Temporomandibular Disorders and Dietary Changes: A Cross-sectional Survey

Running title: Temporomandibular Disorders and Diet

Authors

David C Edwards*[,1], Charlotte C Bowes*[,2], Chris Penlington[3], Justin Durham[3]

[*]Joint first authors

[1]NIHR academic clinical fellow/ honorary speciality trainee (endodontics), Newcastle Dental Hospital, Richardson Road, Newcastle upon Tyne, NE2 4AZ. David.edwards@newcastle.ac.uk.

[2]NIHR in practice-fellow, School of Dental Sciences, Newcastle University, Framlington Place, NE2 4BW.

[3]School of Dental Sciences, Newcastle University, Framlington Place, NE2 4BW.

Acknowledgements

We would like to thank Maisie Roland for her help during the use of Intake24. We would also like to thank Terrie Cowley and Deanne Clare from the TMJA, as well as its registrants who participated in this study.

Conflict of Interest

The authors declare no conflict of interest.

Abstract

Background

Advice about a ‘soft diet’ may be useful in the short-term alleviation of temporomandibular disorders (TMD) but may contradict the long-term aims of multi-dimensional approaches if a poor nutritional state is caused or exacerbated. The changes TMD patients make to their diet, because of their condition or its management, have not previously been explored.

Objectives

To explore the relationship and trends between TMD, TMD interventions and diet using self-report measures.

Methods

Registrants of the Temporomandibular Joint Association (TMJA) were invited to participate. After completing a screening questionnaire to check for eligibility, participants completed a questionnaire exploring demographics, TMD interventions and dietary habits, as well as jaw functional limitation scale (JFLS) score, graded chronic pain scale (GCPS) score, self-assessed limitation of opening and patient health questionnaire-4 (PHQ-4). This was followed by a validated 3-day electronic diet diary. Descriptive and inferential statistics were used to explore the data for trends and differences in the dietary intake of those participating according to various strata including demographic variables; experience of surgery; other interventions for TMD; duration of TMD; limitation of mouth opening.

Results

Eighty-five registrants of the TMJA completed the questionnaire, of which 42 (49%) completed the 3-day diet diary. Most participants (66/85 [77.6%]) reported modifying their diet due to their TMD. The most common modification was to cut food into smaller pieces (61/85 [71.8%]) followed by boiling until soft (36/85 [42.4%]) and mashing (34/85 [40%]).

Higher JFLS scores were associated with participants reduced enjoyment of food *(t*(83)=2.78, *p*=0.007); limitations in the foods they can eat *(t*(83)=2.99*, p*=0.004), necessity for modified food preparation (*t*(83)=3.38*, p*=0.001) and self-reported weight change (*F*(2, 82)=9.31, *p*=0.0002).

Conclusion

This study suggests a significant proportion of TMD patients make alterations to their diet which may impact the nutritional value of their diet. However, self-reported symptoms and interventions for TMD made little difference to nutritional intake as measured by a 3-day diary. Patients reporting self-assessed limited opening had more pain as measured by validated tools, suggesting patients self-reporting of opening is a useful proxy for clinical measurement in monitoring TMD.

Key Words

Temporomandibular Joint Disorders, Pain, Diet, Mastication, Therapeutics, Surveys and Questionnaires.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Background

Temporomandibular disorders (TMD) can be defined as “a group of musculoskeletal conditions that involve the temporomandibular joints (TMJ), the masticatory muscles and all associated tissues”.[1] TMD are common, with one study finding the annual rate of first-incidence painful TMD to be 3.9% in a US adult population.[2]

TMD are frequently painful and is recognised to have the potential to become a persistent (or chronic) illness with a significant detrimental impact on quality of life.[1,3,4,5] The exact cause and pathophysiology of TMD are not yet fully understood, although it is likely that the cause is multifactorial and biopsychosocial in nature.[6]

