Japanese Journal of Comprehensive Rehabilitation Science (2025)

Original Article

Effect of the Presence of Registered Dietitians and Dental Hygienists on the Body Weight and Activities of Daily Living of Elderly Patients with Low BMI in a Kaifukuki (Convalescent) Rehabilitation Ward

Yasuyuki Okamoto, RD,[1,2,3] Shinta Nishioka, RD, PhD, MSc (Epi),[1,4]
Takatsugu Okamoto, MD, PhD[2,5] Ichiro Miyai, MD, PhD[2,6]

[1]Nutrition Committee, Kaifukuki Rehabilitation Ward Association, Japan
[2]Annual Survey Committee, Kaifukuki Rehabilitation Ward Association, Japan
[3]Department of Clinical Nutrition and Food Services, Aijinkai Rehabilitation Hospital, Takatsuki, Osaka, Japan
[4]Graduate School of Regional Design and Creation, Department of Nutrition Science, University of Nagasaki, Nishisonogi County, Nagasaki, Japan
[5]Department of Rehabilitation Medicine, Nishi-Hiroshima Rehabilitation Hospital, Hiroshima, Hiroshima, Japan
[6]Neurorehabilitation Research Institute, Morinomiya Hospital, Osaka, Osaka, Japan.

ABSTRACT
Okamoto Y, Nishioka S, Okamoto T, Miyai I. Effect of the Presence of Registered Dietitians and Dental Hygienists on the Body Weight and Activities of Daily Living of Elderly Patients with Low BMI in a Kaifukuki (Convalescent) Rehabilitation Ward. Jpn J Compr Rehabil Sci 2025; 16: 46−52.

Objective: This study aimed to examine the association between the presence of registered dietitians (RD) and dental hygienists (DH) and the changes in the activities of daily living and body weight in elderly patients with a low body mass index (BMI) who were admitted to a Kaifukuki (convalescent) rehabilitation ward (KRW) class 1.

Methods: Patients aged 70 years or older with a BMI of less than 20.0 kg/m^2, who were admitted to hospitals with a KRW class 1 as per the 2022 survey data from the Japanese Association of Rehabilitation in Post-acute Care, were included in the study. The patients were divided into two groups based on the presence of DH: the RD+DH+ group and the RD+DH− group. The Functional Independence Measure (FIM) gain, change in BMI, and percentage of patients with improved BMI (an increase of ≥0.7 kg/m^2) were compared using univariate and multivariate analyses.

Results: A total of 3,329 patients (61.8% female, mean age of 83.3 years) were analyzed. The RD+DH+ group consisted of 431 patients, and the RD+DH− group consisted of 2,834 patients. No significant difference in FIM gain was found between the two groups. However, the RD+DH+ group showed significantly greater change in BMI and a higher percentage of patients with improved BMI than the RD+DH− group. Furthermore, the change in BMI and the percentage of BMI improvement were associated with the presence of RD and DH.

Conclusion: The findings of this study suggest that the presence of RD and DH in a KRW may improve the BMI of elderly patients.

Key words: Kaifukuki (convalescent) rehabilitation ward, Registered dietitian, Dental hygienist, Low BMI, Weight gain

Correspondence: Yasuyuki Okamoto, RD
Department of Clinical Nutrition and Food Services, Aijinkai Rehabilitation Hospital, 5−7, Hakubaicho, Takatsuki, Osaka 569−1116, Japan.
E-mail: okamoto.yasuyuki@aijinkai-group.com
Accepted: September 15, 2025.
Declaration of Competing Interest: The authors declare no conflicts of interest related to this study.

This work is licensed under a Creative Commons Attribution-NonCommercial NoDerivatives International License.
©2025 Kaifukuki Rehabilitation Ward Association

Introduction

A Kaifukuki (convalescent) rehabilitation ward (KRW) is a specialized unit that provides intensive rehabilitation to stable patients who have completed acute care, with the aims of improving their activities of daily living (ADL), preventing bedriddenness, and facilitating their return to home or society. In Japan, rehabilitation ward fees are set on the basis of the quality and structure of the facility. Among these, KRW class 1 (class 1) imposes the strictest standards, mandating the presence of full-time dedicated physicians; rehabilitation professionals such as physical, occupational, and speech therapists; nurses; nursing assistants; medical social workers; and registered dietitians (RD). These multiprofessional teams must implement individualized rehabilitation plans, providing care for a maximum of 3 h per day, 365 days a year. In addition, the ward must accept a certain proportion of severely ill patients, and functional improvement must be confirmed by the time of discharge. Thus, providing high-quality rehabilitation aimed at social reintegration rather than long-term care purposes is necessary.

