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Review article

# Impact of shortened dental arch therapy on nutritional status and treatment costs in older adults: A systematic review

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ABSTRACT

*Objective:* This review was undertaken to evaluate, whether a shortened dental arch (SDA) was a good alternative to a conventional prosthodontic rehabilitation (RPD) in older adults when nutritional and economic factors are compared.
*Data:* A total of 92 studies were included for the full-text analysis, and finally 4 reports from two RCTs qualified for data extraction and analysis. The final search update was performed on 06.11.2022 and no further searches and updates were performed after this date.
*Sources:* Electronic databases [PubMed (MEDLINE), Embase, CENTRAL] were systematically searched to identify studies comparing nutritional and economic outcomes in partially edentate adults rehabilitated with conventional RPD and SDA therapy.
*Study selection:* Studies were excluded if there were less than 10 participants per group, and if the subjects were not clinically followed up in recall visits. Two investigators performed the data extraction and were reciprocally blinded. Inter-investigator reliability was assessed using Cohen's unweighted kappa (κ). A meta-analysis could not be performed and the results were reported qualitatively.
*Results:* The calculated κ ranged between 0.80 and 1.00. Three reports from two studies reported on nutritional outcomes and one report provided information on economic benefits, when comparing between the SDA therapy and conventional prosthodontic rehabilitation. No significant difference was recorded in the nutritional status of patients rehabilitated using the SDA concept compared with RPDs. Higher costs for treatment provision and maintenance for patients in the RPD group was found when compared to SDA treatment.
*Conclusions:* This systematic review identified the shortened dental arch concept as a reasonable alternative to the conventional prosthodontic rehabilitation where cost-effectiveness and nutrition are concerned based on the limited evidence obtained from current literature.
*Clinical significance:* SDA therapy may be considered as a feasible treatment concept in older adults especially in those with complex medical statuses and limited finances.

## 1. Introduction

Population ageing across the globe is bringing new and difficult challenges for policy makers, particularly those working in social care and healthcare provision [1,2]. Evidence suggests that prevention of systemic diseases, particularly amongst older adults, is strongly linked to maintaining good oral health [2]. Negative impacts on dietary intake and nutritional status are clearly associated with poor oral health, particularly natural tooth loss and diminished salivary output [2,3]. Studies have demonstrated that tooth loss negatively impacts on chewing ability which further impacts on dietary choice and thus nutritional status [2,4,5]. A poor-quality diet in older adults is associated with many chronic systemic diseases including bowel disease, cardiovascular disease, osteoporosis, sarcopenia and cognitive decline [2,6].

Loss of natural teeth and their prosthodontic replacement is an important event in the lifespan of many patients [7–9]. With continuously improving preventive regimes, many more patients are now

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retaining teeth into old age [1,10,11]. The majority of these partially dentate older patients are currently treated with removable partial dentures (RPDs) however some patients fail to accommodate or tolerate a RPD [12–15]. In addition to limited retention and support causing discomfort, some patients find chewing with a RPD to be very challenging, particularly where large numbers of natural teeth are replaced. A further clinical issue is that RPDs may increase the likelihood of developing caries and periodontal diseases, particularly on abutment teeth [15].

Despite current prescribing patterns, there is a significant amount of evidence in the published literature that tooth replacement based on the shortened dental arch (SDA) concept may be a viable alternative to more conventional prosthodontic rehabilitation using RPDs or other interventions [12,14]. The SDA concept, first described in 1981, is now widely accepted by dental professionals and patients [16]. The concept aims to provide patients with a functional dentition of 10 occluding units, where an occluding pair of premolars is one unit and an occluding pair of molars is two units [12,17]. Evidence suggests that when the masticatory system is restored to 10 occluding pairs, patients have suboptimal but sufficient oral function and comfort [14]. Initial concerns about limited chewing ability or increased risk for Temporomandibular Joint Disorders (TMD) or tooth wear in patients with SDAs, have proved unfounded [18,19].

Due to the growing population of older adults with chronic systemic and oral diseases, costs of publicly funded healthcare is expected to increase dramatically in future years [20]. As a result, researchers and policymakers are tasked with considering the cost effectiveness of treatment interventions [21]. For tooth replacement in partially dentate older adults, this includes critically examining the costs involved in providing RPDs compared to alternative treatment interventions, including the SDA concept [10,17,22,23].

Whilst previous systematic reviews have examined tooth replacement options for partially dentate older adults in terms of prosthodontic success and patient reported outcomes, outcomes such as nutritional status and treatment costs (cost effectiveness) have not been examined. Therefore, this systematic review was undertaken to study these important outcome variables compared to patients provided with RPDs. The null hypothesis set for this review was that partially dentate patients rehabilitated according to the principles of the SDA did not suffer from diminished nutrient intake compared to patients restored with RPDs and that this treatment was economically favourable. Based on this null hypothesis set for the study, the PICO (Population Intervention/exposure Comparison Outcome) focus question framed for this systematic review was: "Is a shortened dental arch a good alternative to a conventional prosthodontic rehabilitation for older adults when nutritional and economic factors are compared?"

## 2. Material & methods

### 2.1. Protocol and registration

This systematic review was executed and reported according to the preferred reporting items for systematic reviews (PRISMA) guidelines [24–27]. The review protocol was registered in the international prospective register of systematic reviews (PROSPERO) (CRD42021283848).

### 2.2. Eligibility criteria

Inclusion and exclusion criteria for the inclusion of studies in this systematic review are described in Table 1.

### 2.3. Information sources

All studies reporting on the effect of SDA on patients' nutritional status and cost-effectiveness data were searched in three electronic databases: [Medline (PubMed), Embase, and Cochrane central register of controlled trials (CENTRAL)]. Relevant dental journals that weren't accessible on the internet or those papers without electronic abstracts available were hand-searched. Reference cross-checks were performed to identify studies that weren't discoverable in online databases. To further maximize the pool of relevant studies, queries were posted on research community websites (https://www.researchgate.net) and were also searched on the online search engines (Google Scholar, Yahoo). Additionally, personal contacts with selected authors, active within this field, were utilised. All of these steps were undertaken to maximize the pool of relevant studies for inclusion. The final electronic search was performed on 14.11.2021, a search update was performed on the 06.11.2022. No further searches and updates were performed after this date.

### 2.4. Search strategy

The search strategy was designed and set up by an expert in database searches (MS) and two investigators (NFu and NFa). Search terms employed were based on the PICO strategy. The terms were either medical subject headings (MeSH) search terms and keywords classified under general (all fields) category. The search terms were then combined using Boolean operators "OR" and "AND" to create a final search strategy as illustrated in Table 1. No restrictions concerning language, study designs or time-points were applied. A filter on journal categories was applied to restrict the search findings to "Dental Journals".

### 2.5. Study selection

All studies were included in this systematic review if they fulfilled the inclusion criteria described in Table 1. After an initial sweep, the two investigators (NFu and NFa) independently performed a thorough title and abstract screening. Articles were added to this shortlist of studies through reference cross-checking. After agreement between the two investigators, studies were merged into a final list for full-text analysis and data extraction. Disagreements were resolved by a consensus discussion in a meeting with the senior author (MS). The two investigators both agreed on the final shortlist for data analysis and data extraction. In the case of multiple publications reporting on the same cohort at different time points, only the most recent publication was included in the systematic review.

