop support programmes through regional cooperation as a countermeasure. Interventions that incorporate a Social Determinants of Health perspective could lead to more effective nutritional management for people with CKD. Furthermore, the weight loss observed in this study was multifactorial and the use of a comprehensive assessment tool such as MEALS ON WHEELS (20) may have been useful.

Although no significant changes were observed in oral status (PPD, BOP), improving oral health in patients with CKD remains an important issue. Periodontal disease may induce systemic inflammation and contribute to CKD progression, indicating the need for a comprehensive approach including oral care to improve systemic status. The NST intervention appears to have increased the intake of staple foods more than that of rice (Table VII). However, this increase did not lead to improvements in markers of nutritional status. One possible explanation is that the quantity of intake increased without a corresponding improvement in the quality of nutrients consumed—specifically in terms of protein, vitamins, and minerals essential for CKD patients. Additionally, factors such as persistent inflammation, impaired nutrient absorption, or catabolic states common in CKD may limit the effect of increased energy intake on overall nutritional status.

This study has several limitations. First, this study had a small sample size (n = 27). The comparison of distribution between the NST-intervention observation group and the non-NST intervention observation group for each value was performed using non-parametric testing methods. However, owing to the small sample size and low statistical power, some differences may have persisted between the two groups. Second, a minimum intervention period of 1 month may not be sufficient to observe significant improvements in nutritional status or oral function; although no significant differences in elevated CRP levels were found between the NST-intervention observation and non-NST intervention observation groups, potential inflammation affecting serum albumin levels was not considered in this study. Third, although the Global Leadership Initiative on Malnutrition (GLIM) criteria (21) are becoming the current gold standard in nutritional assessment for assessing low nutrition, we did not use these criteria in the present study. Serum albumin and CRP values were used to ensure consistent nutritional assessment, as full-scale assessment using the GLIM criteria in our hospital started in May 2024. Fourth, this was an observational study, which has limitations in clarifying causal relationships compared to RCTs. However, as an initial study reflecting actual clinical practice, it could encourage future studies to expand the sample size and utilise propensity score matching.

Of the 7,205 hospitals in Japan, 1,584 (22.0 %) employed dentists, of which 324 (20.5 %) included dentists in their NSTs. Even in hospitals that employ dentists, the cooperation between medicine and dentistry is inadequate. Furthermore, many hospitals that do not employ dentists do not provide NST support and comprehensive preoperative oral care to inpatients (22).

Many dentists working in hospitals may be dental surgeons, limiting the provision of general dental services. If dentists and dental surgeons are to be involved in NSTs in the future, they will need to improve their knowledge and skills related to the nutritional management of hospitalised patients.

CONCLUSIONS

This observational study combining NST intervention and dental interventions for patients with CKD did not demonstrate a marked improvement in nutritional status or periodontal changes as originally envisaged. These findings suggest that the strict dietary restrictions inherent in CKD impede nutritional improvement and that dental assessment measures (PPD, BOP) do not capture short-term changes due to dental interventions. However, some study findings, such as improved staple food intake, indicated some value of combining NST intervention and dental response, suggesting that longer-term interventions and selection of appropriate indicators are needed. Future large-scale studies, using adjustment by propensity score matching, with extended intervention periods and comprehensive approaches involving multidisciplinary collaboration, could promote the improvement of nutrition and oral function in patients with CKD.

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Table I. SGA questions

1. Do you have an appetite?
0: yes, 1: not much, 2: not at all, 3: fasting

2. Has there been any change in the amount of food you eat since 1 month before your admission?
0: unchanged, 1: increased, 2: decreased, 3: decreasing, 4: fasting

3. Have you been experiencing digestive symptoms such as nausea, diarrhoea or constipation?
0: no, 1: 1-2 weeks, 2: 2-3 weeks, 3: 3-4 weeks, 4: > 1 month

4. Do you choke when eating?
0: never, 2: sometimes, 3: always

5. Has your weight changed since 1 month before you were admitted to hospital?
0: no change, 1: increased, 2: decreased

6. Do you feel swelling?
0: no, 1: little, 2: very much

7. ADL (Activities of Daily Living)
0: independent, 1: partial assistance, 2: full assistance

8. Body mass index
0: Standard (18.5-24.9), 1: Obese (> 25), 2: Skinny (< 18.4)

Table II. SGA results of the 27 participants

Group	Sex	Age	Total SGA score	Do you have a good appetite?	Has there been any change in the amount of food you eat since 1 month before your admission?	Do you choke when eating?	Has there been any change in weight since 1 month before admission?	Do you feel swelling?	ADL	BMI
Non-NST intervention	F	62	5	Yes	Unchanged	Never	Decreased	Little	Partial assistance	Obese
	F	69	3	Not much	Unchanged	Never	No change	No	Independent	Skinny
	F	78	3	Not much	Unchanged	Never	No change	Little	Independent	Obese
	F	61	5	Not much	Decreased	Never	Decreased	No	Independent	Standard
	F	87	7	Yes	Unchanged	Sometim	Decreased	Little	Independent	Skinny