In Japan's super-aging society, elderly patients are the primary target of KRWs, and their functional recovery greatly contributes to the extension of a healthy lifespan for the entire population. However, malnutrition occurs in approximately 12.6−66.9% of patients admitted to rehabilitation wards [1, 2]. In particular, the risk of malnutrition is high in older adults because of age-related decline in eating function, loss of appetite, and comorbidities. Malnutrition in the elderly not only leads to poor functional outcomes, including dysphagia and in-hospital mortality [3−5], but also results in an increased risk of falls, high readmission rates, and a decline in quality of life [6−8]. Therefore, there is a high need for rapid nutritional assessment [9] and management in KRWs. In 2020, the Japanese medical fees for rehabilitation wards were revised. This revision mandated the full-time placement of a dedicated RD and the establishment of a system for nutritional care in class 1 wards and encouraged efforts in class 2−5 wards.

On the contrary, poor oral health is observed in 73−85% of patients in KRWs [10−12]. In older adults, a decline in oral function caused by periodontal disease, ill-fitting dentures, dry mouth, and taste changes can lead to impaired chewing and swallowing functions, reduced food intake, and malnutrition [13]. Poor oral health is frequently observed in patients with stroke [14] and is associated with sarcopenia and reduced muscle mass and strength [15]. Furthermore, oral health problems in patients admitted to KRWs are associated with ADL at discharge, home discharge rate, in-hospital mortality, and length of stay [11, 12, 16]. Improving oral hygiene and functional impairment in patients with stroke in KRWs is associated with functional independence measure (FIM) gain [17]. Based on these findings, the 2024 Japanese medical fee revision established new fees, such as the fee for developing an oral function management plan during rehabilitation, to encourage outpatient dental care or the establishment of on-site dental clinics.

The roles of RDs in KRWs include nutritional screening, assessment, care plan development and recommendation, monitoring and reassessment, nutritional guidance, participation in rehabilitation conferences, and the creation of discharge nutrition care plans and summaries [18]. As the length of stay in KRWs is longer than that in acute care settings, the nutritional assessment, care plans, and nutritional monitoring by an RD can prevent weight loss and may increase the body mass index (BMI) in underweight patients [19]. The presence of an RD in a KRW is also associated with a lower incidence of weight loss in adult patients [20] and weight and BMI gain at discharge in underweight patients, especially those with stroke [18]. Furthermore, improvements in nutritional status are associated with ADL recovery after hip fracture and cerebrovascular disorders [21−23], whereas weight gain in underweight patients affects ADL at discharge [24].

On the contrary, the roles of dental hygienists (DH) include assisting with dental treatment, screening and assessing oral function and hygiene, creating oral care programs to improve oral function, and providing guidance on oral care products such as toothbrushes to patients and their families [17]. A report has shown that improvements in oral hygiene and function are associated with FIM gain, and patients with good oral hygiene and function had higher Food Intake Level Scale scores at discharge [17], which indicates that DH intervention may improve ADL and swallowing ability. Older individuals are at high risk of malnutrition and declining oral function, which have a combined impact that accelerates ADL decline, making collaboration between RD and DH even more critical.

From these viewpoints, in wards where RD and DH are present, nutritional management and oral care are easily implemented, which may positively affect ADL and weight gain. A previous study reported that the involvement of RD and DH further improved swallowing function in dysphagic patients undergoing rehabilitation [25]. However, large-scale studies that comprehensively examine the combined effect of the presence of RD and DH on weight change and ADL improvement in elderly patients with low BMI in KRWs are lacking. Therefore, this study aimed to investigate the association between the presence of RD and DH and ADL improvement and weight gain in elderly patients with low BMI.