### 2.6. Data collection process

The two investigators (NFu and NFa) were reciprocally blinded and extracted the data from the studies independently. Before finalizing the extracted data, the investigators always reached a consensus. If there were significant doubts regarding the data from a particular study, the corresponding authors were contacted for confirmation of the extracted data. The variables extracted from the included studies are described in Tables 2 and 3.

### 2.7. Data items

From the included studies the following data was extracted: first author; year of publication; comparison / control; number of participants and their study groups; recall period; mean age or age range of participants; outcomes; study findings and conclusions. Extracted data on health status, nutritional status and costs included: average number of appointments per patient; average number of follow-up visits per patient; average material costs per patient; average laboratory costs per patient; average labour costs incurred per patient; average total cost of treatment per patient; cost-effectiveness ratio; Vitamin B12 (ng/l); Serum Folate (ng/ml); Serum Ferritin (ng/ml); Albumin (g/l); Serum Total Cholesterol (mmol/l); Vitamin D (nmol/l); change of median daily intake of Total energy (kcal/day); change of median daily intake of

**Table 1**
Population Intervention/exposure Comparison Outcome (PICO) table showing the focus question, inclusion criteria, information sources, search terms, and the search strategy applied for this systematic review.

| Focus question | Is a shortened dental arch a good alternative to a conventional prosthodontic rehabilitation for older adults when nutritional and economic factors are compared? | |
|---|---|---|
| Criteria | Inclusion criteria | • Studies reporting on the effects of shortened dental arches and conventional prosthodontic rehabilitation on nutrition as well as economics<br>• Sample size >10 cases<br>• Subjects must have been clinically followed in recalls<br>• Randomized and non-randomised clinical studies |
| | Exclusion criteria | • Age < 18 years<br>• Animal studies<br>• In vitro experiments |
| Information sources | Electronic databases | PubMed (MEDLINE), Embase, the Cochrane Central Register of Controlled Trials (CENTRAL), and Web of Science |
| | Journals | Peer-reviewed dental journals available in PubMed (MEDLINE), Embase, CENTRAL, and Web of Science databases |
| | Others | Online search engines (Google, Yahoo), online research community websites (https://www.researchgate.net) |
| Search terms | Population | #1 [MeSH]: “adult” OR “patients” OR “persons” OR “young adult” OR “aged” OR “humans”<br>#2 [All fields]: “adult” OR “adults” OR “adulthood” OR “patient” OR “patients” OR “person” OR “persons” OR “young” OR “old” OR "young adult" OR "aged" OR "people" OR "elderly" |
| | Intervention or exposure | #3 [MeSH]: "dental arch"<br>#4 [All fields]: "short" OR "shorts” OR "shorten" OR "shortened" OR "shortening" OR "shortenings" OR "shortens" OR "dental" OR "arch" OR "dental arch" |
| | Comparison | #5 [MeSH]: "dental implants" OR "denture, partial, removable"<br>OR "denture, partial, fixed, resin-bonded" OR "adhesiveness" OR "adhesives"<br>#6 [All fields]: "implants" OR "dental implants" OR "dental" OR "implant" OR "dental implant" OR "denture" OR "partial" OR "removable" OR "removable partial denture" OR "adhese" OR "adhesion" OR "adhesions" OR "adhesive s" OR "adhesively" OR "adhesiveness" OR "adhesivenesses" OR "adhesives" OR "adhesive" OR "adhesivities" OR "adhesivity" OR "bridge" OR "bridged" OR "bridges" OR "bridging" OR "bridgings" OR "fixed" OR "resin bonded" OR "resin-bonded fixed partial denture" OR "maryland" OR "maryland bridge" OR “cantilever” |
| | Outcome | #7 [MeSH]: “food” OR “diet” OR “meal” OR “meals” OR “feeding behavior” OR “eating” OR “fasting” OR “habits” OR “diet, healthy” OR “diet, mediterranean” OR “diet, high-fat” OR “diet, fat-restricted” OR “diet, protein-restricted” OR “diet, high-protein” OR “diet, ketogenic” OR “caloric restriction” OR “diet, carbohydrate-restricted” OR “diet, gluten-free” OR “dietary approaches to stop hypertension” OR “diet, diabetic” OR “diet, sodium-restricted” OR “diet, macrobiotic” OR “raw foods” OR “food, organic” OR “diet, paleolithic” OR “diet, vegan” OR “vegans” OR “diet, vegetarian” OR “vegetarians” OR “plants” OR “meat” OR “fibers” OR “vegetables” OR “aliment” OR “snack” OR “fast-food” OR "economics" OR "costs and cost analysis" OR "cost benefit analysis" OR "cost-benefit analysis"<br>#8 [All fields]: “food” OR “diet” OR “dietary” OR “meals” OR “meal” OR “eating” OR “eating habits” OR “dietary habits” OR “habits” OR “fasting” OR “food intake” OR “feeding” OR “feeding behavior” OR “nutrition” OR “healthy diet” OR “mediterranean” OR “mediterranean diet” OR “nordic” OR “asian” OR “indian" OR “eastern” OR “high-fat diet” OR “high fat diet” OR “fat-restricted diet” OR “protein-restricted diet” OR “low protein diet” OR “high-protein diet” OR “high protein diet” OR “low fat diet” OR “ketogenic diet” OR “low calorie diet” OR “caloric restriction” OR “carbohydrate-restricted diet” OR “detox” OR “crash” OR “gluten free diet” OR “diabetic diet” OR “dash diet” OR “dietary approaches to stop hypertension” OR “dietary” OR “sodium-restricted diet” OR “low sodium diet” OR “macrobiotic diet” OR “raw foods” OR “organic food” OR “paleolithic diet” OR vegan diet” OR “vegan” OR “vegans” OR “veganism” OR vegetarian OR “vegetarian diet” OR “vegetarians” OR “vegetarianism” OR lactovegetarian OR “lacto-vegetarian” OR “ovo vegetarian” OR “ovo-vegetarian” OR “ovo lacto vegetarian” OR “lacto ovo vegetarian” OR “plant based diet” OR “plant based nutrition” OR “plants” OR “nonmeat” OR “non-meat” OR “non-meat-eaters” OR “non-vegetarian” OR “nonvegetarian” OR “meat-eaters” OR “fish-eaters” OR “poultry-eaters” OR “meat” OR “carnivore” OR “carnivores” OR “omnivore” OR “fruitarian” OR “pescatarian” OR “flexitarian” OR "economical" OR "economics” OR "economic" OR "economically" OR "economization" OR "economize" OR "economized" OR "economizes" OR "economizing" OR "costed" OR "costing" OR "costings" OR "costs" OR "cost" OR "costs and cost analysis" OR "cost-benefit" OR "cost-benefit analysis" OR "cost effectiveness" OR "cheap" OR "cheapness” OR "inexpensive" OR "inexpensively" OR "inexpensiveness" |
| Filters | Journal categories | Dental journals |
| Search Builder | Search combination | #1 OR #2 AND #3 OR #4 AND #5 OR #6 AND #7 OR #8 |
| Search dates | | The final search was performed on the 14th November 2021 and was updated on the 6th of November 2022. No further searches were performed after the last update. |

percentage fat of total energy (%); change of median daily intake of percentage Carbohydrates of total energy (%); change of median daily intake of Sugar (g/day); change of median daily intake of Non Starch Polysaccharide (g/day); change of median daily intake of Protein (g/day); change of median daily intake of Vitamin C (mg/day); change of median daily intake of Vitamin D (μg/day); change of median daily intake of Calcium (mg/day); change of median daily intake of Iron (mg/day); change of median daily intake of fruits and vegetables (g/day); mean MNA (Mini Nutritional Assessment) score, mean MNA-SF (short form of the Mini Nutritional Assessment) score.