Mounting evidence suggests a bidirectional relationship between persistent orofacial pain and nutritional deficiencies.[7,8,9,10] Essential fatty acids which are derived from dietary intake play an essential role in central nervous system (CNS) function, with deficiencies in Omega-3 possibly being linked to inflammatory pain.[10] Further, deficiencies is micronutrients, such as vitamin B12 and folate can lead to painful neuropathies, and vitamin D deficiency leading to musculoskeletal pain.[10] Evidence also suggests that alpha lipoic acids, found in spinach, broccoli and meats, can reduce symptoms in Burning Mouth Syndrome (BMS) through their neuro-regenerative properties.[7,9] Deficiencies in polyamines and magnesium can result in pain sensitization.[10]

Despite this evidence, there is a lack of research on the impact of persistent TMD on diet and nutrition, and the current dietary advice for TMD patients has a very limited evidence-base. This area requires further research, but it seems tenable that the development of nutritional deficiencies due to dietary changes secondary to TMD may contribute to its chronicity, due to the link between deficiency and neuropathic pain. Targeted dietary advice addressing these deficiencies may break the cycle and be a valuable adjunct to other management techniques. This should include appropriate advice on the importance of a balanced diet, with specific advice about the nutritional value of food with possible discussion of dietary supplements and possible input from a patient’s General Medical Practitioner (GMP).

UK data suggest patients suffering from TMD may have altered diets due to functional and/or psychosocial limitations and pain associated with the condition.[11] This is consistent with other data that suggest patients omit certain foods which require more chewing (for example meat, bread and apples), frequently alter their food preparation technique and have a reduced fibre intake.[12,13,14]

The UK’s National Institute for Health and Care Excellence (NICE) recommends a “soft diet” when there is an acute exacerbation of TMD symptoms.[15] Similarly, the National Institute of Dental and Craniofacial Research (NIDCR) have produced a patient information leaflet advising “simple self-care practices such as eating soft foods”.[16] These messages are consistent but provide limited information for the patient regarding nutrition. The Temporomandibular Joint Association (TMJA), on the other hand, which is the largest TMD patient advocacy group in the USA, has produced comprehensive material advising patients of the types of soft foods to eat and to avoid (Figure 1).[17] Despite these consistent messages, recommendations of a soft diet have not been formally evaluated to determine its effect on symptoms, or for its impact on long-term nutritional status.

The aims of this study were to explore the relationship and trends between TMD, TMD interventions and diet using self-report measures. This included a pilot of Intake24 with a sample of patients with TMD, to determine the nutritional intake of the sample and to identify

potential differences in nutritional intake according to characteristics of the condition and its management. Intake24 is an online 24-hour dietary recall system developed by Newcastle University,[18] and has not previously been used in TMD research.

Methods

A cross-sectional survey of a sample of TMD sufferers was undertaken, using a convenience sample from the registrants of the TMJA, an international organisation for those living with TMD. The study was piloted to refine the methodology and data collection by researchers Charlotte Bowes (CB) and David Edwards (DE). Ethical approval was obtained through Newcastle University (Ref: 13397/2018).

Participant recruitment

The TMJA advertised the study to their registrants via their website and social media pages in November 2019. The standardised advertisement contained an electronic link to the study Participant Information Sheet (PIS). Prospective participants were able to register their interest in the study via a secure, study-specific email and given the opportunity to ask questions to the research team (DE; CB) prior to enrolment. Upon registering their interest, a link to an electronic consent form was emailed directly to allow for written consent to be taken electronically prior to enrolment. Participants were also checked against inclusion criteria which were: access to the internet; a diagnosis of persistent TMD for ≥ three months; presence ≥20 teeth; ≥18-years of age; capacity to provide valid consent. Exclusion criteria included: inability to complete documents electronically; TMD < three months duration; <20 teeth; <18-years of age; inability to provide informed consent; presence of a condition other than TMD which causes dietary modification. Consenting individuals next completed a validated six-item TMD screening instrument developed by Gonzalez *et al*. 2011,[19] to assess eligibility to participate in the first phase of data collection.

Data Collection

Data were collected electronically from January to April 2020 to allow time for maximal participation.