Methods

1. Eligibility Criteria and Participants

This study defined elderly patients with low BMI as those aged 70 years or older with a BMI of less than 20.0 kg/m^2, in accordance with the Global Leadership Initiative on Malnutrition criteria, which sets a BMI cutoff value of <20.0 kg/m^2 for the diagnosis of malnutrition in participants aged 70 years or older. These criteria are based on the results of previous studies, that is, a BMI of <20.0 kg/m^2 is associated with reduced muscle mass [26] and increased risk of functional decline [27]. In this study, patients who were admitted to hospitals designated as class 1 from the 2022 survey data provided by the Japanese Kaifukuki Rehabilitation Ward Association were selected. Data with a missing FIM score or BMI at discharge were excluded. The study was limited to class 1 to standardize the rehabilitation therapy, care, and nutritional management provided to the patients. The primary diseases were categorized into three groups: stroke, orthopedic disease, and others (cardiovascular, hospital-associated deconditioning, and other neurological diseases).

2. Exposure

In this study, the presence of RD and DH was defined as having at least one full-time or dedicated staff member, while their absence was defined as having zero full-time or dedicated staff members. The patients were divided into two groups based on the presence or absence of a DH: the RD and DH group (RD+DH+ group) and the RD-only group (RD+DH− group). As the class 1 criteria mandate the presence of a dedicated RD, all wards in the hospitals surveyed had an RD. Therefore, the comparison group was the ward with only an RD present (RD+DH− group).

3. Outcomes

The primary outcomes of this study were (1) FIM gain, (2) change in BMI, and (3) BMI improvement (an increase of ≥0.7 kg/m^2). BMI was calculated by dividing the patient's body weight (kg) at admission and discharge by the square of their height (m)^2. The change in BMI was calculated by subtracting the BMI at admission from the BMI at discharge. A BMI increase of ≥0.7 kg/m^2 was considered as a clinically significant improvement based on a previous study [28].

4. Sample Size Calculation

Sample size calculation was performed using EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan), which is a graphical user interface for R (The R Foundation for Statistical Computing, Vienna, Austria). The required sample size was estimated on the basis of a difference in FIM gain of 9 between the two groups [29], with a standard deviation (SD) of 18.5 [30], an alpha error of 0.05, a power of 0.9, and a group size ratio of 8 [31]. The required total sample size was 450 patients, 50 of whom were included in the RD+DH+ group and 400 in the RD+DH− group.

5. Statistical Analysis

All statistical analyses were performed using STATA/BE 18.0 software (Stata Corporation LLC, College Station, USA). The normality of continuous variables was confirmed with a histogram and skewness/kurtosis tests. Normally distributed continuous variables were presented as the mean and SD, and non-normally distributed continuous variables were presented as the median and interquartile range (IQR). Categorical variables were reported as numbers (%). Hypothesis testing was performed using a t-test for normally distributed data, the Mann-Whitney U test for non-normally distributed data, and the chi-square test or Fisher's exact test for categorical variables. The survey data were considered to be clustered by hospital; thus, in this study, a generalized estimating equation (GEE) was used for analysis. For univariate analysis, FIM gain, a change in BMI, and BMI improvement were used as outcome variables, with group classification as the covariate. For multivariate analysis, FIM gain, a change in BMI, and BMI improvement were used as outcome variables, while age, sex, disease, group classification, days from onset to admission, BMI at admission, cognitive FIM at admission, and total rehabilitation units were used as covariates, as these variables could influence the outcomes based on previous literature and clinical judgment [20, 32]. The significance level was set at $P < 0.05$.

6. Ethical Considerations

This study was conducted in accordance with the ethical standards established by the 1964 Declaration of Helsinki and its subsequent amendments. The study protocol was approved by the Ethics Committee of the Japanese Kaifukuki Rehabilitation Ward Association on October 8, 2024. Responding hospitals were provided with an opt-out opportunity to withdraw from the study at any time.

Results

Of the 20,188 patients who responded to the 2022 survey, 3,329 were analyzed, after excluding 7,457 patients aged under 70 years or who had a BMI of 20.0 kg/m^2 or higher, 6,703 patients from class 2−5 wards, and 2,699 patients with missing data. The basic characteristics of the subjects are shown in Table 1. A total of 2,056 patients (61.8%) were female, with a median (IQR) age of 84 (78−88) years and a median (IQR) BMI at admission of 17.9 kg/m^2 (16.5−19.0 kg/m^2). The median (IQR) number of days from onset to admission was 25 (15−40) days, and the median (IQR) length of stay was 67 (40−89) days.