### 2.8. Missing data

Where information was missing or unclear within a study, the corresponding authors were contacted in order to request the missing information. Reminders were sent in case of a non-response. If finally, no response was received, the available data was analysed qualitatively.

### 2.9. Risk of bias and quality assessment of the included studies

The risk of bias in the included studies was assessed using the Cochrane Collaboration’s tool [28].

### 2.10. Summary measures

In this systematic review the main outcome measures were nutritional status and costs, and this included:

a Nutritional status, dietary intake and haematological biomarkers: Vitamin B12 (ng/l), Serum Folate (ng/ml), Serum Ferritin (ng/ml), Albumin (g/l), Serum Total Cholesterol (mmol/l), Vitamin D (nmol/l), Change of median daily intake of Total energy (kcal/day), Change of median daily intake of percentage fat of total energy (%), Change of median daily intake of percentage of carbohydrates of total energy (%), Change of median daily intake of Sugar (g/day), Change of median daily intake of Non starch polysaccharide (g/day), Change of

**Table 2**
Studies comparing the nutritional improvements in the participants rehabilitated with a functionally-oriented shortened dental arch (SDA) and conventional removable dental prostheses (RDPs) treatments.

| First Author (year) | Study-setting | Study design | Study groups | Participants (n) | Mean age ± SD (years) | Recall period (months) | Study findings | Study conclusions |
|---|---|---|---|---|---|---|---|---|
| McKenna et al. (2014)[13] | University & geriatric hospital settings | RCT | SDA Vs. RDP | SDA = 45: ♂ = 44.68%, ♀ = 55.32%<br>RDP = 44: ♂ = 46.67%, ♀ = 53.33% | SDA = 73.2 ± 5.67<br>RDP = 72.89 ± 6.31 | 12 | Mean Vit. B12 (ng/l):<br>SDA = 266 ±115<br>RDP = 266 ± 109<br>p = 0.9392<br>Mean Serum Folate (ng/ml):<br>SDA = 7.7 ± 3.7<br>RDP = 9 ± 4.4<br>p = 0.5827<br>Mean Serum Ferritin (ng/ml):<br>SDA = 143 ± 109<br>RDP = 135 ± 95<br>p = 0.6964<br>Mean Albumin (g/l):<br>SDA = 41.3 ± 3.8<br>RDP = 41.1 ± 3.3<br>p = 0.8179<br>Mean Serum Total Cholesterol (mmol/l):<br>SDA = 5.1 ± 0.8<br>RDP = 4.9 ± 0.8<br>p = 0.367<br>Mean Vitamin D (nmol/l):<br>SDA = 79 ± 32<br>RDP = 79 ± 33<br>p > 0.05 | Regarding the impact on the nutritional status, treatment of partially edentate adults with the shortened dental arch concept is not inferior to conventional rehabilitation with RDPs. |
| McKenna et al. (2015)[29] | University & geriatric hospital settings | RCT | SDA Vs. RDP | SDA = 45<br>RDP = 44 | Overall mean 70.18 years<br>Age range: 65-92 years (at the start of the study) | 12 | Mean MNA:<br>SDA = 22.94 ± 3.98<br>RDP = 23.2 ± 3.52<br>Mean MNA-SF:<br>SDA = 12.02 ± 1.91<br>RDP = 12.00 ± 1.68 | Significant improvements in the MNA were observed within both treatment groups. |
| Moynihan et al. (2000)[30] | Dental hospital setting | RCT | SDA Vs. RDP | SDA = 20: ♂ = 9, ♀ = 11<br>RDP = 19: ♂ = 8, ♀ = 11 | SDA = 64.7 (8.5)<br>RDP = 65.5 (10.4) | 12 | Change of median daily intake of Total energy (kcal/day):<br>SDA = 57<br>RDP = 1.7<br>p = 0.82<br>Change of median daily intake of<br>Per cent fat of total energy (%):<br>SDA = -0.3<br>RDP = 3.3<br>p = 0.51<br>Change of median daily intake of Per cent Carbohydrates of total energy (%):<br>SDA = -1.0<br>RDP = -0.7<br>p = 0.44<br>Change of median daily intake of Sugar (g/day):<br>SDA = 8.2<br>RDP = -6.9<br>p = 0.14<br>Change of median daily intake of Non starch polysaccharide (g/day):<br>SDA = 0.8<br>RDP = 0.6<br>p = 0.9<br>Change of median daily intake of Protein (g/day):<br>SDA = 0.9<br>RDP = 0.9<br>p = 0.88 | There was no dietary improvement after rehabilitation of the severely shortened dental arch neither with RBB nor with RDP. |

(*continued on next page*)

**Table 2** (*continued*)

| First Author (year) | Study-setting | Study design | Study groups | Participants (n) | Mean age ± SD (years) | Recall period (months) | Study findings | Study conclusions |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Change of median daily intake of Vitamin C (mg/day):<br>SDA = 9.5<br>RDP = 0.7<br>p = 0.21<br>Change of median daily intake of Vitamin D (µg/day):<br>SDA = 0.3<br>RDP = 0.3<br>p = 0.94<br>Change of median daily intake of Calcium (mg/day):<br>SDA = -71<br>RDP = 55<br>p = 0.16<br>Change of median daily intake of Iron (mg/day):<br>SDA = -0.1<br>RDP = -0.2<br>p = 0.65<br>Change of median daily intake of fruits and vegetables (g/day):<br>SDA = 6<br>RDP = -1<br>p = 0.98 | |

n: number; RCT: Randomized controlled trial; SDA: shortened dental arch; RBB: resin bonded adhesive bridgework; RDP: removable dental prosthesis; MNA: Mini-nutritional assessment; MNA-SF: Mini-nutritional assessment short form

**Table 3**
Studies comparing the cost-effectiveness of the functionally-oriented shortened dental arch (SDA) treatment concept with conventional removable dental prosthesis (RDP) therapy.

| First Author (year) | Study setting | Study design | Study groups | Participants (n) | Mean age ± SD (years) | Recall period (months) | Study findings | Study conclusions |
|---|---|---|---|---|---|---|---|---|
| McKenna et al. (2014) [22] | University & geriatric hospital settings | RCT | SDA Vs. RDP | SDA = 46: ♂ = 20, ♀ = 26<br>RDP = 46: ♂ = 21, ♀ = 25 | SDA = 70.89<br>RDP = 69.2 | 12 | Average number of appointments per patient: SDA = 4.5, RDP = 8.6; p < 0.001<br>Average number of follow-up visits per patient: SDA = 0.7, RDP = 2.3; p < 0.001<br>Average material costs per patient (€): SDA = 26.1, RDP = 22.37; p = 0.01<br>Average laboratory costs per patient (€): SDA = 234.71, RDP = 346.09; p < 0.001<br>Average laboratory costs incurred per patient (€): SDA = 122.73, RDP = 217.91; p < 0.001<br>Average total cost of treatment per patient (€): SDA = 384.05 ± 98.71, RDP = 586.37 ± 124.85; p < 0.001<br>Cost-effectiveness ratio (SDA:RDP) = 1:1.84 | Functionally oriented treatment with SDA was more cost-effective than conventional treatments with RDPs. |

n: number; SD: standard deviation; RCT: randomized controlled trial; SDA: shortened dental arch; RDP: removable dental prostheses; €: Euros.

median daily intake of Protein (g/day), Change of median daily intake of Vitamin C (mg/day), Change of median daily intake of Vitamin D (µg/day), Change of median daily intake of Calcium (mg/day), Change of median daily intake of Iron (mg/day), Change of median daily intake of fruits and vegetables (g/day)

b Anthropometrics: Mean MNA (Mini Nutritional Assessment) score, Mean MNA-SF (short form of the Mini Nutritional Assessment) score

c Costs: Average number of appointments per patient, Average number of follow-up visits per patient, Average material costs per patient, Average laboratory costs per patient, Average labour costs incurred per patient, Average total cost of treatment per patient, Cost-effectiveness ratio

### 2.11. Synthesis of results

Inter-investigator reliability was assessed using a calculated Kappa (κ) score. Due to the completely different methods for measuring nutritional status in the included studies it was not possible to conduct a meta-analysis from the data extracted. Therefore, the included studies were reported qualitatively.