Phase 1: Study questionnaire

After completing consent, eligible participants were sent a link via email to the main study questionnaire using an online survey building platform (Jisc© 2020) for phase 1 of data collection (Appendix 1). This questionnaire collected demographics and data including information about self-reported dietary issues and limitation of function and pain. Further validated tools were used including Jaw Functional Limitation Scale Short form (JFLS-8),[20] Graded Chronic Pain Scale (GCPS),[21] and Patient Health Questionnaire (PHQ-4),[22] a brief assessment tool for anxiety/depression.

Phase 2: Intake24

Following completion of phase one, participants were asked to complete a three-day diet diary using Intake24 for phase two of data collection. Developed by Newcastle University, features of Intake24 include a database of >2500 foods; validated portion size images; automatic coding to nutrient data; reminder emails sent at day three and seven if the diet diary was not completed.[18] A summary can be found at: https://www.youtube.com/watch?v=70Wm_kyxpvg (appendix 2).

Data analysis

Data were anonymised, cleaned and crosschecked for accuracy by two researchers (DE/CB). Descriptive and inferential statistics were used to explore the data ~~collected~~ for trends and differences in the dietary intake of those participating according to various strata including demographic variables; experience of surgery; other interventions for TMD; duration of TMD; limitation of mouth opening. Pearson Chi-square test was used to analyse categorical variables. Numerical data were tested for normality using Shapiro-Wilk test and Q-Q plots. Parametric numerical data were analysed against categorical variables using 2-factors t-test or ANOVA; non-parametric data were analysed using Mann Whitney U-test or Kruskal-Wallis H-test. Correlations were identified in parametric numerical data using bivariate analysis, Pearson's correlation coefficient for parametric categorical data and Spearman's rank correlation for non-parametric data.

Results

Participant demographics

From an initial response of 146 TMJA registrants who consented to participate in the study, 118 completed the six-item screener to determine eligibility.[19] 113 individuals were eligible; 85 participants completed the questionnaire (phase one) and 42 completed the three-day diet diary (phase two). The mean age of participants was 50.7 years (SD±13.74) with 93% being female. In total, participants were recruited from 11 countries (Table 1). Participants had suffered TMD symptoms for a mean of 18.7 years (SD±15.5).

GCPS and PHQ-4 classification of participants are shown in table 2. Mean (SD) JFLS-8 score was 3.58 (±1.92). A higher JFLS-8 score was found in those with self-reported limitation of opening (M=3.88, SD±1.87) compared to those without (M=1.77, SD±1.09), t(83)=3.87, p≤0.001 and a limitation in opening indicated by the number of fingers a participant could place in-between their incisors (F(2, 80)=13.26, p=0.0001). Higher JFLS scores were associated with participants that reported reduced enjoyment of food (M=3.80, SD±1.92) compared to those that did not (M=2.14, SD±1.24), t(83)=2.78, p=0.007; limitations in the foods they can eat (M=3.79, SD±1.89) compared to participants without limitations (M=1.85, SD±1.26), t(83)=2.99, p=0.004, necessity for modified food preparation (M=3.94, SD±1.91) compared to those not reporting modification (M=2.24, SD±1.33), t(83)=3.38, p=0.001 and self-reported weight loss (M=4.86, SD±1.98) compared to those that reported no weight change or weight gain (M=3.29, SD±1.80), t(83)=3.08, p=0.003. A majority (78%) of respondents reported modifying their food preparation due to their TMD (Table 3).

Participants reported several different management approaches for their TMD, with all participants receiving at least one intervention type. Nearly two-thirds (66%) of participants reported receiving pharmacological therapy; membrane stabilising drugs were most prescribed followed by centrally acting analgesics. Ninety-five percent of participants reported receiving non-surgical intervention (Table 4).

Forty percent of participants received surgery for their TMD. For all types of surgery, this was more likely to be bilateral, and where participants reported receiving surgery for their TMD, they were likely to have received multiple surgeries (Table 4).

Participants who had received surgery were less likely to report limited opening (X^2(1, N= 85)= 5.84, p= 0.016) and more likely to report weight loss (X^2(1, N= 85)= 5.40, p= 0.020) than those that had not had surgery.