Of the subjects, 85.1% (2,834 patients) were included in the RD+DH− group, and 12.9% (431 patients) in the RD+DH+ group. The RD+DH+ group had a significantly longer median length of stay by 6 days and a significantly longer median number of days to admission by 2 days. The proportion of orthopedic diseases was high in both groups. The FIM score at admission was significantly higher in the RD+DH− group, but no significant difference was found between the two groups at discharge.

The changes in BMI and FIM gain are shown in Table 2. The median (IQR) FIM gain was comparable between the RD+DH− group 21 (7−35) and the RD+DH+ group 22 (7−36), and no differences in subgroups by disease were found. The median (IQR) BMI change was significantly higher in the RD+DH+ group at 0.05 kg/m^2 (−0.39−0.71 kg/m^2). Although no difference was found in the stroke subgroup, the change was significantly higher in the RD+DH+ group and the orthopedic disease

Table 1. Characteristics of 3,329 elderly patients with low BMI in a Kaifukuki (Convalescent) Rehabilitation Ward Class 1.

Factor	All (*N*=3,329)	RD+DH− (*N*=2,834)	RD+DH+ (*N*=431)	*P* value
Age, years, median (IQR)	84(78−88)	83(78−88)	84(78−89)	0.112*1
Female, *n* (%)	2,056(61.8)	1,762(62.2)	294(59.4)	0.237*2
BMI at admission, median (IQR)	17.9(16.5−19.0)	17.9(16.5−19.0)	17.9(16.6−19.0)	0.346*1
Days from onset to admission, median (IQR)	25(15−40)	24(15−40)	26(16−42)	0.045*1
Length of stay, median (IQR)	67(40−89)	66(39−89)	72(44−90)	0.019*1
Disease, *n* (%)				0.503*2
Stroke	1,257(37.9)	1,061(37.5)	196(39.7)	
Orthopedic disease	1,600(48.2)	1,374(48.6)	226(45.7)	
Others (cardiovascular, hospital-associated deconditioning, and other neurological diseases)	464(13.9)	392(13.9)	72(14.6)	
Tube feeding				
Admission, *n* (%)	328(10.4)	278(10.3)	50(10.7)	0.839*2
Discharge, *n* (%)	268(8.5)	223(8.3)	45(9.6)	0.354*2
FIM score median (IQR)				
Admission (all)	53(35−74)	54(35−75)	51(34−71)	0.030*1
Stroke	44(26−67)	45(26−69)	39.5(25−63)	0.068*1
Orthopedic diseases	60(44−79)	61(44−79)	56(42−78)	0.328*1
Discharge (all)	83(48−109)	83(49−109)	80(48−108)	0.208*1
Stroke	67(34−104)	69(34−105)	62(32−100.5)	0.239*1
Orthopedic diseases	94(65−112)	94(65−112)	94(67−112)	0.945*1
Discharge destination, *n* (%)				0.211*3
Home	1,753(63.6)	1,512(64.5)	241(58.5)	
Death	63(2.3)	52(2.2)	11(2.7)	
Acute care hospital	335(12.2)	276(11.8)	59(14.3)	
Long-term hospital	181(6.6)	149(6.4)	32(7.8)	
Nursing home	423(15.4)	354(15.1)	69(16.7)	

BMI: Body Mass Index, FIM: Functional Independence Measure
*1Mann-Whitney U test, *2Chi-square test, *3Fisher's exact test

Table 2. Results of FIM gain and change in BMI.

