EUROPEAN JOURNAL OF TRANSLATIONAL
AND CLINICAL MEDICINE 2026;9(1):00-00

META-ANALYSIS

Does dietary advice combined with complete dentures improve the nutrient intake and nutritional status of edentulous patients? A systematic review with meta-analysis

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Abstract

Background: The purpose of this systematic review and meta-analysis was to assess the nutrient intake and nutritional status of edentulous patients who received dietary advice combined with complete dentures. **Material and methods:** Data were extracted from PubMed/Medline, Google Scholar, Scopus, and ScienceDirect from February 2002 to February 2025 by 2 independent reviewers. Ebscohost was searched for full-text articles from 1994 to 2025, in English. 1596 articles were excluded based on exclusion criteria and after removing 7 duplicates. Eight articles were included for qualitative analysis, followed by 3 articles for meta-analysis. **Results:** Non-significant improvements were seen in the intake of calcium ($p = 0.17$), iron ($p = 0.10$), protein ($p = 0.21$) and vitamin D ($p = 0.93$). Heterogeneity was low, indicating consistent results. GRADE analysis indicated a low level of evidence. **Conclusions:** Our results have not shown any significant improvement in nutrient intake after dietary advice and rehabilitation. In addition, the limited number of studies available for this meta-analysis highlights the need for more standardized, long-term clinical trials to achieve a higher level of evidence.

Keywords: systematic review · complete denture · nutritional deficiency · nutrient intake · dietary advice

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Citation

Rani S, Jain N, Gupta S, Kaur B. Does dietary advice combined with complete dentures improve the nutrient intake and nutritional status of edentulous patients? A systematic review with meta-analysis. Eur J Transl Clin Med. 2026;9(1):00-00.

DOI: 10.31373/ejtcm/222198

Introduction

The loss of teeth (edentulism) is considered an indication of poor oral cavity health [1-2]. Adequate nutrition is vital in maintaining a healthy life, especially in geriatric patients with complete removable prostheses [3]. Chen et al. reported that an estimated 0.35 billion people were affected by edentulism, accounting for 4.44% of the whole population [4]. This trend first increased in developed countries (e.g. UK and Japan) and later in developing countries such as India [5]. Literature has shown that dental status is closely linked to an individual's nutritional status. Hence, for improved human health, dentition status should be monitored for nutritional counselling, particularly in the elderly [6].

Diet and nutrition are often misunderstood as synonyms, but they differ in that diet constitutes the ingestion of food, whereast nutrition integrates macro and micronutrients for the building and repairing of tissues [7]. The European Society for Clinical Nutrition and Metabolism recommends 1.0-1.2 g/kg body weight/day for healthy older adults and 1.2-1.5 g/kg/day for older adults who are malnourished or have a chronic illness [8]. The nutritional status of elderly people is often impaired due to selective food intake, as they are more comfortable with certain food items that are easy to chew with their current prostheses [9]. In addition to this, elderly patients often swallow inadequately chewed food as a compensatory mechanism for reduced masticatory efficiency, which may also indirectly contribute to nutritional deficiencies.

Evidence from the literature shows that edentulism is associated with a high risk of malnutrition [10-11]. In developed countries, adults aged 60 years or older without functional dentition were found to be at a higher risk of malnutrition compared to those with functional dentition [10]. Authors also emphasized the importance of using validated tools to determine malnutrition in the elderly population. In two systematic reviews, nutritional assessment was measured using the Mini Nutritional Assessment (MNA) or its short form (MNA-SF) [10-11]. In another systematic review, McGowan et al. examined the nutritional status of adults after prosthetic rehabilitation (dentures) combined with dietary advice, dietary outcomes, as assessed by the Brief-Type Self-Administered Diet History Questionnaire (BDHQ), and serum marker levels reported in analyzed studies [12].

Several studies have demonstrated that tooth loss is associated with a reduced intake of fruits and vegetables, as well as proteins and dietary fiber [13-14]. Previous research by Hamada et al. and Moynihan et al. have shown that prosthetic rehabilitation alone leads to less predictable positive dietary behavior change [15-16]. The evidence remains inconclusive regarding whether complete rehabilitation of functional dentition alone leads to significant improvement in overall nutritional status. Additionally, the combined effect of removable complete dentures and dietary counseling was not comprehensively assessed in completely edentulous patients. Hence, we conducted a systematic review with meta-analysis in order to synthesize the data on the improvement in nutrient intake and nutritional status of patients who received dietary advice combined with complete removable dentures.

Material and methods

Review design and registration

This review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) checklist (2020) and the Cochrane Handbook for Systematic Reviews and Meta-analysis [17-18]. The PRISMA flowchart is shown in Figure 1. Our systematic review was registered in PROSPERO (registration number CRD42025633956) on January 4, 2025. Data extraction was updated in PROSPERO on 1st March 2025.

