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Review Article

Biting into accuracy: Evaluating food frequency questionnaires for denture wearers: A systematic review

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ABSTRACT

Objectives: The correlation between denture usage and nutrition is a subject of ongoing debate, with numerous authors attempting to investigate it using food frequency questionnaires (FFQ). This systematic review aimed to assess the quality of research reporting on the use of FFQ as a tool for evaluating nutrient intake in individuals who wear dentures.

Methods: Studies were sourced through online databases, encompassing publications from 1990 to 2024. Four studies employing FFQ to evaluate the nutritional status of denture wearers and meeting the specified inclusion-exclusion criteria were incorporated into this systematic review. Quality assessment of the included studies was independently conducted by two reviewers, utilizing the summary score provided by Dennis *et al*.

Results: All the studies included in the review utilized semi-quantitative FFQ, with most adopting the widely accepted and validated FFQ developed by Willet and Block. The majority of these studies received high-quality scores as per the assessment criteria established by Dennis *et al*. However, one study under review received a low score due to several shortcomings. This included failure to report the FFQ items utilized in the study, lack of repetition in quality checks, absence of nutrient database utilization for FFQ coding, inadequate portion size estimation, and insufficient information regarding survey completion time.

Conclusion: The articles included in the review, along with their quality assessments, provided insights into various aspects of FFQ design that enhance validity. These include the comprehensiveness of items covered, frequency of intake reporting, accuracy of portion size calculations, choice of reference technique, and method of delivery. It was observed that the majority of studies favored the interview administration of FFQ, which was deemed to be more reliable and acceptable during quality analysis.

Keywords: Dentures, dietary assessment, elderly individuals, food frequency questionnaires, food frequency questionnaire, nutritional status, oral prosthesis

Introduction

The food frequency questionnaire (FFQ) is presently the main method of estimating the role of diet in the etiology of chronic diseases. The attractive part of FFQ is based on its low cost and feasibility as compared to other diet assessment scales.[1] There is still some limitation to FFQ, its mainly related to non-discrimination of specific food items from food groups.[2] In addition, the food group list limits its flexibility related to the handwritten food and diet records; like data on cooking procedure get lost and person has to confirm daily portion size with that of listed on the form. Due to this weakness of FFQ, validity and reliability of each questionnaire need to be assessed.[1] Each study design estimate dietary intake based on study aims and objectives, it also differs in study population and accuracy of list of the food groups and dietary data.[3] Although the FFQ has few limitations, it is less expensive method of obtaining information from large population with low compliance from the individual over longer period of time.[3] In dietary evaluation, there is no specific "gold standard" or there is a "benchmark" to ensure the accuracy of the FFQ.[4] Thus the, determining the relative validity of a tool relies on a comparative validation, with a superior and ideally separate technique.[5]