### 2.12. Risk of publication bias and additional analyses

Qualitative, descriptive analysis of the extracted data was performed.

## 3. Results

### 3.1. Screening, Study selection and inter-investigator agreement

The complete search, screening, identification, selection and inclusion procedure are shown in Fig. 1. Initially 13718 articles were identified from 3 databases (PubMed n = 5046, Embase n = 1873, CENTRAL n = 6799). After a first sweep, 13582 articles were eliminated, with 136 articles included for title and abstract screening. After elimination of duplicates, reviews, irrelevant articles and those that did not meet the inclusion criteria, 92 articles remained for full-text analysis. After the full-text analysis, 88 records were eliminated resulting in four reports from two studies remaining for data extraction and analysis [13,22,29,30]. The calculated κ for the entire search, identification, screening, and inclusion process ranged between 0.80 and 1.00.

### 3.2. Characteristics of included studies

#### 3.2.1. Study population

In a randomised controlled clinical trial (RCT) by McKenna et al. (2014, 2014, 2015) patients were recruited from a Dental Hospital and a nursing home in, Cork, Ireland [13,22,29]. With an overall age ranging from 65 - 92 years, 45 patients were rehabilitated to an SDA using Resin-Bonded Adhesive Bridgework (RBB) (mean age: 73.2 ± 5.67 years, 55.32% females) compared to 44 Patients (mean age :72.89 ± 6.31 years, 53.33% females) treated using an RPD. Inclusion criteria for both study groups was a minimum of six sound teeth in one arch in positions which could be restored to an SDA.

Moynihan et al. (2000) conducted a RCT with patients awaiting

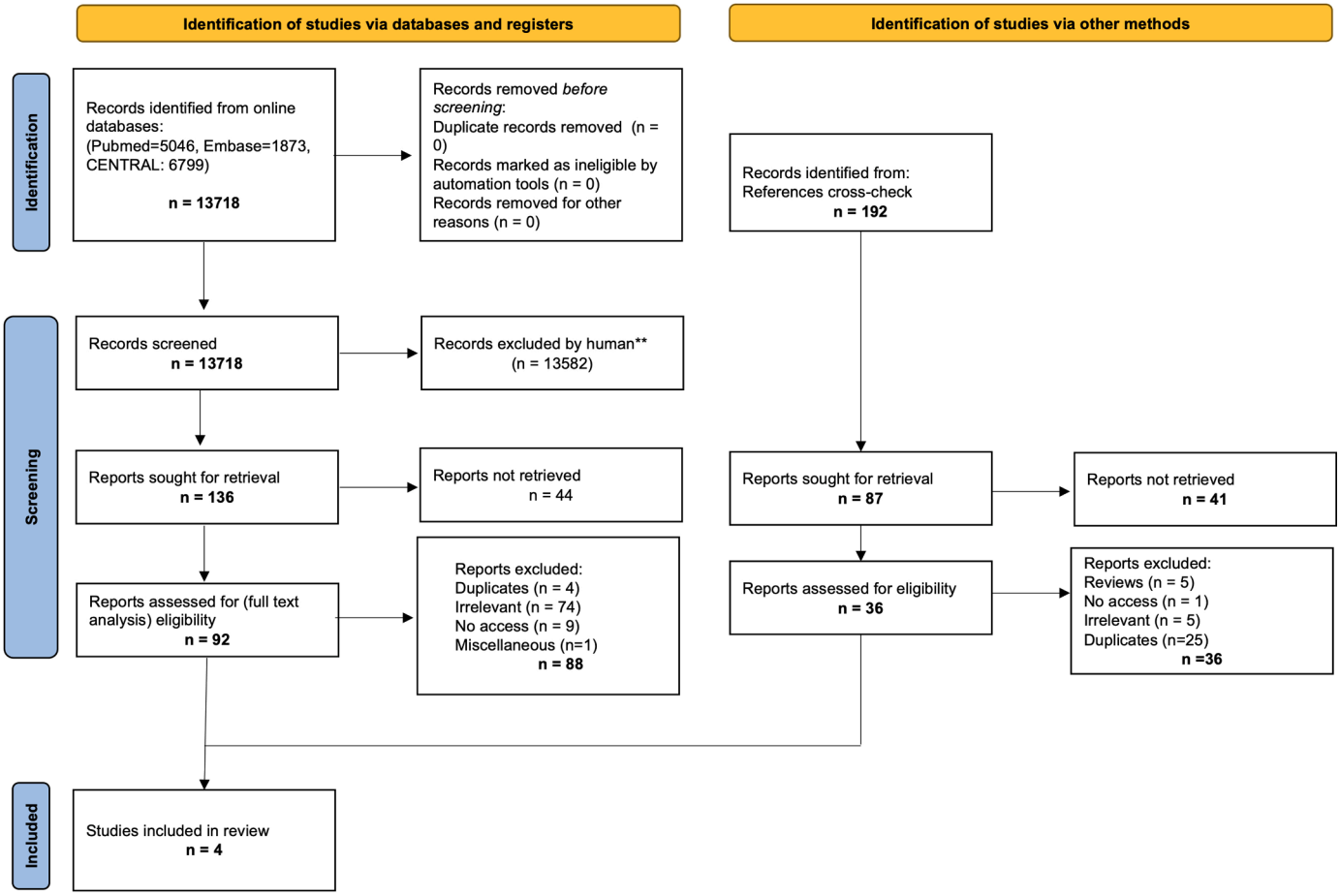


**Fig. 1.** PRISMA (preferred reporting items for systematic reviews and meta-analysis) flow diagram showing the screening, identification and inclusion process of the studies included for the systematic review (n=number).