Facter		All	RD+DH−	RD+DH+	*P* value
FIM gain, Median (IQR)	All	22(7–35)	21(7–35)	22(7–36)	0.525
	Stroke	17(3–34)	17(3–34)	17(4–33.5)	0.889
	Orthopedic disease	25(13–37)	25(12–37)	26.5(16–39)	0.163
Change in BMI, median (IQR)	All	0.00(−0.45–0.47)	0.00(−0.46–0.47)	0.05(−0.39–0.71)	0.014
	Stroke	0.00(−0.48–0.56)	0.00(−0.49–0.53)	0.14(−0.40–0.73)	0.766
	Orthopedic diseases	0.00(−0.44–0.42)	0.00(−0.46–0.40)	0.04(−0.39–0.62)	0.027
Number (%) of patients with BMI improvement of ≥0.7 kg/m^2	All	638(19.2)	514(18.1)	124(25.0)	0.005
	Stroke	274(21.8)	222(20.9)	52(26.5)	0.203
	Orthopedic diseases	266(16.6)	216(15.7)	50(22.1)	0.019

BMI: Body Mass Index, FIM: Functional Independence Measure

subgroup at 0.04 kg/m^2 (−0.39−0.62 kg/m^2). The percentage of BMI improvement was significantly higher in the RD+DH+ group and orthopedic disease subgroup by 6.9% and 6.4%, respectively.

The association between the presence of both professionals and FIM gain, BMI change, and BMI improvement is shown in Table 3. Multivariate analysis using GEE showed that the presence of RD and DH was not associated with FIM gain. However, it was associated with BMI change (B = 0.157, 95% CI: 0.021−0.294) and the percentage of BMI improvement (odds ratio 1.399, 95% CI: 1.041−1.879).

Table 3. Association between RD and DH presence and FIM gain and BMI change.*1

Outcome	B*2	[95%CI]		SE*3	*P* value
		Lower	Upper		
FIM gain	−0.464	−2.576	1.649	1.078	0.667
Change in BMI	0.172	0.044	0.299	0.065	0.008

Outcome	Odds Ratio	[95%CI]		SE*3	*P* value
		Lower	Upper		
BMI improvement*4	1.399	1.041	1.879	0.211	0.026

BMI: Body Mass Index, FIM: Functional Independence Measure
*1Estimated effect of the RD+DH+ group compared to the RD+DH− group using Generalized Estimating Equations, *2partial regression coefficient, *3Standard Error, *4BMI increase of ≥0.7 kg/m^2

Discussion

In this study, two key findings were identified among patients admitted to a KRW class 1. First, the presence of an RD and DH was not associated with FIM gain. Second, the presence of both professionals was associated with changes and improvements in BMI.

The lack of association between the presence of both professionals and FIM gain in patients in post-acute rehabilitation wards is consistent with previous research, which reported that collaborative intervention by an RD and DH can improve swallowing function but not ADL [25]. FIM gain is influenced by a wide range of factors, including the amount of rehabilitation provided, patient severity, cognitive function, and degree of malnutrition. In this study, the RD+DH+ group had a longer median time from onset to admission and a longer median length of stay compared with the RD+DH− group. The FIM score at admission was also lower among patients with stroke in the RD+DH+ group. These baseline differences indicate that the RD+DH+ group may have included a higher proportion of more severely ill patients, which may explain the absence of a significant difference in FIM gain [33, 34]. For example, a low body weight (BMI <18.5 kg/m^2) has been reported to be significantly associated with poor functional recovery in patients with stroke [35]. In addition, a previous study reported that patients without stroke, with less severe stroke, and with good swallowing function, nutritional status, and oral health had higher FIM scores [36]. Imbalances in these confounding factors may affect FIM gain. Moreover, unexamined factors such as malnutrition severity and oral health status may have differed between the two groups.

The presence of a DH was also associated with changes and improvements in BMI. Unintentional weight loss is common in elderly patients because of reduced activity, taste changes, and medication effects [37]. A decline in oral function is a significant cause of poor food intake in elderly patients. For example, poor oral health can prolong the time required for oral intake, which leads to an earlier feeling of fullness, thereby hindering adequate nutrient intake [38]. In such a situation, apart from individualized nutritional management by an RD, the involvement of a DH may synergistically improve nutritional status through improved oral hygiene, denture adjustments, and oral function training to increase food intake. Previous studies supported the findings of this study, reporting that the presence of an RD in a post-acute rehabilitation ward is associated with an increase in BMI [18]. Moreover, intervention by a dentist and DH in university hospitals is associated with improved nutritional intake at discharge, a higher number of functional teeth, and improved oral health status [39].