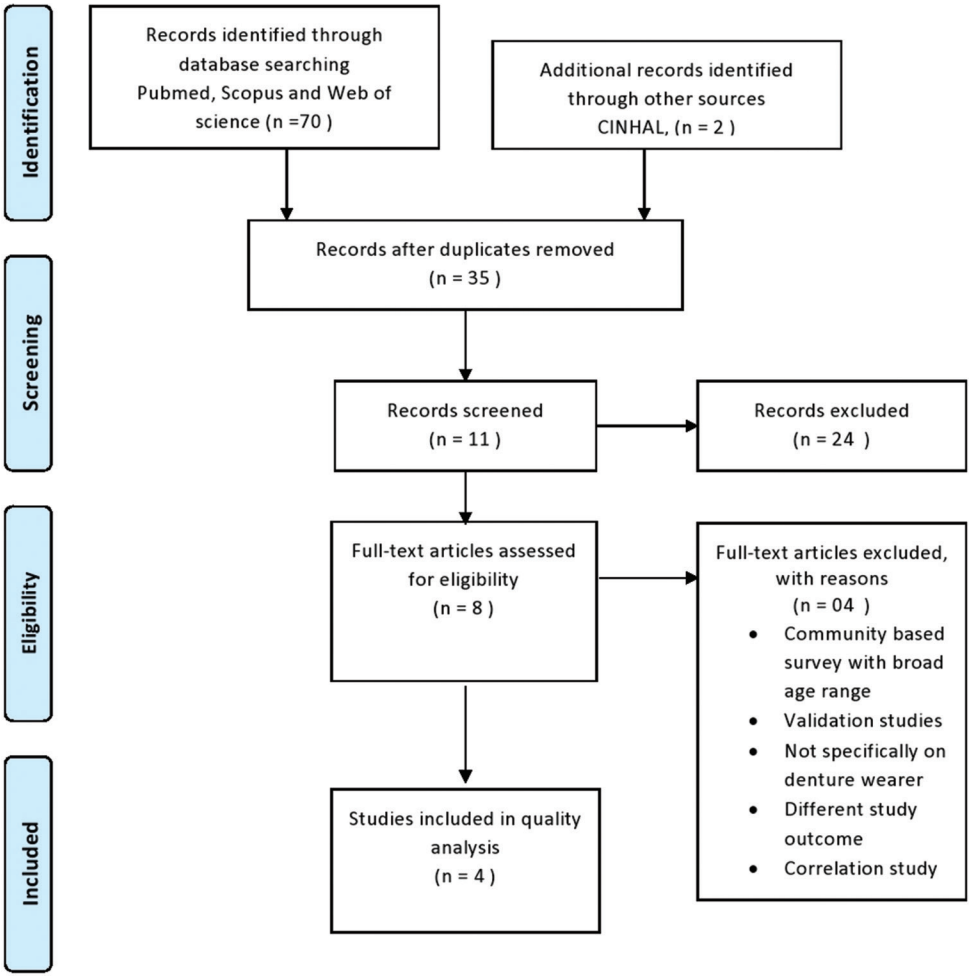
Throughout the world, the number of elderly people is expected to rise and among them tooth loss would be a major oral health problem globally.[6,7] Despite of continuous progress in industrialized countries, edentulousness remains a dominant issue in dental diseases[2] and a large population is projected to be impacted for the near future.[8] In relation to overall well-being, focus has recently been given to oral health. As mastication is the primary function of teeth, their loss may

decrease the ability to masticate.[9] The elderly individual with loss of tooth usually wear denture to improve their ability to eat, but they often avoid some types of food due to ill-fitting nature of denture. This ultimately results in lower nutritional status among them. It is critical to consider the changes that have occurred in the elderly because they can affect dietary needs.[6]

About 33% of denture wearers reported that the prosthesis does not fit and not suitable for eating. Compared to those with full dentition, patients with ill-fitting dentures are considered to lack 19 nutrients. Patients with ill-fitting dentures often lack 19 essential nutrients, primarily due to their reduced ability to consume certain hard foods such as meat, vegetables, fruits, and beans. The nutrients commonly lacking include protein, fiber, vitamins (such as Vitamin B12, Vitamin D, and Vitamin C), and minerals (such as calcium, iron, and zinc).[8] The impact of these nutrient deficiencies on health is significant. For elderly patients, deficiencies can exacerbate the risk of chronic diseases, reduce physical and cognitive functions, and impair the overall quality of life. Ensuring a balanced diet and proper denture fitment can help mitigate these risks and improve nutritional intake.[7,9] Researcher have also shown that food intake and nutrients are connected not only with the presence of dentures but also the consistency of the denture fit.[10] The relationships among tooth loss, use of dentures, and nutrition remain controversial. One research did not report any relationships between these variables.[11] However, other research has found that nutritional status is correlated with the use of dentures.[12,13] A variety of methods have frequently been used to determine diet and nutrient intake, but sadly, inappropriate nutritional methodologies have also been used.[8] The aim of this systematic literature review was to describe and assess the quality of studies reporting on use of FFQ as a method for assessing food and nutrient intakes or dietary patterns among denture wearers. This review was unique in its specific focus on denture wearers, unlike previous research which often broadly examined various populations. It distinguishes itself by critically evaluating the quality of research reporting on the use of FFQs to assess nutrient intake in denture wearers, highlighting methodological gaps and suggesting improvements for future studies.

Materials and Methods

Based on the finding of the previous studies, this systematic review was conducted using preferred reporting items for systematic reviews and meta-analyses Statement.[14] This review is not published or registered anywhere because it is an evaluation of the quality of studies carried among the denture wearers and it does not base on a health-related results.