ob						es					
ser vat	F	88	0	Yes	Unchanged	Never	No change	No	Independent	Standa rd
ion	F	89	3	Yes	Unchanged	Never	No change	Little	Independent	Skinny
gro up	F	73	2	Yes	Unchanged	Never	Increased	Little	Independent	Standa rd
(*n*	F	74	0	Yes	Unchanged	Never	No change	No	Independent	Standa rd
= 17	F	73	9	Not much	Decreased	Sometim es	Decreased	Little	Partial assistance	Standa rd
)	M	55	0	Yes	Unchanged	Never	No change	No	Independent	Standa rd
	M	75	6	Not much	Decreased	Never	Decreased	Little	Independent	Standa rd
	M	56	1	Yes	Unchanged	Never	No change	No	Partial assistance	Standa rd
	M	71	2	Yes	Unchanged	Never	No change	No	Partial assistance	Obese
	M	84	0	Yes	Unchanged	Never	No change	No	Independent	Standa rd
	M	71	3	Yes	Unchanged	Never	Decreased	Little	Independent	Standa

										rd
	M	56	5	Not much	Decreased	Never	No change	No	Partial assistance	Obese
NST intervention observation group (*n* = 10)	F	74	1	Yes	Unchanged	Never	No change	No	Partial assistance	Standard
	F	72	2	Yes	Unchanged	Never	No change	No	Independent	Skinny
	F	89	1	Not much	Unchanged	Never	No change	No	Independent	Standard
	F	67	0	Yes	Unchanged	Never	No change	No	Independent	Standard
	F	72	1	Not much	Unchanged	Never	No change	No	Independent	Standard
	M	85	9	Not much	Increased	Sometimes	Decreased	Little	Independent	Skinny
	M	73	1	Yes	Unchanged	Never	No change	No	Independent	Obese
	M	68	5	Yes	Increased	Never	Increased	Little	Independent	Skinny
	M	86	9	Not much	Decreased	Always	Decreased	No	Partial assistance	Standard
	M	69	0	Yes	Unchanged	Never	No change	No	Independent	Standard

All 27 respondents answered ‘no’ to the SGA item ‘Do you have ongoing gastrointestinal symptoms such as nausea, diarrhoea or constipation’ (selected from none, 1-2 weeks, 2-3 weeks, 3-4 weeks and > 1 month). The Mann-Whitney U-test was used to examine the differences between the non-NST intervention observation group and NST intervention observation group for each SGA item score and total score, and none of the differences were significant. SGA: Subjective Global Assessment; ADL: activities of daily living; BMI: body mass index.

Table III. Single coefficients of correlations between SGA items (Spearman's rank correlation)

	Sex M, 1 F, 2	**Age**	**Appetite**	**Meal intake**	**Mealtime swallowing**	**Weight change**	**Swelling**	**ADL**	**BMI**
Non-NST intervention observation group: 0 NST intervention observation group: 1	-0.086	0.104	0.047	-0.315*	0.128	-0.168	-0.271	-0.104	0.196
Sex M, 1; F, 2		0.244	0.069	0.031	-0.062	-0.051	0.069	-0.151	0.168
Age			0.128	-0.074	0.378	0.135	0.237	-0.239	0.250
Appetite				0.469* (*p* = 0.014)	0.335	0.376	0.047	0.071	-0.045
Meal intake					0.163	0.440* (*p* = 0.022)	-0.154	0.382* (*p* = 0.049)	-0.356
Mealtime swallowing						0.596* (*p* = 0.001)	0.303	0.246	0.291

Weight change							0.301	0.210	-0.001
Swelling								-0.104	0.201
ADL									-0.431* (*p* = 0.025)

For questions 2, 5 and 8, the values were transformed as 0 → 1, which increased, and 1 → 0, which remained the same, in order to make it an ordinal scale. *indicates significant correlation. Significance probabilities are shown in brackets. SGA: Subjective Global Assessment; ADL: activities of daily living; BMI: body mass index.

Table IV. Results of the Mann-Whitney U test comparing mean dental intervention scores between the NST-intervention and non-NST intervention observation groups