Disease-specific subgroup analyses showed that the presence of both professionals did not significantly affect BMI change or the improvement in patients with stroke, but their presence had a significant effect on patients with orthopedic diseases. This discrepancy may be due to oral dysfunction, severe dysphagia, and higher brain dysfunction in patients with stroke. Post-stroke sequelae such as hemiplegia affect eating behavior and activity, thereby hindering oral intake recovery and weight gain. In contrast, in patients with orthopedic diseases, eating difficulties are more often due to physical factors other than oral function (e.g., pain or limited range of motion). Thus, DH support may more directly improve intake in this group. The finding that DH involvement had limited effects on BMI improvement in patients with stroke does not imply that the presence of a DH is unnecessary. The role of a DH extends beyond BMI improvement and includes preventing aspiration pneumonia through maintaining oral hygiene and improving ADL via good oral health [40]. These findings underscore the need for individualized oral and nutritional interventions based on patient and disease characteristics. For example, in elderly patients with low BMI and stroke, a comprehensive, multidisciplinary approach, including collaboration with speech therapists for intensive swallowing training, the use of dysphagia-friendly diets, and improvements in the eating environment, may be necessary to improve BMI.

This study has several limitations. First, despite the data gathered on the presence of DHs, the frequency or content of their interventions was not investigated, and not all patients in DH-present wards received comparable care. Second, data on confounding factors such as hemiplegia severity, level of consciousness, overall disease severity, and comorbidities were unavailable, which may cause residual confounding. Third, information on nutritional status at admission and discharge, as well as energy and protein intake, were lacking, preventing evaluation of whether nutritional care was standardized.

In conclusion, the presence of an RD and a DH may contribute to weight gain in elderly patients with low BMI, but the effect of their presence on ADL improvement remains unclear. Thus, further research should assess the impact of RD and DH interventions on ADL improvement, considering other professional inputs, nutritional management, disease severity, intake levels, and dental care involvement.

Acknowledgments

We would like to express our sincere gratitude to the hospital staff who cooperated in the annual survey of the Kaifukuki Rehabilitation Ward Association for their assistance in data collection.