Research question and PICOS

The research question for this systematic review was: "does supplemental dietary advice along with complete rehabilitation enhance nutrient intake and nutritional status for completely edentulous patients?" The studied population consisted of completely edentulous patients with removable complete dentures. The intervention involved supplementary dietary advice in any form for individuals with complete dentures. Control involved rehabilitation with complete dentures without dietary advice. The outcome measured was nutrient intake and nutritional status. We included full-text randomized clinical trials (RCTs), observational studies, and prospective clinical studies published in the English language. Exclusion criteria were: studies in which implant rehabilitation or partial rehabilitation was performed (the research question focused on complete denture therapy as the sole prosthetic rehabilitation), cross-sectional studies, case reports, theses, dissertations, pilot studies, studies published not in the English language, and unpublished data. Gray literature was not searched in this review.

Data extraction

Two authors (SR and NJ) independently extracted data from PubMed/Medline (as of April 2, 2025), Google Scholar (as of February 24, 2025), Scopus (as of February 10, 2025), and ScienceDirect (as of February 22, 2025), covering the period from February 2002 to February 2025. Ebscohost (as of February 7, 2025) was searched using a filter for full text, covering the years 1994-2025, in English. The search strategy for individual databases is presented in Table 1.

Review outcomes

Our systematic review focused on assessing the nutritional status of completely edentulous patients post-intervention. The nutrient intake was measured in terms of fruit and vegetable (F/V) intake, fiber, protein, fatty acids, energy, micronutrients, and macronutrients. At the same time, nutritional status was assessed using established questionnaires (MNA, MNA-SF, BDHQ) for the same or subsequent measurement of biochemical markers.

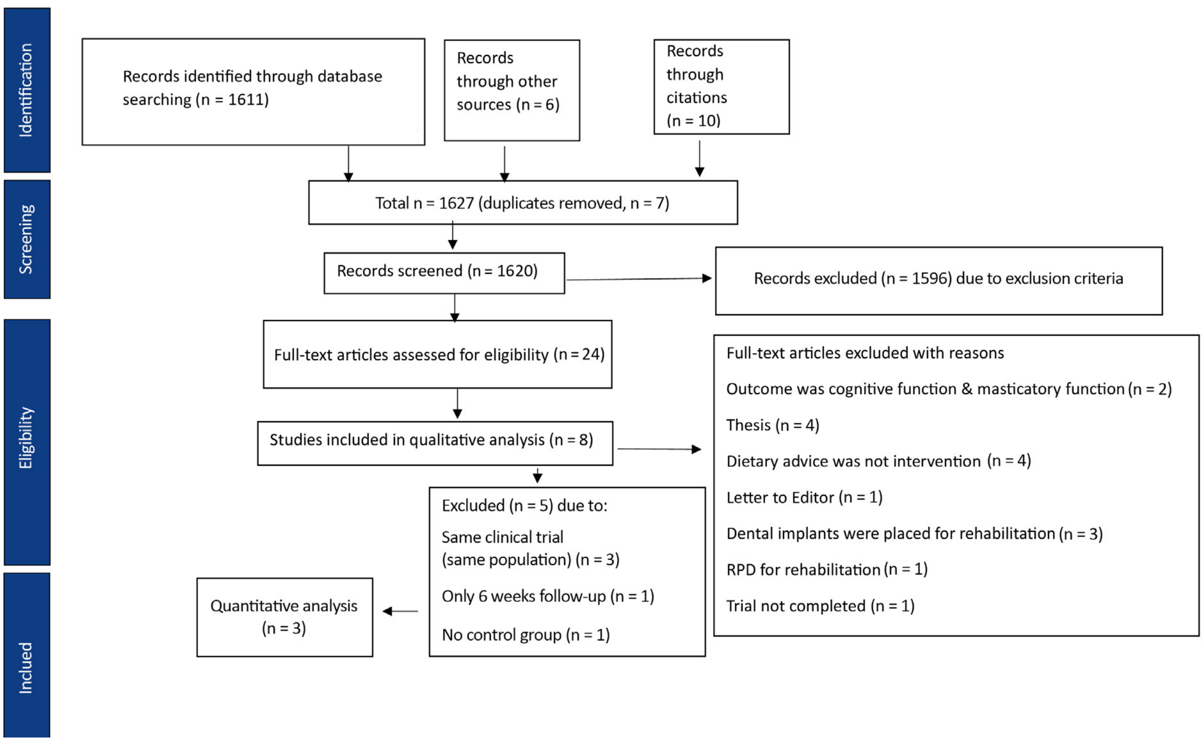
Meta-analysis

Two authors (SR and NJ) independently extracted data into a spreadsheet, detailing the authors, year of publication, country, demographic data, intervention details, and results at various time intervals. A meta-analysis was conducted using fixed-effects models to pool the quantitative data on patient nutrient intake, incorporating the mean and standard deviation values provided in the studies (Review Manager (Rev Man), v 5.4, Cochrane Collaboration). I^2 statistics were used to calculate the heterogeneity.