Participants that had received surgery were also significantly more likely to have received a referral to a nutritionist (X^2(1, N= 85)=4.25, *p*= 0.039) and prescribed medication (X^2(1, N= 85)=4.62, *p*= 0.032) than those that had not. They were no more likely to have received other management than participants that had not received surgery.

Overall, macro and micronutrient intake did not differ significantly within groups using subjective and objective measures of TMD severity, and its management, as measured using Intake24 (Table S1). Mean daily KCal intake was 1459.9 (95%CI: 660.2-3115.9; SD±531.6). Mean calorie intake was higher in participants that reported their enjoyment of food was affected by their symptoms (*M*=1534.5; SD±519.8) compared to those that reported their enjoyment was not impacted (*M*=1012.4; SD±381), U=42.0, *p*=0.016. Participants who had received surgery reported a lower mean daily fibre intake (*M*=9.76g, SD±6.26) than those that had not (*M*=14.34g, SD± 6.84), *t*(40)= 2.142, *p*= 0.038, but other macro and micro-nutrients were not significantly affected by a history of TMD surgery.

The number of years a participant had been diagnosed with TMD correlated with their macro/micro-nutrient intake as assessed by Spearman's correlation, with an increased number of years being weakly correlated with lower total sugar intake (r(40)=-.33, *p*=0.031), weakly correlated with reduced non-milk extrinsic sugar intake (r(40)=-.309, P=0.046), moderately correlated with lower vitamin C intake (r(40)=-.448, *p*=0.003) and weakly correlated with lower fibre intake (r(40)=-.355, *p*=0.021).

Self-reported limited opening was associated with a higher mean daily saturated fat intake (*M*=21.85g, SD±10.66) than those without limited opening (*M*=10.02g, SD±4.93, U=21.0, *p*=0.02. Similarly, limited opening reported by finger measurement was associated with increased mean saturated fat intake (1 finger *M*=26.6g, SD±26.62; 2 fingers *M*=21.3g, SD±11.32; 3 fingers *M*=16.7g, SD±10.43), F(2, 37)= 4.34, *p*=0.020. Self-reported referral to a nutritionist or receiving dietary advice did not appear to significantly affect dietary intake.

Discussion

Initial interest and support from the TMJA for this study emphasises the need for further research into TMD and diet. The response rate for the study questionnaire was positive with 85 participants recruited. A higher proportion of females participated in the study; this is concurrent with evidence showing that females have a higher prevalence of TMD compared to males.[23] Many participants reported a long mean duration of suffering from TMD, with a high proportion of respondents having undergone surgery which may have increased their motivation for participating in the study.

The study indicates that the 3-day diet diary has the potential to collect meaningful data about nutrition on a large scale in this population. However, response rate was approximately half that of the other measures and may have been limited by the UK-centric nature of some of the food choices included, therefore our results should be treated as a pilot in this respect and treated with caution.

Study Questionnaire

From existing literature, it was expected that reporting of limited opening would correlate with a negative impact on diet, although it was not known to what extent. Analyses demonstrate that increased JFLS-8 score was reliably correlated with the number of fingers participants could place between their incisors. In turn both of these measures correlated with negative impacts upon diet including reduced enjoyment of food, limited range of foods eaten and the requirement to modify food preparation. Furthermore, the correlation between JFLS-8 score

and self-reported opening, as measured by fingers, validates self-reporting of functional limitation. This is especially important as we move towards gathering patient histories remotely due to the COVID-19 pandemic.

Modifying food preparation to facilitate ease of eating can cause a decrease in the nutritional value of food due to physical and chemical changes that occur during the cooking process; comparatively dry cooking methods, such as grilling, help retain nutrients.[24] The majority of participants reported modifying their food preparation due to TMD (Table 3); with mashing, boiling and pureeing food appearing to be common practice, thereby potentially reducing nutritional values. Such approaches would be in line with current recommendations for patients with TMD.[15,16,17]

Participants reported receiving a range of interventions for TMD management, with all reporting at least one intervention type. Interestingly, just over half of participants reported receiving dietary advice as an intervention. This finding may likely be attributable to a lack of understanding from a patient perspective as to what constitutes 'dietary advice.' There may be an expectation of detailed dietary discussion, where instead, the tenuous recommendation of 'soft-diet' is given, and this may not be interpreted as receiving dietary intervention.