References

1. Clark AB, Reijnierse EM, Lim WK, Maier AB. Prevalence of malnutrition comparing the GLIM criteria, ESPEN definition and MST malnutrition risk in geriatric rehabilitation patients: RESORT. Clin Nutr 2020; 39(11): 3504−11.
2. Shimizu A, Maeda K, Honda T, Ishida Y, Ueshima J, Nagami S, et al. Comparison between the Global Leadership Initiative on Malnutrition and the European Society for Clinical Nutrition and Metabolism definitions for the prevalence of malnutrition in geriatric rehabilitation care. Geriatr Gerontol Int 2020; 20(12): 1221−7.
3. Inoue T, Maeda K, Nagano A, Shimizu A, Ueshima J, Murotani K, et al. Undernutrition, Sarcopenia, and Frailty in Fragility Hip Fracture: Advanced Strategies for Improving Clinical Outcomes. Nutrients 2020; 12(12): 3743.
4. Wakabayashi H, Sashika H. Malnutrition is associated with poor rehabilitation outcome in elderly inpatients with hospital-associated deconditioning a prospective cohort study. J Rehabil Med 2014; 46(3): 277−82.
5. Fujishima I, Fujiu-Kurachi M, Arai H, Hyodo M, Kagaya H, Maeda K, et al. Sarcopenia and dysphagia: Position paper by four professional organizations. Geriatr Gerontol Int 2019; 19(2): 91−7.
6. Xu Q, Ou X, Li J. The risk of falls among the aging population: A systematic review and meta-analysis. Front Public Health 2022; 10: 902599.
7. Sullivan DH, Sun S, Walls RC. Protein-energy undernutrition among elderly hospitalized patients: a prospective study. JAMA 1999; 281(21): 2013−19.
8. Lengfelder L, Mahlke S, Moore L, Zhang X, Williams G 3rd, Lee J. Prevalence and impact of malnutrition on length of stay, readmission, and discharge destination. JPEN J Parenter Enteral Nutr 2022; 46(6): 1335−42.
9. Nishioka S, Takayama M, Watanabe M, Urushihara M. Nutritional disorders in patients admitted to recovery rehabilitation wards in Japan and their relation to outcomes and ADL outcomes in elderly stroke patients. J JSPEN 2015; 30(5): 1145−51.
10. Shiraishi A, Yoshimura Y, Nagano F, Shimazu S. Association of impaired oral health status with chronic kidney disease in post-acute rehabilitation. Gerodontology 2021; 38(3): 300−7.
11. Shiraishi A, Yoshimura Y, Wakabayashi H, Tsuji Y. Poor oral status is associated with rehabilitation outcome in older people. Geriatr Gerontol Int 2017; 17: 598−604.
12. Shiraishi A, Yoshimura Y, Wakabayashi H, Tsuji Y, Shimazu S, Jeong S. Impaired oral health status on admission is associated with poor clinical outcomes in post-acute inpatients: A prospective cohort study. Clin Nutr 2019; 38: 2677−83.
13. de Sire A, Ferrillo M, Lippi L, Agostini F, de Sire R, Ferrara PE, et al. Sarcopenic Dysphagia, Malnutrition, and Oral Frailty in Elderly: A Comprehensive Review. Nutrients 2022; 14(5): 982.
14. Todayama N, Hara R, Tabata T, Hatanaka Y, Mukai T, Someya M, et al. Systemic and Oral Characteristics of Convalescent Inpatients Requiring Oral-Health Management by a Dental Specialist during Hospitalization. Geriatrics (Basel) 2024; 9(3): 82.
15. Shiraishi A, Yoshimura Y, Wakabayashi H, Tsuji Y. Prevalence of stroke-related sarcopenia and its association with poor oral status in post-acute stroke patients: Implications for oral sarcopenia. Clin Nutr 2018; 37(1): 204−7.
16. Shiraishi A, Yoshimura Y, Wakabayashi H, Tsuji Y, Yamaga M, Koga H. Hospital dental hygienist intervention improves activities of daily living, home discharge and mortality in post-acute rehabilitation. Geriatr Gerontol Int 2019; 19(3): 189−96.
17. Oishi K, Nishioka S, Okazaki Y, Hirakawa K, Nakamura M, Ichinose A, et al. Relationship between oral hygiene and function and activities of daily living at discharge in convalescent patients with stroke. Jpn J Compr Rehabil Sci 2022; 13: 17−25.
18. Nishioka S, Kokura Y, Okamoto T, Takayama M, Miyai I. Assignment of Registered Dietitians and Other Healthcare Professionals Positively Affects Weight Change of Underweight Patients in Convalescent (Kaifukuki) Rehabilitation Wards: A Secondary Analysis of a Nationwide Survey. J Nutr Sci Vitaminol (Tokyo) 2019; 65(5): 435−42.
19. Nishioka S, Sugawara H, Takayama M, Urushihara M, Watanabe M, Kiriya Y, et al. Relationship between weight gain, functional recovery and nutrition monitoring in