Risk of bias

The Cochrane tool was used to assess the risk of bias (RoB), including domains selection bias, performance bias, detection bias, attrition bias, reporting bias, and other bias. A revised JBI RoB tool was used for observational studies [19]. Two independent reviewers reported RoB for all included studies under the high-risk, low-risk, or unclear-risk categories.

Figure 1. PRISMA flowchart of our systematic review



Level of evidence

The level of evidence was calculated using theGRADE-pro GDT software (Evidence Prime Sp. z o.o., Kraków, Poland, available from gradepro.org). The quality was assessed as high, moderate, low or very low based on 5 criteria (risk of bias, inconsistency, indirectness, imprecision, other considerations).

Results

Search results

A total of 1611 articles were retrieved from the database search: 12 articles in PubMed, 1470 in Google Scholar, 70 in Ebscohost, 7 in Scopus and 52 in ScienceDirect. A manual search of the included articles' reference lists identified 10 additional articles. 6 additional articles were selected from other sources (e.g., data registries, journals not indexed in databases). Google Scholar data was searched using MeSH keywords with Boolean operators AND and OR. Duplicates were removed manually by two independent reviewers (no software was used for removing duplicates in any database) (Table 1).

After removing 7 duplicates, the titles and abstracts were reviewed and 1596 articles were excluded based on the criteria listed earlier. If there was any confusion about an article, then the full text was read independently by 2 authors (SG and BK). To clarify any discrepancies regarding the inclusion of an article, a third reviewer was consulted until a clear consensus was reached. A total of 24 articles were assessed for eligibility and 8 were included for qualitative analysis (Figure 1). After excluding 5 more articles, 3 articles were included in the meta-analysis. In the event of any ambiguity, the decision was made by a third author (SR).

Included studies

A total of 7 RCTs and 1 observational study were included for systematic review; 1 study was conducted in the UK [20], 3 in India [21-23] and 4 in Japan [24-27]. In one of the studies (Kumar et al.) all of the participants were female [21]. Ethical approval and informed consent were reported in all of the analysed trials. In most of the included studies, dietary advice was provided to the patients in the form of written pamphlets either at the time of fitting or insertion of dentures [20, 22-27]. An exception is the study by Kumar et al., in which patients received dietary advice in the form of food supplements for 3 months [21]. The Brief Self-Administered Diet History Questionnaire (BDHQ) was used to assess the nutritional status of patients in 3 studies [24-26]. In 1 study the MNA tool was used to determine the participants' nourishment [23], while its short version (MNA-SF) was used in 2 others [22, 27]. Serum biomarkers (e.g. Vit D, Hb, serum Ca, BMI, BMD) were analysed in 3 studies [20-21, 23]. Masticatory performance was assessed in 2 studies [21, 25], 1 study also evaluated muscle activity using EMG [21] and one study assessed oral health-related quality of life [24] as secondary outcomes (Table 2). Baseline and follow-up mean values (along with standard deviation) for all included studies are provided in the Supplementary Table 1. The minimum follow-up time period in the included studies was 6 weeks, and the maximum follow-up period was 6 months. A summary of outcomes at different time periods is provided in Table 3.

Table 1. Search strategy used in this systematic review

Database	Search strategy	Articles
PubMed/Medline	((“Complete rehabilitation” [All Fields] AND “dietary counseling” [All Fields] AND “nutritional status” [All Fields] OR “nutritional biomarkers” [All Fields] AND “completely edentulous patients” [All Fields]	12
Google Scholar		1470
Scopus		7
EBSCOhost	TI Complete denture rehabilitation OR TX Completely edentulous AND TX Dietary supplements AND TX Dietary advice AND TX Nutritional status OR TI (dietary interventions or dietary advice or dietary recommendations) with filter (Full text 1994-2025, English)	70
ScienceDirect	Advanced research using keywords “edentulous”, “complete denture”, “dietary advice”, “nutrient intake”	52

Table 2. Partcipant demographics and dietary advice described in the included studies