**Table 4**
Risk of bias assessment of the included RCTs using the Cochrane Collaboration tool.

| Study/Year | Sequence allocation | Allocation concealment | Blinding | Incomplete outcome data | Selective outcome reporting | Other sources of bias |
|---|---|---|---|---|---|---|
| Mckenna et al. (2014)[13] | Low | Low | Unclear | Low | Unclear | Low |
| Mckenna et al. (2014)[22] | Low | Low | Unclear | Low | Unclear | Low |
| McKenna et al. (2015)[29] | Low | Low | Unclear | Low | Unclear | Low |
| Moynihan et al. (2000)[30] | Unclear | Unclear | Unclear | Low | Low | Low |

provision of a lower bilateral free-end saddle denture from a Dental Hospital in Newcastle-upon-Tyne, United Kingdom.[30] Within this study, patients were treated either using a lower partial denture (n = 19; mean age: 65.5 ± 10.4 years, 8 males, 11 females) or provided with bridgework to restore them to a SDA in the lower arch (n = 20; mean age: 64.7 ± 8.5 years, 9 males, 11 females). The mean number of lower teeth remaining was 6.7 for denture group and 6.6 for the SDA group. In the opposing arch, 19 SDA patients had complete upper dentures compared to 17 denture patients. Four patients had a partial upper denture. The inclusion criteria for this study were a maximum of 8 lower teeth and 1 to 2 anterior spaces allowed, provided, they were restorable using RBBs. In addition, plaque scores of 20% or less were required prior to the treatment interventions.

#### 3.2.2. Intervention

In the two included studies, patients were restored to SDAs using RBB. For the control arm in both studies, patients in the RPD groups were rehabilitated using cast metal framework prostheses replacing all missing teeth.

#### 3.2.3. Outcome measures: NUTRITION

Haematological samples were used to measure nutritional biomarkers and data were also generated using the MNA and MNA-SF in reports by Mckenna et al. (2014, 2015) [13,29]. In the study by Moynihan et al. (2000), nutritional status was measured using questionnaires and diet diaries [30].

#### 3.2.4. Outcome measures: Treatment Costs

McKenna et al. (2014) recorded costs involved in each procedure including laboratory bills after 12 months [22]. The calculated costs for these studies were based on a publicly funded body. To assess cost-effectiveness, the cost of achieving the minimally important clinical difference (MID) in OHIP-14 was measured and compared. No other studies included a measurement of treatment costs.

### 3.3. Characteristics of excluded studies

The details of the excluded studies and the reasons for their exclusion are provided in Appendix a.

### 3.4. Qualitative data analysis of the searched outcome

#### 3.4.1. Nutritional status

According to the analysis of haematological biomarkers, no significant difference was recorded in the nutritional status of patients rehabilitated using the SDA concept compared with RPDs in the study by McKenna et al. (2014), and improvements in Vitamin D levels in both the control and intervention groups were observed (Table 2) [13]. Both groups demonstrated improved MNA scores 12 months after treatment as reported in Mckenna et al. (2015), but no significant between group differences were noted [29]. Moynihan et al. (2000) observed a significant increase in percentage of energy from fat consumed by patients from the RPD group, and no other significant difference was observed between the two groups in this study (Table 2) [30].

#### 3.4.2. Costs

McKenna et al. (2014) calculated significantly higher costs for treatment provision and maintenance for patients in the RPD group, compared to SDA treatment group (Table 3). The authors concluded that SDA treatment was more cost-effective than RPDs [22]. The cost-effectiveness ratio, calculated by comparing the total costs of achieving the MID, was 1:1.84 (SDA:RPD) [22].

### 3.5. Risk of bias and quality assessment of the included studies

The risk of bias as assessed by the Cochrane collaboration tool for the two included RCTs was found to be between low and moderate (Table 4).

## 4. Discussion

This systematic review identified two records with three reports [13,29,30], which could be included for descriptive, qualitative data analysis on nutritional status and, one report which included information on treatment costs [22]. Quantitative data analysis by meta-analysis was not possible due to the different methods (diet diaries compared to haematological biomarkers and the MNA) used to assess nutritional status.

In the study by McKenna et al. (2014), a panel of haematological biomarkers of nutritional status were compared at baseline and at follow up for the two treatment groups [13]. Aside from Vitamin D, no inter-group differences were observed following prosthodontic rehabilitation. Similar results were observed for MNA and MNA-SF scores [29]. In the study by Moynihan et al. (2000), a significant increase in fat intake in the RPD group was reported which may be due to a diet higher in softer, processed foods consumed by patients rehabilitated using removable partial dentures [30].

As in studies reporting on the nutritional status of edentate patients, both of the included RCTs illustrate that replacing missing teeth alone is insufficient to illicit behaviour change by way of dietary intake [31–33]. A later paper by Wallace et al. (2018) [34], describing the same patient cohort as the reports from McKenna et al. (2014, 2015) [13,29], demonstrated that patients in both the SDA and RPD groups experienced an improvement in masticatory performance but not in the dietary intake or the nutritional status. Given the complex nature of nutrition behaviour, whilst oral rehabilitation is important, it is necessary to combine prosthodontic interventions with tailored dietary interventions. In order to improve nutritional status in partially dentate older adults, a multidisciplinary approach may be necessary involving oral health practitioners, dietitians, and nutritionists [33].

Whilst the included studies for this systematic review were both RCTs, blinding of the included patients and clinicians was not achieved or feasible. In the reports from McKenna et al. (2014, 2014, 2015), the outcome assessors were blinded to the treatment groups [13,22,29]. The sample sizes were quite small in both studies but sample size calculations were included. The design of the RPDs in both RCTs followed conventional removable prosthodontic designs where clasps were used to retain the prostheses [13,29,35]. No studies on implants or other prosthodontic interventions were included.

The study by McKenna et al. (2014) was the only included study to detail treatment costs [22]. The authors concluded that SDA treatment was more cost-effective than conventional treatments with RPD which conforms with the null hypothesis for this review. The calculated costs for these studies were based on a publicly funded body so it was

estimated that the difference in the cost-effectiveness could have been even greater in other countries or in private practice settings [22]. The SDA study group had lower laboratory costs and significantly less treatment time which influenced the estimated costs dramatically. Also, significantly less follow-up visits were required in the RBB group compared to the RPD group. This has already been shown in earlier studies [36]. This gave the SDA treatment additional advantages in terms of opportunity-costs to the patient [22].

The question remains as to how cost-effectiveness will change over time for both treatment groups. Previous studies found that restored SDAs had similar survival rates compared to restoration by RPDs and that the RPD's required more maintenance than the RBBs [36,37]. The success rates for the treatments provided in the McKenna et al. study were reported again at 3 years post intervention [38,39]. The survival analysis demonstrated an overall success rate of 90.4% for the SDA treatment compared to 73.0% for the RPD group. This would suggest a widening of the cost-effectiveness ratio in favour of the SDA treatment. Furthermore, it was demonstrated that a large proportion of lower RPDs constructed as part of the study were not being worn after three years, which suggests a large amount of public funds being wasted on this treatment. In a similar study, caries prevalence was found to be higher in patients with RPDs than in those with fixed bridgework [40]. Again, this would suggest that the costs of RPDs will continue to rise in line with the caries prevalence [22].

This systematic review followed the guidelines directed by the PRISMA checklist and reported as such. Thus, the present systematic review adhered to robust methodology. Even though all available, relevant studies have been identified, only a very small number of studies could be included for data analysis. A major limitation of this systematic review is that no meta-analysis could be performed and therefore the estimate of treatment effect is limited. This would suggest that further studies are required to examine the important outcomes of nutritional status and treatment costs associated with prosthodontic interventions, perhaps in combination with behaviour change interventions.

## 5. Conclusion

This systematic review identified the shortened dental arch concept as a reasonable alternative to the conventional prosthodontic rehabilitation where cost-effectiveness and nutrition are concerned based on the limited evidence obtained from current literature.

## Declaration of Competing Interest

The authors declare no conflicts of interests.

## Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

## Appendix A. Studies excluded after full text analysis

| Sl. No. | Study | Reason for exclusion |
|---|---|---|
| 1 | Sasse M, Kern M, Marré B, Walter MH. Clinical performance of cantilevered fixed dental prostheses abutments in the shortened dental arch. J Dent. 2014;42(3):373-6 | Not nutrition/cost-effectiveness |
| 2 | Gerritsen AE, Witter DJ, Bronkhorst EM, Creugers NH. Increased risk for premolar tooth loss in shortened dental arches. J Dent. 2013;41(8):726-31 | Not nutrition/cost-effectiveness |
| 3 | Wöstmann B, Michel K, Brinkert B, Melchheier-Weskott A, Rehmann P, Balkenhol M. Influence of denture improvement on the nutritional status and quality of life of geriatric patients. J Dent. 2008;36(10):816-21 | Not SDA |
| 4 | Thomason JM, Moynihan PJ, Steen N, Jepson NJ. Time to survival for the restoration of the shortened lower dental arch. J Dent Res. 2007;86(7):646-50 | Not nutrition/cost-effectiveness |
| 5 | Wallace S, Samietz S, Abbas M, McKenna G, Woodside JV, Schimmel M. Impact of prosthodontic rehabilitation on the masticatory performance of partially dentate older patients: Can it predict nutritional state? Results from a RCT. J Dent. 2018;68:66-71 | Results from McKenna et al. (2014) |
| 6 | Khan S, Chikte UM, Omar R. Outcomes with a posterior reduced dental arch: a randomised controlled trial. J Oral Rehabil. 2017;44 (11):870-8 | Not nutrition/cost-effectiveness |
| 7 | Tanasić I, Radaković T, Šojić LT, Lemić AM, Soldatović I. Association Between Dentition Status and Malnutrition Risk in Serbian Elders. Int J Prosthodont. 2016;29(5):484-6 | Not SDA |
| 8 | Iwasaki M, Yoshihara A, Ogawa H, Sato M, Muramatsu K, Watanabe R, et al. Longitudinal association of dentition status with dietary intake in Japanese adults aged 75 to 80 years. J Oral Rehabil. 2016;43(10):737-44 | Not SDA |
| 9 | Walter MH, Dreyhaupt J, Hannak W, Wolfart S, Luthardt RG, Stark H, et al. The Randomized Shortened Dental Arch Study: Tooth Loss Over 10 Years. Int J Prosthodont. 2018;31(1):77-84 | Not nutrition/cost-effectiveness |
| 10 | Kern JS, Wolfart S, Hilgers RD, Marré B, Scheller H, Strub J, et al. The randomized shortened dental arch study: influence of two different treatments on interdental spacing over 5 years. Clin Oral Investig. 2017;21(6):1945-51 | Not nutrition/cost-effectiveness |
| 11 | Peršić S, Kranjčić J, Pavičić DK, Mikić VL, Čelebić A. Treatment Outcomes Based on Patients' Self-Reported Measures after Receiving New Clasp or Precision Attachment-Retained Removable Partial Dentures. J Prosthodont. 2017;26(2):115-22 | Not SDA |
| 12 | van Eekeren PJ, Aartman IH, Tahmaseb A, Wismeijer D. The effect of implant placement in patients with either Kennedy class II and III on oral health-related quality of life: a prospective clinical trial. J Oral Rehabil. 2016;43(4):291-6 | Not SDA |
| 13 | Kumar Y, Chand P, Arora V, Singh SV, Mishra N, Alvi HA, et al. Comparison of Rehabilitating Missing Mandibular First Molars with Implant- or Tooth-Supported Prostheses Using Masticatory Efficiency and Patient Satisfaction Outcomes. J Prosthodont. 2017;26 (5):376-80 | Not SDA |
| 14 | Campos CH, Gonçalves TM, Garcia RC. Implant-Supported Removable Partial Denture Improves the Quality of Life of Patients with Extreme Tooth Loss. Braz Dent J. 2015;26(5):463-7 | Not SDA |
| 15 | Fueki K, Baba K. Shortened dental arch and prosthetic effect on oral health-related quality of life: a systematic review and meta-analysis. J Oral Rehabil. 2017;44(7):563-72 | Not nutrition/cost-effectiveness |
| 16 | Levey C, Dunbar C. Shortened dental arch concept shown to be cost effective. Evid Based Dent. 2015;16(1):19-20 | Commentary on McKenna et al. (2014) |
| 17 | Gonçalves TM, Campos CH, Garcia RC. Effects of implant-based prostheses on mastication, nutritional intake, and oral health-related quality of life in partially edentulous patients: a paired clinical trial. Int J Oral Maxillofac Implants. 2015;30(2):391-6 | Not SDA |
| 18 | Swelem AA, Gurevich KG, Fabrikant EG, Hassan MH, Aqou S. Oral health-related quality of life in partially edentulous patients treated with removable, fixed, fixed-removable, and implant-supported prostheses. Int J Prosthodont. 2014;27(4):338-47 | Not nutrition/cost-effectiveness |