Search strategy

The PubMed, Scopus, CINAHL, and Web of Science, ERIC, and PsycINFO were searched for all the publications describing FFQ in denture wearer on October 30, 2020. Studies were discovered by scanning web sources and manually digging at related literature of original articles. The search focused on appropriate studies published from 1990 to 2024 and was restricted to those written in English, with no country restrictions. Medical Subject Headings, and free text terms were created under four group headings, A. Age: Above 45 years, B. Oral Prosthesis: Dentures, Dental Prosthesis, Oral prosthesis, dental status, C. Diet: Nutritional status, Nutritional intake, dietary pattern, food intake, food groups, eating pattern, D. Dietary: Assessment tool: FFQ. Key terms and combinations were found in free text, paper titles, and abstracts and used to conduct a database search.

Eligibility criteria

Studies that used FFQ in the assessment of nutritional status of denture wearer and met the inclusion exclusion criteria were included in this systematic review. Due to the lack of randomized clinical trials, case reviews, case series, and case control studies, the study was restricted to cohort studies.

Inclusion Criteria

- Studies involving healthy individuals
- Studies where nutritional intake is reported
- Studies where FFQ used
- Age +45 years
- Denture or oral prosthesis users

Exclusion Criteria

- Studies focused on diseased and unhealthy individuals
- Age group below 45 years
- Correlation study of disease and impact on food consumption
- Intervention studies of nutrients
- Studies focusing on malnutrition
- Studies measuring physiological effect of nutrients
- Studies of eating behaviours
- Population or community based survey

Study selection

Two reviewers (RG and HA) independently screened the titles and abstracts of related publications blindly and in a systematic manner. The full texts of all potentially qualifying articles were then extracted and analyzed to find research that meets all of the conditions for inclusion. If the decision on study inclusion or exclusion was ambiguous, disagreements between reviewers were settled by consensus. Full-text publications that met all of the requirements for inclusion were subjected to a second screening process as the final step before being considered for publication.

Data extraction

The data mining sheet was made depending on examples found in the literature. Two researchers (RG and HA) separately analyzed all of the findings that were used in order to collect data and enter it into the table, which was then cross checked by both authors separately. A concise report of four four articles included in the study is reflected in Table 1. The areas of interest included: population variables (number, age, and country), FFQ structures (type of FFQ, consumption interval, administration technique, portion estimation, and number of FFQ administered), reference technique utilized, type of denture used, and usage of FFQ validation methods by authors.

Quality assessment

Two reviewers (RG and HA) independently completed quality assessment of the included studies using the summary score given by Dennis *et al*.[15] which assessed the quality of the nutrition information from the FFQ. This scoring tools evaluated methodological quality of the relevant studies and evaluate the degree to which a study addressed the bias in their design, and analysis. The summary score by Dennis *et al*.[15] scores studies based on objective measures of quality dietary assessment. According to Dennis *et al*.,[15] the studies that had a summary score of ≥7 were classified as being "high quality" and scores <7 as "low quality."

Risk of bias

In evaluating the risk of bias across the included studies, several key areas like Selection bias and performance bias detection bias were assessed to ensure a thorough and critical analysis by both the researchers independently. The overall quality of the studies was systematically evaluated using Newcastle-Ottawa Scale (NOS) Assessment, highlighting common methodological weaknesses, and providing a comprehensive summary of the risk of bias.

Results

Search outcome

The initial search yielded a total of 72 hits (PubMed: 36, Scopus: 14, CINAHL: 2, and Web of Science: 20, ERIC: 0, PsycINFO: 1). After the duplicates have been removed, there were 35 papers left for analysis, each with a distinguished from title and abstract. After application of inclusion and exclusion criteria, 11 articles selected for full text review. Out of those eight studies were included for quality appraisal. Since all of the studies were cross-sectional in nature, they were categorized as level IV data[3] Following quality appraisal four studies were excluded, leaving four articles[6,16-18] identified as assessing the nutritional status of denture wearer using FFQ. All four studies were reported from different countries (Indonesia, Finland, Canada, North America).