Author details, year [reference]	Country	Sample size, sex distribution	Mean age	Study type & duration	Dietary intervention	Time of dietary advice	Nutritional status assessment tools
Bradbury et al., 2006 [20]	UK	n = 32 (C), n = 34 (I)	45-80 years, C = 66.7 ± 6.7, I = 65.4 ± 8.9	RCT, Feb. 2000 – Jul. 2001	2 sessions, tailored written package	At baseline and 6 weeks of wearing dentures	BMI, mamicro- and macronutrients
Kumar et al., 2023 [21]	India	n = 50 (C), 56 (I) females only	CD = 49.6 ± 7.95, DWFS = 51.3 ± 7.9, DwoFS = 50.5 ± 8.85	non-RCT	Food supplement in lukewarm water	1 sachet/ day for 3 months	Albumin, hemoglobin, vitamin D, calcium
Amagai et al., 2017 [24]	Japan	n = 31 for each group, C = 16 (F) + 15 (M), I = 15 (F) + 16 (M)	Mean age C = 78.6, I = 75.3	RCT	1 session, 20 minutes of simple dietary advice in pamphlet form	At the time of denture insertion	BDHQ
Suzuki et al., 2018 [27]	Japan	n = 31 for each group, C = 15 (M) + 16 (F), I = 16 (M) + 15 (F)	Mean age C = 78.6, I = 75.3	RCT, Jun. 2015 – Sept. 2016	2 sessions, 20 minutes of simple dietary advice in pamphlet form	At the time of denture fitting and insertion	BDHQ
Kanazawa et al., 2019 [26]	Japan	n = 29 (C), n = 30 (I), C = 14 (F) + 15 (M), I = 15 (F), 15 (F)	Mean age C = 78.6, I = 74.8	RCT, Jun. 2015 – Dec. 2016	2 sessions, dietary advice in pamphlet form	At the time of denture fitting and insertion	BDHQ
Suzuki et al., 2019 [25]	Japan	n = 29 (C), n = 30 (I), C = 15 (M) + 14 (F), I = 15 (M) + 15 (F)	C = 78.6, I = 74.8	RCT, Jun. 2015 – Sept. 2016	2 sessions, dietary advice in pamphlet form	At the time of fitting and insertion	MNA-SF
Agarwal et al., 2023 [22]	India	n = 50	Not mentioned	obser-vational study, Apr. – Jul. 2023	2 sessions, dietary counseling in documented form	At the time of denture fitting and insertion	MNA-SF
Vijaya et al., 2024 [23]	India	n = 35 in each group, C = 17 (M) + 18 (F), I = 22 (M) + 13 (F)	I = 65.57, C = 65.77	non-RCT	Tailored dietary advice in pamphlet form	At the time of denture insertion	MNA, BMI

BDHQ – Brief-Type Self-Administered Diet History Questionnaire, BMI – body mass index, C – control group, CD – completely dentate, DWFS – complete dentures without food supplement, DwoFS – complete dentures without food supplement, F – female, I – intervention group, M – male, MNA – Mini Nutritional Assessment, MNA-SF – Mini Nutritional Assessment-Short Form, non-RCT – non-randomized controlled trial, RCT – randomized controlled trial

Table 3. Outcome assessment of included studies

Author details, year [reference]	Primary outcome (nutrient intake)	Secondary outcomes	Follow-up time period	Primary outcome at follow-up	Secondary outcomes at follow-up
Bradbury et al., 2006 [20]	F/V intake, energy, micro- and macronutrients	1) Nutritional status (BMI) 2) stage of change 3) chewing ability	6 weeks	1) F/V intake Iincreased in Group ($p = 0.001$), 2) Only vitamin C ($p < 0.0005$) and β-carotene ($p = 0.036$) differed significantly.	1) BMI didn't increase significantly ($p = 0.497$) 2) significant movement from pre-action to action stages of change 3) chewing ability didn't differ significantly ($p = 0.269$) b/w groups
Kumar et al., 2023 [21]	nutritional status (Hb, serum calcium, serum albumin, vitamin D)	1) Bone mineral density 2) Masticatory performance 3) EMG	3 and 6 months	No statistical difference except for calcium	Statistical difference in BMD, masticatory performance and EMG
Agarwal et al., 2023 [22]	MNA-SF	–	Baseline, 1 month, 3 months	After 3 months, the nutritional status was significantly improved ($p = 0.0331$). Only 17.3% were at risk of malnutrition compared to 32 % at baseline.	–
Vijaya et al., 2024 [13]	Nutrient intake (protein, dietary fiber, iron, carbohydrates, calcium) energy	1) nutritional status (MNA) 2) BMI	3 months	Nutrient intake (e.g. protein, dietary fiber, total fat, calcium, carbohydrate, energy, iron, vitamin B12) was higher in the intervention group, though it was not statistically significant.	1) At 3 months there was an improvement in the MNA scores ($p < 0.001$) in both the groups, but the improvement was significantly higher in the intervention group than in the control group. 2) A statistically significant improvement in the BMI of participants in the intervention group ($p = 0.030$).
Amagai et al., 2017 [24]	Food intake (BDHQ)	OHRQoL (OHIP-Edent-J)	3 months	After 3 months, significantly greater intake of chicken ($p = 0.013$), fish with bones ($p = 0.012$), and carrots and pumpkins ($p = 0.025$)	Non-significant difference between the groups
Suzuki et al., 2018 [25]	Food intake (BDHQ)	Masticatory function	3 months	After 3 months, intake of protein ($p = 0.001$), lipid ($p = 0.041$), sodium ($p = 0.013$), potassium ($p = 0.007$), magnesium ($p \leq 0.001$), phosphorus ($p = 0.001$), iron ($p = 0.011$), zinc ($p = 0.001$), vitamin B1 ($p = 0.004$), vitamin B2 ($p = 0.027$), vitamin B6 ($p = 0.002$), niacin ($p = 0.002$), folic acid ($p = 0.031$), and pantothenic acid ($p \leq 0.001$) significantly increased in the intervention group	Non-significant difference between the control and intervention groups at post-treatment