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| Sl. No. | Study | Reason for exclusion |
|---|---|---|
| 19 | McKenna G, Allen PF, O'Mahony D, Cronin M, DaMata C, Woods N. The impact of rehabilitation using removable partial dentures and functionally orientated treatment on oral health-related quality of life: a randomised controlled clinical trial. J Dent. 2015;43 (1):66-71 | Not nutrition/cost-effectiveness |
| 20 | Gonçalves TM, Campos CH, Rodrigues Garcia RC. Mastication and jaw motion of partially edentulous patients are affected by different implant-based prostheses. J Oral Rehabil. 2014;41(7):507-14 | Not SDA |
| 21 | Wolfart S, Müller F, Gerß J, Heyedcke G, Marré B, Böning K, et al. The randomized shortened dental arch study: oral health-related quality of life. Clin Oral Investig. 2014;18(2):525-33 | Not nutrition/cost-effectiveness |
| 22 | Sánchez-Ayala A, Gonçalves TM, Ambrosano GM, Garcia RC. Influence of length of occlusal support on masticatory function of free-end removable partial dentures: short-term adaptation. J Prosthodont. 2013;22(4):313-8 | Not nutrition/cost-effectiveness |
| 23 | Grover M, Vaidyanathan AK, Veeravalli PT. OHRQoL, masticatory performance and crestal bone loss with single-implant, magnet-retained mandibular overdentures with conventional and shortened dental arch. Clin Oral Implants Res. 2014;25(5):580-6 | Not nutrition/cost-effectiveness |
| 24 | Gates WD, 3rd, Cooper LF, Sanders AE, Reside GJ, De Kok IJ. The effect of implant-supported removable partial dentures on oral health quality of life. Clin Oral Implants Res. 2014;25(2):207-13 | Not nutrition/cost-effectiveness |
| 25 | Walter MH, Hannak W, Kern M, Mundt T, Gernet W, Weber A, et al. The randomized shortened dental arch study: tooth loss over five years. Clin Oral Investig. 2013;17(3):877-86 | Not nutrition/cost-effectiveness |
| 26 | McKenna G, Allen PF, Woods N, O'Mahony D, DaMata C, Cronin M, et al. A preliminary report of the cost-effectiveness of tooth replacement strategies for partially dentate elders. Gerodontology. 2013;30(3):207-13 | Preliminary report on McKenna et al (2014a) |
| 27 | McKenna G, Allen PF, O'Mahony D, Cronin M, DaMata C, Woods N. Impact of tooth replacement on the nutritional status of partially dentate elders. Clin Oral Investig. 2015;19(8):1991-8 | Preliminary report on McKenna et al. (2014) |
| 28 | Fueki K, Igarashi Y, Maeda Y, Baba K, Koyano K, Akagawa Y, et al. Factors related to prosthetic restoration in patients with shortened dental arches: a multicentre study. J Oral Rehabil. 2011;38(7):525-32 | Not nutrition/cost-effectiveness |
| 29 | Emami E, Feine JS. Resin-bonded cantilever partial dentures are effective in terms of patient satisfaction in the restoration of the mandibular shortened dental arch. J Evid Based Dent Pract. 2010;10(1):64-6 | Not nutrition/cost-effectiveness |
| 30 | Luthardt RG, Marré B, Heinecke A, Gerss J, Aggstaller H, Busche E, et al. The Randomized Shortened Dental Arch study (RaSDA): design and protocol. Trials. 2010;11:15 | Not nutrition/cost-effectiveness |
| 31 | Allen PF, O'Sullivan M, Locker D. Determining the minimally important difference for the Oral Health Impact Profile-20. Eur J Oral Sci. 2009;117(2):129-34 | Not SDA |
| 32 | Wolfart S, Heydecke G, Luthardt RG, Marré B, Freesmeyer WB, Stark H, et al. Effects of prosthetic treatment for shortened dental arches on oral health-related quality of life, self-reports of pain and jaw disability: results from the pilot-phase of a randomized multicentre trial. J Oral Rehabil. 2005;32(11):815-22 | Not nutrition/cost-effectiveness |
| 33 | Jepson NJ, Moynihan PJ, Kelly PJ, Watson GW, Thomason JM. Caries incidence following restoration of shortened lower dental arches in a randomized controlled trial. Br Dent J. 2001;191(3):140-4 | Not nutrition/cost-effectiveness |
| 34 | Kapur KK, Deupree R, Dent RJ, Hasse AL. A randomized clinical trial of two basic removable partial denture designs. Part I: Comparisons of five-year success rates and periodontal health. J Prosthet Dent. 1994;72(3):268-82 | No access |
| 35 | Montero J, Castillo-Oyagüe R, Lynch CD, Albaladejo A, Castaño A. Self-perceived changes in oral health-related quality of life after receiving different types of conventional prosthetic treatments: a cohort follow-up study. J Dent. 2013;41(6):493-503 | Not SDA |
| 36 | Okabe Y, Takeuchi K, Izumi M, Furuta M, Takeshita T, Shibata Y, et al. Posterior teeth occlusion and dysphagia risk in older nursing home residents: a cross-sectional observational study. J Oral Rehabil. 2017;44(2):89-95 | Not SDA |
| 37 | Stock C, Jürges H, Shen J, Bozorgmehr K, Listl S. A comparison of tooth retention and replacement across 15 countries in the over-50s. Community Dent Oral Epidemiol. 2016;44(3):223-31 | Not SDA |
| 38 | Wolfart S, Marré B, Wöstmann B, Kern M, Mundt T, Luthardt RG, et al. The randomized shortened dental arch study: 5-year maintenance. J Dent Res. 2012;91(7 Suppl):65s-71s | Not nutrition/cost-effectiveness |
| 39 | Furuyama C, Takaba M, Inukai M, Mulligan R, Igarashi Y, Baba K. Oral health-related quality of life in patients treated by implant-supported fixed dentures and removable partial dentures. Clin Oral Implants Res. 2012;23(8):958-62 | Not SDA |
| 40 | Goshima K, Lexner MO, Thomsen CE, Miura H, Gotfredsen K, Bakke M. Functional aspects of treatment with implant-supported single crowns: a quality control study in subjects with tooth agenesis. Clin Oral Implants Res. 2010;21(1):108-14 | Not SDA |
| 41 | Cardoso MG, Diniz-Freitas M, Vázquez P, Cerqueiro S, Diz P, Limeres J. Relationship between functional masticatory units and cognitive impairment in elderly persons. J Oral Rehabil. 2019;46(5):417-23 | Not SDA |
| 42 | Peruchi CT, Poli-Frederico RC, Cardelli AA, Fracasso ML, Bispo CG, Neves-Souza RD, et al. Association between oral health status and central obesity among Brazilian independent-living elderly. Braz Oral Res. 2016;30(1):e116 | Not SDA |
| 43 | Kim EJ, Jin BH. Comparison of oral health status and daily nutrient intake between elders who live alone and elders who live with family: Based on the Korean National Health and Nutrition Examination Survey (KNHANES VI) (2013-2015). Gerodontology. 2018;35(2):129-38 | Not SDA |
| 44 | Yamasaki Y, Kuwatsuru R, Tsukiyama Y, Oki K, Koyano K. Objective assessment of mastication predominance in healthy dentate subjects and patients with unilateral posterior missing teeth. J Oral Rehabil. 2016;43(8):575-82 | Not nutrition/cost-effectiveness |
| 45 | Antunes JL, Tan H, Peres KG, Peres MA. Impact of shortened dental arches on oral health-related quality of life. J Oral Rehabil. 2016;43(3):190-7 | Not nutrition/cost-effectiveness |
| 46 | Wiener RC, Wiener MA. Shortened dental arch and body mass index in adults 45-65 years of age: results from National Health and Nutrition Examination Survey 2005-2008. Int Dent J. 2015;65(5):277-82 | Not clinically followed in Recalls |
| 47 | Tan H, Peres KG, Peres MA. Do people with shortened dental arches have worse oral health-related quality of life than those with more natural teeth? A population-based study. Community Dent Oral Epidemiol. 2015;43(1):33-46 | Not nutrition/cost-effectiveness |
| 48 | Ito N, Kimoto S, Kawai Y. Does wearing dentures change sensory nerve responses under the denture base? Gerodontology. 2014;31 (1):63-7 | Not nutrition/cost-effectiveness |
| 49 | Adiatman M, Ueno M, Ohnuki M, Hakuta C, Shinada K, Kawaguchi Y. Functional tooth units and nutritional status of older people in care homes in Indonesia. Gerodontology. 2013;30(4):262-9 | Not SDA |
| 50 | Kreulen CM, Witter DJ, Tekamp FA, Slagter AP, Creugers NH. Swallowing threshold parameters of subjects with shortened dental arches. J Dent. 2012;40(8):639-43 | Not nutrition/cost-effectiveness |
| 51 | Guiney H, McKenna G, Whelton H, O'Mullane D. Is the shortened dental arch an underused treatment strategy in the Republic of Ireland? Community Dent Health. 2011;28(4):265-8 | Not nutrition/cost-effectiveness |
| 52 | Armellini DB, Heydecke G, Witter DJ, Creugers NH. Effect of removable partial dentures on oral health-related quality of life in subjects with shortened dental arches: a 2-center cross-sectional study. Int J Prosthodont. 2008;21(6):524-30 | Not nutrition/cost-effectiveness |
| 53 | Hattori Y, Mito Y, Watanabe M. Gastric emptying rate in subjects with experimentally shortened dental arches: a pilot study. J Oral Rehabil. 2008;35(6):402-7 | Not nutrition/cost-effectiveness |
| 54 | Chai J, Chu FC, Chow TW, Shum NC, Hui WW. Influence of dental status on nutritional status of geriatric patients in a convalescent and rehabilitation hospital. Int J Prosthodont. 2006;19(3):244-9 | Not SDA |