Group statistics	**NST-intervention group (*n* = 10)**		**Non-NST intervention group (*n* = 17)**		**Mann-Whitney U-test**	***p*-value**
Group	**Mean**	**Std. Deviation**	**Mean**	**Std. Deviation**		
Dental intervention day	3.60	0.966	3.53	0.514	82.500	0.890
Residual teeth at the start of the intervention	16.60	7.397	17.29	9.026	75.500	0.633
Residual teeth at the end of the intervention	16.50	7.307	17.29	9.026	75.000	0.615
Maximal PPD at the start of the intervention	5.00	1.563	5.24	2.078	80.500	0.819
Maximum PPD at	5.00	1.944	4.65	1.498	78.500	0.737

the end of the intervention						
BOP at the start of the intervention	5.10	2.601	7.82	6.617	67.000	0.364
BOP at the end of the intervention	5.20	6.861	6.18	4.362	61.000	0.225
Weight at the start of the intervention (kg)	52.580	11.15495	56.4794	11.18237	59.000	0.192
Weight at the end of the intervention (kg)	51.680	11.34987	54.8735	10.57793	63.000	0.269
BMI at the start of the intervention	20.8185	3.62302	22.4224	3.87890	65.000	0.315
BMI at the end of the intervention	20.4602	3.72465	21.7996	3.78100	66.000	0.340
BMI difference at the end of the intervention	0.3733	0.38644	0.7191	0.63130	58.500	0.183

eGFR at the time of intervention	5.8960	1.6025	6.1800	2.61609	76.000	0.651
Intervention at end-of-life eGFR	6.0230	0.9791	5.6935	1.86363	63.000	0.269
Albumin at the start of the intervention	3.3370	0.7482	3.6094	1.0535	67.500	0.378
Albumin at the end of the intervention	2.9000	0.6377	3.1282	0.52612	71.000	0.481
CRP at the start of the intervention	0.3430	0.29549	2.6759	2.99231	47.000	0.056
CRP at the end of the intervention	0.7220	1.26467	1.7135	3.09571	69.500	0.436

BOP: bleeding on probing; PPD: probing pocket depth; BMI: body mass index; CRP: C-reactive protein; NST: nutritional support team.

Table V. Pre- and post-intervention effects on the NST-intervention observation group ($n = 10$)

	Mean	**SD**	***p*-value**
Residual teeth at the start of the intervention	16.60	7.4	0.32
Residual teeth at the end of the intervention	16.50	7.31	
Maximal PPD at the start of the intervention	5.00	1.56	1.00
Maximum PPD at the end of the intervention	5.00	1.94	
BOP at the start of the intervention	5.10	2.60	0.48
BOP at the end of the intervention	5.20	6.86	
Weight at the start of the intervention (kg)	52.58	11.15	0.02 $p < 0.05$
Weight at the end of the intervention (kg)	51.68	11.35	
BMI at the start of the intervention	20.82	3.62	0.02 $p < 0.05$
BMI at the end of the intervention	20.46	3.72	
eGFR at the time of intervention	5.90	1.60	0.32
Intervention at end-of-life eGFR	6.02	0.98	
Albumin at the start of the intervention	3.34	0.75	0.16
Albumin at the end of the intervention	2.90	0.64	
CRP at the start of the intervention	0.34	0.3	0.29
CRP at the end of the intervention	0.72	1.26	

Paired samples statistics. SD: standard deviation; BOP: bleeding on probing; PPD: probing pocket depth; BMI: body mass index; CRP: C-reactive protein; NST: nutritional support team.

Table VI: Pre- and post-intervention effects on the non-NST intervention observation group (control group, n = 17)

	Mean	**SD**	***p*-value**
Residual teeth at the start of the intervention	17.29	9.03	1.00
Residual teeth at the end of the intervention	17.29	9.03	
Maximal PPD at the start of the intervention	5.24	2.08	0.07
Maximum PPD at the end of the intervention	4.65	1.5	
BOP at the start of the intervention	7.82	2.60	0.12
BOP at the end of the intervention	6.18	6.62	
Weight at the start of the intervention (kg)	56.48	11.18	0.01 $p < 0.01$
Weight at the end of the intervention (kg)	54.87	10.58	
BMI at the start of the intervention	22.42	3.88	0.01 $p < 0.01$
BMI at the end of the intervention	21.8	3.78	
eGFR at the time of intervention	6.18	2.62	0.33
Intervention at end-of-life eGFR	5.7	1.86	
Albumin at the start of the intervention	3.61	1.05	0.20
Albumin at the end of the intervention	3.13	0.53	
CRP at the start of the intervention	2.68	3.0	0.29
CRP at the end of the intervention	1.71	3.1	

SD: standard deviation; BOP: bleeding on probing; PPD: probing pocket depth; BMI: body mass index; CRP: C-reactive protein; NST: nutritional support team.

Table VII: Percentage change in rice and staple food intake from start to end in the NST-intervention observation and non-NST intervention observation groups

		NST intervention observation group (*n* = 10)	**Non-NST intervention observation group (*n* = 17)**	***p*-value**
Rice	Intake improved	2 (20 %)	5 (29 %)	0.664
	Maintained intake	3 (30 %)	5 (29 %)	
	Decreased intake	5 (50 %)	7 (41 %)	
Staple food	Intake improved	5 (50 %)	2 (11 %)	0.041 $p < 0.05$
	Maintained intake	3 (30 %)	10 (58 %)	
	Decreased intake	2 (20 %)	5 (29 %)	