BDHQ – Brief-Type Self-Administered Diet History Questionnaire, BMD – bone mineral density, BMI – body mass index, EMG – electromyography, F/V – food and vegetable intake, Hb – hemoglobin, MNA – Mini Nutritional Assessment, MNA-SF – Mini Nutritional Assessment-Short Form, OHIP-Edent-J – Oral Health Impact Profile for Edentulous Patients (Japanese version), OHRQoL – Oral-health-related quality of life

Table 3. Outcome assessment of included studies (continued)

Author details, year [reference]	Primary outcome (nutrient intake)	Secondary outcomes	Follow-up time period	Primary outcome at follow-up	Secondary outcomes at follow-up
Kanazawa et al., 2019 [26]	Food intake (BDHQ)	–	3 and 6 months	At 3 months post-treatment, the nutrient intake was significantly higher in the intervention group. At 6 months post-treatment, plant protein (p = 0.028) intake was significantly higher in the intervention group than the control group; on the contrary, a significantly higher intake of animal proteins (p = 0.049) and vitamin B12 (p = 0.028) was noted in the control group	–
Suzuki et al., 2019 [27]	Nutritional Status (MNA-SF)	–	3 and v6 months	1) Non-significant at 3 months (p = 0.48) 2) Significantly higher than the control group by 6 months (p = 0.01)	–

BDHQ – Brief-Type Self-Administered Diet History Questionnaire, BMD – bone mineral density, BMI – body mass index, EMG – electromyography, F/V – food and vegetable intake, Hb – hemoglobin, MNA – Mini Nutritional Assessment, MNA-SF – Mini Nutritional Assessment-Short Form, OHIP-Edent-J – Oral Health Impact Profile for Edentulous Patients (Japanese version), OHRQoL – Oral-health-related quality of life

Bias assessment

According to Cochrane's tool for risk of bias assessment of RCTs, 6 of the included RCTs showed a low risk of bias and only one study had a high risk of bias [20]. Randomization and concealment of allocation were done adequately in 6 of the included studies. Reporting bias was also reduced by incorporating the appropriate measurement tool. In contrast, detection bias was high in 2 studies and unclear in 4 studies. The risk of bias in the 7 included RCTs is summarized in Figure 2. One of the included studies was observational and was found to have a low risk of bias, as calculated using the revised JBI tool [23].

Meta-analysis

It was not possible to conduct a meta-analysis of nutritional status because 1 of the studies in which the MNA-SF was used was an observational study with no control group of participants [22].

A qualitative analysis was conducted on a total of 8 studies, and a further quantitative analysis was performed on 3 of these studies for nutrient intake. We included 4 different articles published from the same single clinical trial, featuring a different outcome measure in one of the studies and differences in the follow-up [24-27]. To avoid double-counting data or introducing bias, in the meta-analysis, , the same population with the same outcomes was considered only once across those 4 articles from the same clinical trial.

In the comparison of nutritional intake after a 3-month follow-up, 3 studies were included in the meta-analysis [21, 23, 26]. The heterogeneity across studies for the outcome 'calcium intake' was low (44%), so a fixed-effects model was used for analysis (Figure 3). The mean difference between the groups was -0.25 (95% confidence interval: -0.61 to 0.11). The pooled estimate did not show statistically significant differences (p = 0.17) in calcium intake between the intervention and control groups and the overall effect across studies showed results favouring the intervention group. Thus, it can be concluded that the mean calcium intake was better in the

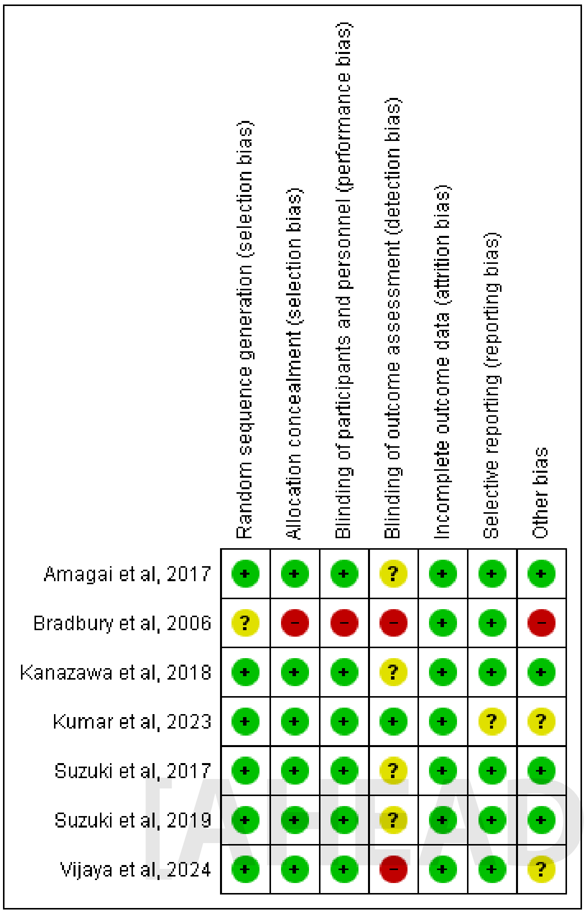


Figure 2. Risk of bias graph of the included RCTs using the Cochrane tool

supplement group across all studies, although that difference was not statistically significant.