underweight tube-fed stroke patients. Jpn J CoMpr Rehabil Sci 2018; 9: 3−10.
20. Nishioka S, Kokura Y, Okamoto T, Takayama M, Miyai I. Risk of Weight Loss in Adult Patients and the Effect of Staffing Registered Dietitians in Kaifukuki (Convalescent) Rehabilitation Wards: A Retrospective Analysis of a Nationwide Survey. Healthcare (Basel) 2021; 9(6): 753.
21. Nishioka S, Wakabayashi H, Momosaki R. Nutritional Status Changes and Activities of Daily Living after Hip Fracture in Convalescent Rehabilitation Units: A Retrospective Observational Cohort Study from the Japan Rehabilitation Nutrition Database. J Acad Nutr Diet 2018; 118(7): 1270−6.
22. Nii M, Maeda K, Wakabayashi H, Nishioka S, Tanaka A. Nutritional Improvement and Energy Intake Are Associated with Functional Recovery in Patients after Cerebrovascular Disorders. J Stroke Cerebrovasc Dis 2016; 25(1): 57−62.
23. Saito T, Kamachi M. Actual situation of nutritional management and factors related to activities of daily living ability at discharge in convalescent rehabilitation ward. Jpn J Compr Rehabil Sci 2024; 15: 71−8.
24. Kokura Y, Nishioka S, Okamoto T, Takayama M, Miyai I. Weight gain is associated with improvement in activities of daily living in underweight rehabilitation inpatients: a nationwide survey. Eur J Clin Nutr 2019; 73(12): 1601−4.
25. Wakabayashi H, Kakehi S, Kishima M, Itoda M, Nishioka S, Momosaki R. Impact of registered dietitian and dental hygienist involvement on functional outcomes in patients with dysphagia: triad of rehabilitation, nutrition, and oral management. Eur Geriatr Med 2023; 14(6): 1301−6.
26. Akazawa N, Kishi M, Hino T, Tsuji R, Tamura K, Moriyama H. Using GLIM criteria, cutoff value for low BMI in Asian populations discriminates high or low muscle mass: A cross-sectional study. Nutrition 2021; 81: 110928.
27. Akazawa N, Kishi M, Hino T, Tsuji R, Tamura K, Hioka A, et al. Nutritional and swallowing statuses but not intramuscular adipose tissue and muscle mass are related to activities of daily living in older inpatients who are judged as severely low body mass index in the Global Leadership Initiative on Malnutrition criteria. Clin Nutr ESPEN 2022; 49: 411−6.
28. Wouters EF. Minimal clinically important differences in COPD: body mass index and muscle strength. COPD 2005; 2(1): 149−55.
29. Suzuki R, Nagano A, Wakabayashi H, Maeda K, Nishioka S, Takahashi M, et al. Assignment of Dental Hygienists Improves Outcomes in Japanese Rehabilitation Wards: A Retrospective Cohort Study. J Nutr Health Aging 2020; 24(1): 28−36.
30. Miyai I, Sonoda S, Nagai S, Takayama Y, Inoue Y, Kakehi A, et al. Results of new policies for inpatient rehabilitation coverage in Japan. Neurorehabil Neural Repair 2011; 25(6): 540−7.
31. Kaifukuki rehabilitation ward association. Survey Report on the Current Situation and Issues in Rehabilitation Units for the Recovery Period. 2024. p. 109−78. Japanese.
32. Nishioka S, Wakabayashi H, Nishioka E, Yoshida T, Mori N, Watanabe R. Nutritional Improvement Correlates with Recovery of Activities of Daily Living among Malnourished Elderly Stroke Patients in the Convalescent Stage: A Cross-Sectional Study. J Acad Nutr Diet 2016; 116(5): 837−43.
33. Kamimoto T, Shindo K, Shimomura T, Akimoto T, Yamada T, Mori N, et al. Relationship between initial nutritional status and functional independence measures at discharge in subacute stroke. J Stroke Cerebrovasc Dis. 2022 (11): 106754.
34. Koton S, Bornstein NM, Tsabari R, Tanne D. Derivation and validation of the prolonged length of stay score in acute stroke patients. Neurology. 2010; 74(19): 1511−6.
35. Burke DT, Al-Adawi S, Bell RB, Easley K, Chen S, Burke DP. Effect of body mass index on stroke rehabilitation. Arch Phys Med Rehabil. 2014; 95(6): 1055−9.
36. Hara R, Todayama N, Tabata T, Mukai T, Hatanaka Y, Watanabe M, et al. Association between oral health status and functional independence measure on admission in convalescent hospitalized patients. BMC Oral Health 2024; 24(1): 63.
37. Fischer J, Johnson MA. Low body weight and weight loss in the aged. J Am Diet Assoc 1990; 90(12): 1697−706.
38. Wijlens AG, de Graaf C, Erkner A, Mars M. Effects of Oral Exposure Duration and Gastric Energy Content on Appetite Ratings and Energy Intake in Lean Men. Nutrients 2016; 8(2): 64.
39. Aoyagi M, Furuya J, Matsubara C, Yoshimi K, Nakane A, Nakagawa K, et al. Association between Improvement of Oral Health, Swallowing Function, and Nutritional Intake Method in Acute Stroke Patients. Int J Environ Res Public Health 2021; 18(21): 11379.
40. Shiraisi A, Yoshimura Y, Wakabayashi H, Nagano F, Bise T, Shimazu S. Improvement in Oral Health Enhances the Recovery of Activities of Daily Living and Dysphagia after Stroke. J Stroke Cerebrovasc Dis 2021; 30(9): 105961.