Study characteristics

After thorough literature search four full text original articles identified assessing the nutritional status of denture wearer

Table 1: Characteristics of included studies evaluating the use of food frequency questionnaire and its quality

Author	Country	Sample size (Male/female)	Age range	FFQ food items	Consumption interval	FFQ type	Administration method	Portion size	Type of Denture/s	Reference Method	Type of validated Questionnaire used	Quality Score As per Dennis *et al.*	Quality level
Budiman *et al.*	Indonesia	26 (17/9)	45 years and above	NR	Baseline, 1, 2, 3, 6, 9, and 12 months	Semi-quantitative	Interviewer-administered	NR	RPD-12 CD-14	MNA-Short Form questionnaire	Used Validated Questionnaire (Willet)	05	Low
Jauhiainen *et al.*	Finland	(2241) (911/1215)	55–80 years	128	Previous 12 months	Semi-quantitative	Self-administered	cups of coffee	RPD- 657 CD-592	NR	Used Validated Questionnaire	08	High
Savoca *et al.*	North Carolina	635 (54.1% were female, 21.4% were African American and 30.7% were American Indian)	mean age of 71.5±0.4 years	110	NR	Semi-quantitative	Interviewer-administered	NR	RPD-94 CD-246 Both- 41	Healthy Eating Index-2005	Validated Questionnaire (Block)	09	High
Muller *et al.*	Canada	53 (31/22)	41–70 years	61	Previous 12-month period.	Semi-quantitative	Interviewer-administered	Specified portion size from all food-groups is listed	CD-24 ISO-29	Body mass index, Laboratory Analysis	Validated Questionnaire (Willet)	07	High

CD: Complete denture, RPD: Removable partial denture, ISO: Implant supported overdenture, NR: Not reported

Table 2: Newcastle-Ottawa scale (NOS) assessment of included studies

Author	Selection	Comparability	Outcome	NOS score
Budiman *et al.*	****	*	***	8
Jauhiainen *et al.*	****	**	***	9
Savoca *et al.*	****	**	***	9
Muller *et al.*	****	**	***	9

using FFQ which were published between 1990 and 2020. The number of participants in these studies was in the range of 26–2241. All included studies[6,16-18] used expected age which was 45 years and above except the study done by Muller *et al*.[18] One[6] out of four, none recorded the number of FFQ used in the research, whereas the majority included FFQ ranging from 61 to 128. All included studies used semi quantitative FFQ.[6,16-18] Three studies[6,16-18] considered the consumption interval of previous 12 months to record the nutritional status of individual except Savoca *et al*.[17] Three studies[6,17,18] was conducted using the interview method, which has been carried out by a research associate who had been trained and calibrated, but one study used the self-administered questionnaire method.[16] Study done by Budiman *et al*.[6] and Savoca *et al*.[17] did not report the estimation of portion size and Muller *et al*.[18] vaguely defined it whereas Jauhiainen *et al*.[16] clearly mentioned the portion size estimation. All four studies[6,16-18] clearly reported the type of denture used among study participants. Use of reference method to assess the nutritional status is every common in nutritional survey, three studies[6,17,18] used range of reference methods such as MNA-Short Form, Healthy Eating Index-2005, body mass index and Laboratory Analysis while study done by Jauhiainen *et al*.[16] Did not mention the reference method. Three[6,17,18] out of four used most accepted and validated FFQ given by Willet[19] and Block[20] whereas Jauhiainen *et al*.[16] used FFQ which was validated by Moynihan PJ *et al*.[22]. To get the information about FFQ used in all four selected studies, cross referencing was performed and referred articles by authors were thoroughly examined for the type of validation process.[19-22]

Quality assessment

Each included report underwent a systematic evaluation utilizing the critical appraisal skills program checklist to assess its quality. In terms of usability and efficiency, the tool proved to be straightforward and demonstrated a satisfactory level of validity. Table 1 shows the quality score and interpretation of four studies under review. As all studied under review mentioned the use of validated questionnaire, we performed cross checked to identify the referred article and then performed quality assessment. Using Dennis *et al*.[15] score, study done by Budiman *et al*.[6] that looked at nutrient intake among denture wearers had a low quality rating, while the other two studies had a high quality rating. The criteria that found lacking in Budiman *et al*.[6] Study included non-reporting of FFQ items used in the study and no measures were

taken to check the quality of response received from patients. Furthermore, nutrient database was not used to code FFQ and even portion size estimation and survey completion time was not mentioned. Although the remaining studies quality score was high, only Savoca *et al*.[17] Mentioned the survey completion time, whereas Jauhiainen *et al*.[16] and Muller *et al*.[18] performed quality control to reduce the bias in the study. Moreover, it was found that, only Jauhiainen *et al*.[16] reported the use of nutrient database to code the FFQ.