For the outcome 'iron intake' the heterogeneity across the analysed studies was low (0%), so a fixed-effects model was used for analysis (Figure 4). The mean difference between the groups was 1.16 (95% confidence interval: -0.21 to 2.54). The pooled estimate did not show statistically significant differences (p-value = 0.10) in iron intake between the intervention and control groups and the overall effect across studies showed results favouring the control group. Thus, it can be concluded that the mean iron intake was not (statistically) significant different between the two groups, however in clinical terms the control group showed comparable results to the intervention group.

The heterogeneity across studies for the outcome 'protein intake' was low (0%), so a fixed-effects model was also used for analysis (Figure 5). The mean difference between the groups was 7.48 (95% confidence interval: -4.25 to 19.21). The pooled estimate showed no statistically significant differences (p-value = 0.21) in protein intake between the intervention and control groups, and the overall effect across studies showed results favouring the control group. Thus, it can be concluded that the mean protein intake was not (statistically) significantly different between the two groups, although clinically the control group showed comparable results to the test group.

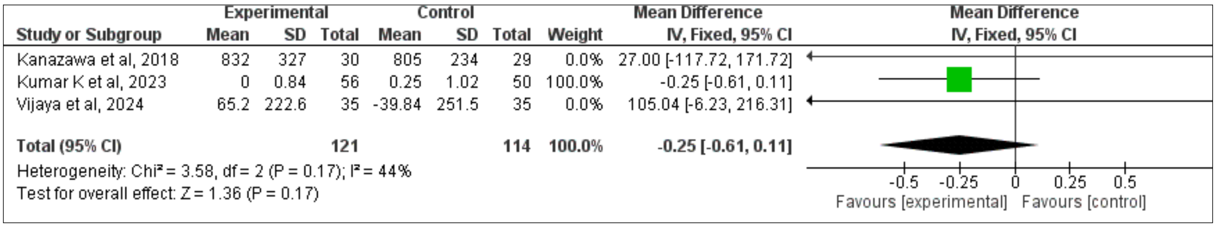


Figure 3. Forest plot distribution showing an outcome (calcium intake) with fixed effect model and 95% confidence interval

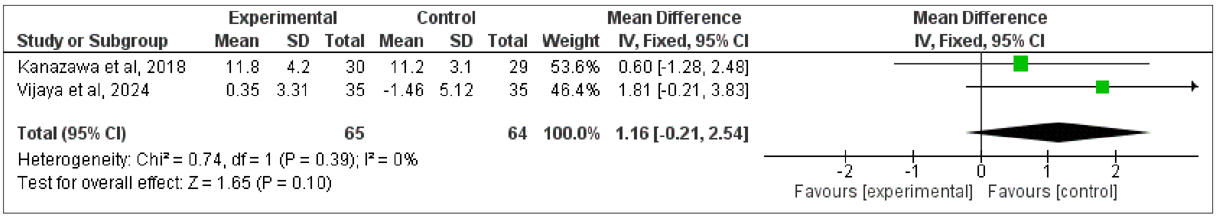


Figure 4. Forest plot distribution showing an outcome (iron intake) with fixed effect model and 95% confidence interval

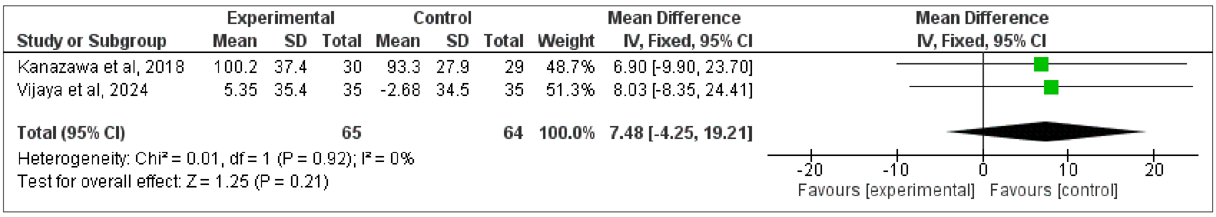


Figure 5. Forest plot distribution showing an outcome (protein intake) with fixed effect model and 95% confidence interval