Participants who received surgery were also more likely to have received referral to a nutritionist; it cannot be specified whether referral was part of first line, conservative management, or subsequent to surgery. Overall, there were only 11.8% of participants reporting receiving referral to a nutritionist. This figure indicates that nutritionist referral may not be considered a first line conservative intervention in the management of TMD. In addition, participants receiving surgical intervention for TMD were no more likely to receive more conservative management than those who had not had surgical intervention, despite the indication for surgery often being cited as a failure of conservative approaches.[25]

Forty percent of participants reported receiving surgical intervention for their TMD. Interestingly, where surgery was received, this occurred on multiple occasions (Table 4), which may suggest that surgical intervention is rarely definitive, with many participants entering a continuous cycle of invasive treatment. This may be linked with presence of comorbidity, as there is evidence to suggest that the more numerous existing comorbidities, the reduction in success of surgical intervention.[26] There also appears to be international variation in the frequency with which a surgical approach is undertaken. This would be an interesting direction for future research to identify the point at which a person is referred for surgery.

3-day Diet Diary

Overall daily KCal intake of participants (1459.9KCal/day) that completed the three-day diet diary was lower than national averages.[27] However, amongst participants, results indicate an increased intake of calories when enjoyment is affected, with a higher consumption of fat and saturated fat in participants with limited function. There was a reduced fibre intake for individuals reporting that they modify the preparation of their food as a mechanism to manage their TMD, and in individuals reporting limited opening, consistent with existing literature.[15] There is no obvious effect of previous referral to a nutritionist for TMD management and macro/micro-nutrient intake, although figures for those being referred to a nutritionist are low.

These observations are reasonable in that it would be expected that reduced enjoyment of food and limited function would affect food choices. It is possible that the increased

consumption of fatty, low fibre foods account for the higher calorie intake, which can contribute to detrimental health effects through poorer nutritional choices.

Despite modification of food having the potential to negatively affect nutritional value, there were no significant differences in overall calorie, micro- and macro- nutrient intake, other than reduced fibre intake, between participants that reported food modification and those that did not. Further, the TMD management type received also did not affect nutrient intake. The length of time the participants had suffered from experienced TMD was correlated with a reduction in several macro and micro- nutrient intakes, which would warrant further investigation in future studies.

Limitations

There is a risk that individuals may have underreported their food intake; women may be more likely to under-report and, in certain subgroups, underreporting can be as high as 70%.[18,28] Some participants reported that they found it difficult to engage with Intake24 which may be due to the tool being developed in the UK and not translating well to some international contexts. Difficulties encountered may have led to low completion rates and may have impacted on accuracy of recording.

Our analyses identified correlations between nutrient intake, surgical intervention, the enjoyment of food, length of time diagnosed with TMD, and limitation of opening. However, the low number of participants completing the 3-day recall means these results must be interpreted with caution. Likewise, the lack of correlation between interventions and nutritional intake should also be viewed in context. Adjustments for multiple hypothesis testing were not made in the analysis. This is an exploratory study, and any future projects would benefit from a larger sample size and multivariate analysis to identify key variables.

Conclusion

This exploratory study suggests TMD and its management may have a negative impact on diet. Participants self-reported making modifications to their food which is in line with the ‘soft diet’ recommendation. This may negatively affect the nutritional value of their diet, although the demonstration of this using a 3-day electronic diet diary was limited. Our study indicates the possibility that consequences of TMD can lead to unhealthier food choices. Type of TMD management received and modifying food preparation does not appear to impact calorie and micro-/ macro-nutrient intake.

This study demonstrated a potential international approach to exploring the impact of TMD on patients. For future research, we would suggest the use of an internationally accepted electronic diet reporting method to improve participant engagement.