Risk of bias

The NOS assessment reveals that the studies by Jauhiainen *et al*., Savoca *et al*., and Muller *et al*. achieved the highest quality level with a score of 9, indicating robust methodologies and reliable findings. The study by Budiman *et al*. also demonstrated high quality, with a score of 8, although it had slight limitations in controlling confounding factors [Table 2].

Discussion

In this systematic review, using standardized Dennis *et al*.[15] quality assessment method, we evaluated four studies which were focused on the denture wearer and used FFQ to assess the nutritional intake among them. FFQs are commonly used to measure nutritional status because of their simplicity, pragmatism, low cost, and low participant engagement, as well as their ability to assess dietary status over time.[23,24] However, in literature, there was a limited use of this instrument among denture wearer.[3]

Most of the studies in this review used interview method for administration of FFQ and found to be promising for assessing nutritional status of denture wearer. In contrast to self-administered FFQs, Cade *et al*.[4] found that when the FFQ was administered by an interviewer, the correlation coefficients have been increased.[3] The study done by Jauhiainen *et al*.[16] was based on self-administration which has been shown to be a valid method but mainly for assessing the habitual and long term food consumption.[16,24] Furthermore, it must be understood that as people grow older, they are more likely to develop memory problems. In this situation, retrospective approaches is ineffective and may be improved if a caregiver is available.[22] Since FFQs are known to overvalue energy consumption, using portion size in addition to the traditional reference approach tends to have some advantages.[3] In this review, most of the studies did not mention the estimation of portion size while Jauhiainen *et al*.[16] used standard cups for estimating the portion size. There was variation in number of FFQ items used for recording nutritional intake which might affect the overall outcome of studies. In a systematic review by Henríquez-Sánchez *et al*.,[26] an improvement in correlation coefficients (r 0·52) was seen when the number of food items included in the FFQ was >100 (r 0·47). The average number of food items used in the present studies included in this review was 99.[3] There was considerable variability between studies on methods of data collection, including consumption interval, reference method, and FFQ design. Because of this variance, it was impossible to compare FFQs directly in this study and similar was recorded by McLean RM *et al*.[27] FFQs are popular because they can approximate typical intake (over a set period of time) in a single interaction. While day-to-day variability is taken into account by FFQs that measure consumption over a month, but seasonal variance is not taken into consideration. A questionnaire that asks participants regarding their consumption over a period of 12 months will account for seasonal variance but may be more susceptible to recall bias, leading to higher sampling error.[28]

Overall, it has been reported that FFQ was valid and reliable tool for estimation of nutritional intake among denture wearer. Complete dentures or removable dentures, on the other hand, were found to eat less vegetables and fruit than dentate individuals. It was reported that edentulous full denture wearers ate a less healthy diet, consumed more surgary drinks, had lower Vitamin C and E consumption, and consumed less dietary fiber.[29,30] Almost half of all denture wearers admitted removing their dentures while eating at least some time, regardless of denture form. Hummel SK and colleagues[31] reported that the denture quality, chewing capability, and perceived chewing ability were not linked to diet quality among those with full dentures.[31] Others have shown that poor denture fit has been associated with lower dietary quality.[29,32]

Despite the fact that a patient's traditional denture has a reduced masticatory capacity, they may adapt to the new ways of chewing and preparing food in order to maintain a healthy diet.[18] The mean FFQ score found improved with the duration of denture wearing; however, no significant changes were observed after 2 months. This may be due to adaption to the denture.[6] Moreover, Muller *et al*.[18] observed that conventional denture wearers did not avoid harder foods, even after chewing problems.

Conclusion

This systematic literature review presented a summary of the quality of studies performed on denture wearer using FFQs. The included studies and quality assessment have provided information on aspects of FFQ design that increase validity, such as the number of items included, consumption interval, portion size estimations, reference method, and administration method. Most of the studies used interview administration of FFQ, which found to be more acceptable in quality analysis. Since there was an insufficient data to compare various FFQ parameters among denture wearers, the data were narratively synthesized and presented. All the included studies in this review used previously validated questionnaires, instead of that validation study among denture wearer might give better picture of validity and reliability of questionnaire estimating nutritional intake.

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Conflicts of Interest

The authors declare that there is no conflict of interest.

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