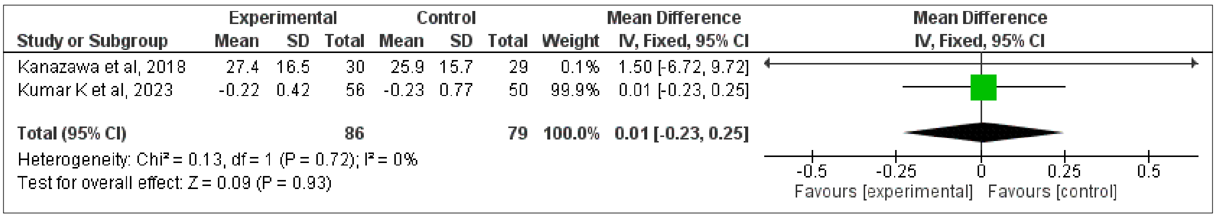


Figure 6. Forest plot distribution showing an outcome (vitamin D intake) with fixed effect model and 95% confidence interval

In terms of the outcome 'vitamin D intake', the heterogeneity across studies was low (0%), so a fixed-effects model was used for analysis (Figure 6). The mean difference between the groups was 0.01 (95% confidence interval: -0.23 to 0.25). The pooled estimate showed no statistically significant differences (p-value = 0.93) in vitamin D intake between the intervention and control groups, and the overall effect across studies showed results favoring both the intervention and control groups. Thus, it can be concluded that the mean vitamin D intake was similar results in the intervention and control groups. Publication bias was not assessed as only 3 studies were included in the meta-analysis.

GRADE analysis

According to GRADE, there was a low level of evidence for the outcomes of 'calcium intake', 'iron intake', 'protein intake', and 'vitamin D intake', respectively. The evidence was downgraded considering 2 domains: risk of bias and imprecision. One of the included RCTs was of high risk, whereas the other 2 studies showed low risk. Imprecision among the studies was also graded as serious, considering the wide uncertainty surrounding the estimates and the crossing of decision thresholds (Table 4).

Discussion

Complete tooth loss is directly related to dietary intake and nutritional status of individuals [28]. Completely edentulous patients with less functional occlusion tend to consume fewer fruits and vegetables and, hence, are more prone to systemic diseases [29-30]. In their systematic review, Hussein et al. indicated that people > 60 years of age who experience complete tooth loss face a 21% chance of malnutrition [11]. In another systematic review, the risk of malnutrition was found to be high in individuals who were partially/fully edentulous [12]. Findings from an umbrella review demonstrated that tooth loss (partial or complete) is a significant risk factor for malnutrition, indicating that compromised oral health can negatively impact nutritional status [31]. Although the above-cited systematic reviews demonstrated an association between nutritional status and the elderly population, we did not find a comprehensive review regarding the completely edentulous patients.

People with tooth loss tend to avoid chewing raw fruits and vegetables, which reduces their intake of protein and fiber, leading to low energy levels. Rehabilitation of functional units with complete dentures can empower patients to maintain a healthy nutrient intake [32]. However, studies have also shown that prosthetic rehabilitation alone may not be sufficient to enhance nutritional status [27, 33]. Simple dietary advice, supplemented with comprehensive rehabilitation, has been proven as an effective way to improve the nutritional outcomes of patients [25, 28].

Dietary advice can be provided in various forms (e.g. written pamphlets, individual consultations, tailored dietary regimens or specified food supplements), all of which can be customized according to age, sex, and individual requirements. However, providing tailored diet plans for patients in a dental setting is difficult as dentists lack specific knowledge of dietary supplements. Hence, in most of the included studies, simple dietary advice was provided to participants in written pamphlet form [22, 24-27].

There are various standardized tools for assessing nutritional status, while nutrient intake is evaluated through different components, including macronutrients and micronutrient intake. In our systematic review, the BDHQ questionnaire was administered in 3 studies [24-26]. Although the BDHQ is short (4 pages, can be completed in 10-15 minutes) and easy to understand, the drawback of this tool is that answers depend on the patients' recall of key details (e.g. the food they consumed, diet preparation, intake of beverages, including alcohol). This may result in recall bias during assessment of elderly participants.

A few studies measured components of fruit and vegetable intake, macronutrients, and micronutrients after intervention [20, 23-26]. In our review, it was found that the nutrient intake of calcium, iron, protein, and vitamin D was slightly improved after dietary advice, although the difference was non-significant. Our results were not consistent with other studies, as in a clinical trial conducted by Kanazawa et al., the intake of protein (p = 0.004), iron (p = 0.035) was statisticaly significant, but calcium (p = 0.281) and vitamin D (p = 0.295) were not statistically significant in the intervention group after 3 months of follow-up [26]. In a study by Vijaya