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| Sl. No. | Study | Reason for exclusion |
|---|---|---|
| 55 | Sarita PT, Witter DJ, Kreulen CM, Van't Hof MA, Creugers NH. Chewing ability of subjects with shortened dental arches. Community Dent Oral Epidemiol. 2003;31(5):328-34 | Not nutrition/cost-effectiveness |
| 56 | Jones JA, Orner MB, Spiro A, 3rd, Kressin NR. Tooth loss and dentures: patients' perspectives. Int Dent J. 2003;53(5 Suppl):327-34 | Not SDA |
| 57 | Sheiham A, Steele JG, Marcenes W, Finch S, Walls AW. The impact of oral health on stated ability to eat certain foods; findings from the National Diet and Nutrition Survey of Older People in Great Britain. Gerodontology. 1999;16(1):11-20 | Not SDA |
| 58 | Hildebrandt GH, Dominguez BL, Schork MA, Loesche WJ. Functional units, chewing, swallowing, and food avoidance among the elderly. J Prosthet Dent. 1997;77(6):588-95 | Not SDA |
| 59 | Allen PF, Witter DF, Wilson NH, Kayser AF. Shortened dental arch therapy: views of consultants in restorative dentistry in the United Kingdom. J Oral Rehabil. 1996;23(7):481-5 | Not nutrition/cost-effectiveness |
| 60 | Aukes JN, Käyser AF, Felling AJ. The subjective experience of mastication in subjects with shortened dental arches. J Oral Rehabil. 1988;15(4):321-4 | Not nutrition/cost-effectiveness |
| 61 | Chauncey HH, Muench ME, Kapur KK, Wayler AH. The effect of the loss of teeth on diet and nutrition. Int Dent J. 1984;34(2):98-104 | No access |
| 62 | Baxter JC. The nutritional intake of geriatric patients with varied dentitions. J Prosthet Dent. 1984;51(2):164-8 | No access |
| 63 | Jiffry MT. Variations in the particles produced at the end of mastication in subjects with different types of dentition. J Oral Rehabil. 1983;10(4):357-62 | No access |
| 64 | Osterberg T, Steen B. Relationship between dental state and dietary intake in 70-year-old males and females in Göteborg, Sweden: a population study. J Oral Rehabil. 1982;9(6):509-21 | No access |
| 65 | Olley RC, Renton T, Frost PM. Observational study investigating tooth extraction and the shortened dental arch approach. J Oral Rehabil. 2017;44(8):610-6 | Not nutrition/cost-effectiveness |
| 66 | Nogawa T, Takayama Y, Ishida K, Yokoyama A. Comparison of Treatment Outcomes in Partially Edentulous Patients with Implant-Supported Fixed Prostheses and Removable Partial Dentures. Int J Oral Maxillofac Implants. 2016;31(6):1376-83 | Not nutrition/cost-effectiveness |
| 67 | Al-Omiri MK, Sghaireen MG, Alhijawi MM, Alzoubi IA, Lynch CD, Lynch E. Maximum bite force following unilateral implant-supported prosthetic treatment: within-subject comparison to opposite dentate side. J Oral Rehabil. 2014;41(8):624-9 | Not nutrition/cost-effectiveness |
| 68 | Bessadet M, Nicolas E, Sochat M, Hennequin M, Veyrune JL. Impact of removable partial denture prosthesis on chewing efficiency. J Appl Oral Sci. 2013;21(5):392-6 | Not nutrition/cost-effectiveness |
| 69 | Witter DJ, Woda A, Bronkhorst EM, Creugers NH. Clinical interpretation of a masticatory normative indicator analysis of masticatory function in subjects with different occlusal and prosthodontic status. J Dent. 2013;41(5):443-8 | Not nutrition/cost-effectiveness |
| 70 | Gerritsen AE, Witter DJ, Bronkhorst EM, Creugers NH. An observational cohort study on shortened dental arches–clinical course during a period of 27-35 years. Clin Oral Investig. 2013;17(3):859-66 | Not nutrition/cost-effectiveness |
| 71 | Charyeva OO, Altynbekov KD, Nysanova BZ. Kennedy classification and treatment options: a study of partially edentulous patients being treated in a specialized prosthetic clinic. J Prosthodont. 2012;21(3):177-80 | Not nutrition/cost-effectiveness |
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| 73 | Baba K, Igarashi Y, Nishiyama A, John MT, Akagawa Y, Ikebe K, et al. The relationship between missing occlusal units and oral health-related quality of life in patients with shortened dental arches. Int J Prosthodont. 2008;21(1):72-4 | Not nutrition/cost-effectiveness |
| 74 | Kuboki T, Okamoto S, Suzuki H, Kanyama M, Arakawa H, Sonoyama W, et al. Quality of life assessment of bone-anchored fixed partial denture patients with unilateral mandibular distal-extension edentulism. J Prosthet Dent. 1999;82(2):182-7 | Not nutrition/cost-effectiveness |
| 75 | Vermeulen AH, Keltjens HM, van't Hof MA, Kayser AF. Ten-year evaluation of removable partial dentures: survival rates based on retreatment, not wearing and replacement. J Prosthet Dent. 1996;76(3):267-72 | Not nutrition/cost-effectiveness |
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| 77 | Jemt T. Masticatory mandibular movements. Analysis of a recording method and influence of the state of the occlusion. Swed Dent J Suppl. 1984;23:1-52 | Not nutrition/cost-effectiveness |
| 78 | Jemt T, Hedegård B, Wickberg K. Chewing patterns before and after treatment with completè maxillary and bilateral distal-extension mandibular removable partial dentures. J Prosthet Dent. 1983;50(4):566-9 | Not nutrition/cost-effectiveness |
| 79 | Käyser AF. Shortened dental arches and oral function. J Oral Rehabil. 1981;8(5):457-62 | Not nutrition/cost-effectiveness |
| 80 | Nagasawa T, Tsuru H. A comparative evaluation of masticatory efficiency of fixed and removable restorations replacing mandibular first molars. J Prosthet Dent. 1973;30(3):263-73 | Not nutrition/cost-effectiveness |
| 81 | Iwashita H, Tsukiyama Y, Kori H, Kuwatsuru R, Yamasaki Y, Koyano K. Comparative cross-sectional study of masticatory performance and mastication predominance for patients with missing posterior teeth. J Prosthodont Res. 2014;58(4):223-9 | Not nutrition/cost-effectiveness |
| 82 | Shetty VD, Bijle MN, Patil S. The relationship between prosthetic status and the Geriatric Oral Health Assessment Index in a group of institutionalized elderly of an Indian city: a cross-sectional study. J Contemp Dent Pract. 2013;14(6):1173-7 | Not nutrition/cost-effectiveness |
| 83 | Mjör IA, Burke FJ, Wilson NH. The relative cost of different restorations in the UK. Br Dent J. 1997;182(8):286-9 | No access |
| 84 | Inukai M, Baba K, John MT, Igarashi Y. Does removable partial denture quality affect individuals' oral health? J Dent Res. 2008;87(8):736-9 | Not SDA |
| 85 | Rosenoer LM, Sheiham A. Dental impacts on daily life and satisfaction with teeth in relation to dental status in adults. J Oral Rehabil. 1995;22(7):469-80 | No access |
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| 87 | Hartsook EI. Food selection, dietary adequacy, and related dental problems of patients with dental prostheses. J Prosthet Dent. 1974;32(1):32-40 | No access |
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