Table 4. Level of evidence assessed using the GRADE method

Certainty assessment	**№ of studies [reference]**	**3 [21, 23, 26]**	**№ of studies [reference]**	**2 [23, 26]**
	Risk of bias	not serious	**Risk of bias**	serious
	Inconsistency	not serious	**Inconsistency**	not serious
	Indirectness	not serious	**Indirectness**	not serious
	Imprecision	serious	**Imprecision**	not serious
	Other considerations	none	**Other considerations**	none
№ of patients (n)	**Calcium intake**	121	**Iron intake**	65
	Placebo	114	**Placebo**	64
Effect	**Relative**	–	**Relative**	–
	Absolute	MD **0.25 lower** (0.61 lower to 0.11 higher)	**Absolute**	MD **1.16 higher** (0.21 lower to 2.54 higher)
Certainty		⊕⊕⊕◯ moderate[a]		⊕⊕⊕◯ moderate[a]
Importance		IMPORTANT		IMPORTANT

[a] – wide uncertainty around the estimate and crossing decision thresholds, [b] – high risk of bias, CI – confidence interval, MD – mean difference

Table 4. Level of evidence assessed using the GRADE method (continued)

Certainty assessment	**№ of studies [reference]**	**2 [23, 26]**	**№ of studies [reference]**	**2 [21, 26]**
	Risk of bias	serious[b]	**Risk of bias**	not serious
	Inconsistency	not serious	**Inconsistency**	not serious
	Indirectness	not serious	**Indirectness**	not serious
	Imprecision	serious[a]	**Imprecision**	serious[a]
	Other considerations	none	**Other considerations**	none
№ of patients (n)	**Protein intake**	65	**Vitamin D**	86
	Placebo	64	**Placebo**	79
Effect	**Relative**	–	**Relative**	–
	Absolute	MD **7.48 higher** (4.25 lower to 19.21 higher)	**Absolute**	MD **0.01 higher** (0.23 lower to 0.25 higher)
Certainty		⊕⊕◯◯ low[a,b]		⊕⊕⊕◯ moderate[a]
Importance		IMPORTANT		IMPORTANT

[a] – wide uncertainty around the estimate and crossing decision thresholds, [b] – high risk of bias, CI – confidence interval, MD – mean difference

et al., the intervention group showed no statistically significant differences in protein (p = 0.30) or calcium intake (p = 0.196) after the same follow-up period [23]. In contrast, Kumar et al. found that calcium intake was significantly higher with supplements (p = 0.01), but not with vitamin D (p = 0.30). The differences in these results may be due to variations in the demographic distributions of the populations, as 1 of the analysed studies was conducted in Japan and the other 2 in India. Another variation was the exclusion of male participants in one of the analysed studies [23].

In their meta-analysis Bezerra et al. concluded that in completely edentulous patients the bioavailability of the nutrients remained stable with implant-supported dentures. They also emphasized the role of the nutritional specialist for the outcomes of rehabilitation [34]. Additionally, nutrient intake is influenced by multiple factors, particularly in edentulous patients, therefore the systemic health condition of the included population in trials should be taken into consideration. The meta-analysis also reveals low heterogeneity, as indicated by the forest plots, with consistent results and a low level of evidence. In one of the analysed studies, Kumar et al. presented calcium and Vitamin D intake were presented as median and IQR [21]. By using the formula described by Wan et al., we converted these values into mean and SD for inclusion in our meta-analysis [35].

For, The MNA [23], MNA-SF [22, 27], or more informative assessments, such as BMI [20, 23], and serum biomarkers (Hb, Ca, Fe) [21], have been used by the authors for assessment of the participants' nutritional status in the included studies. The MNA-SF determines the population at risk of malnutrition via only 6 questions, compared to the MNA form which includes screening followed by a detailed assessment. In a study, after a 3-month follow-up, nutrient intake was significantly better in the intervention group (p = 0.0331) [22], compared to another study in which significant improvement was found after 6 months (p = 0.01) [25]. Vijaya et al. reported that MNA scores were significantly improved in both the control and intervention groups after 3 months (p < 0.001), while there was only a slight improvement in the intervention group when inter-group comparison was carried out [23]. This result was supported by a more reliable marker (BMI), which significantly improved in that study's intervention group [23].

A limitation of our analysis is that most of the included studies were conducted in Japan, India, and the UK, therefore the dietary advice provided in these studies cannot be generalized to other populations. The dietary advice was limited to only 1 or 2 consultations during the study period. There was a paucity of literature on the assessment of nutritional status using the same tool for meta-analysis with a long follow-up. More RCTs are needed using a standard tool to determine the nutrient intake and nutritional status of edentulous patients when supplemented with dietary advice and complete denture therapy. Long-term follow-up and regular reinforcement of dietary advice are required in future studies to assess whether the outcomes are due to prostheses or dietary advice.

Conclusions

Within the limitations of our analysis, it can be concluded that there was no significant difference in the nutrient intake of calcium, iron, protein, and vitamin D in people who received dietary advice along with complete dentures. Furthermore, nutritional status was improved in the intervention group, but additional standardized long-term RCTs are required to obtain conclusive results.

Funding

Self funded.

Conflict of interest

None.

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