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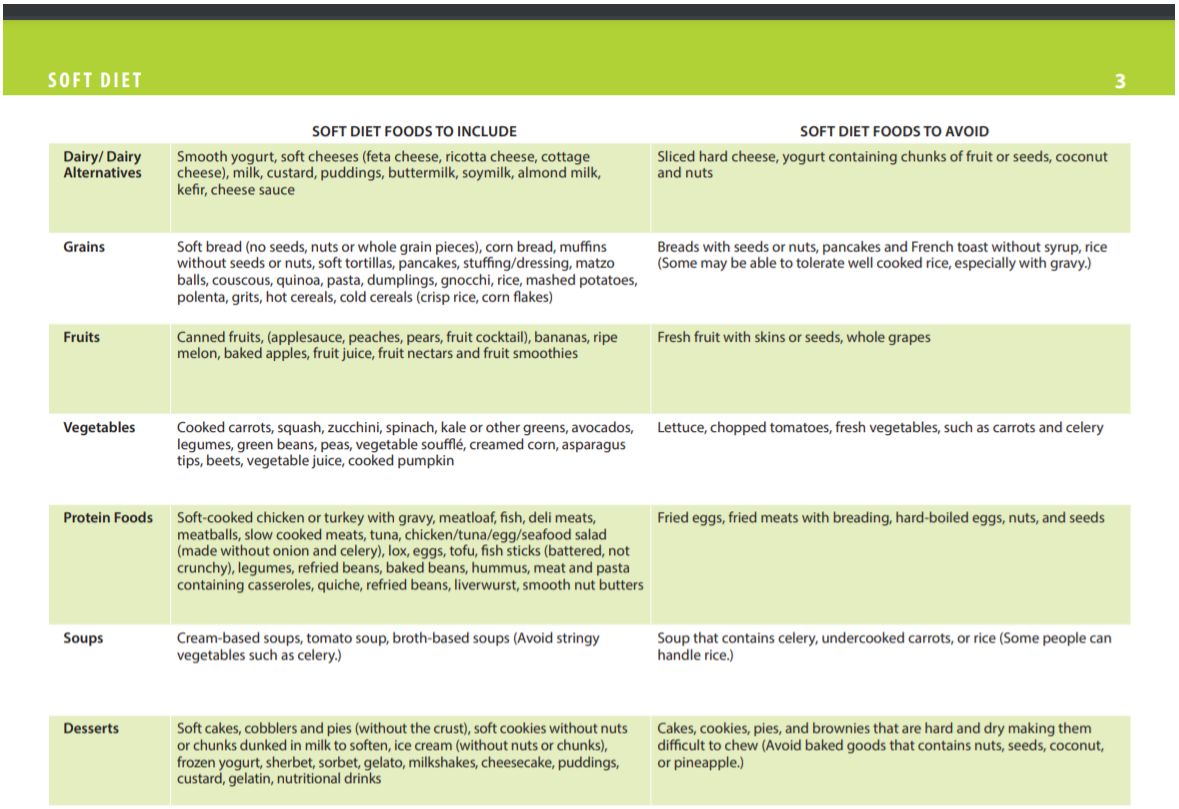
Figures

Figure 1: table from TMJA (2015) highlighting suggested soft foods



SOFT DIET 3

	SOFT DIET FOODS TO INCLUDE	SOFT DIET FOODS TO AVOID
Dairy/ Dairy Alternatives	Smooth yogurt, soft cheeses (feta cheese, ricotta cheese, cottage cheese), milk, custard, puddings, buttermilk, soymilk, almond milk, kefir, cheese sauce	Sliced hard cheese, yogurt containing chunks of fruit or seeds, coconut and nuts
Grains	Soft bread (no seeds, nuts or whole grain pieces), corn bread, muffins without seeds or nuts, soft tortillas, pancakes, stuffing/dressing, matzo balls, couscous, quinoa, pasta, dumplings, gnocchi, rice, mashed potatoes, polenta, grits, hot cereals, cold cereals (crisp rice, corn flakes)	Breads with seeds or nuts, pancakes and French toast without syrup, rice (Some may be able to tolerate well cooked rice, especially with gravy.)
Fruits	Canned fruits, (applesauce, peaches, pears, fruit cocktail), bananas, ripe melon, baked apples, fruit juice, fruit nectars and fruit smoothies	Fresh fruit with skins or seeds, whole grapes
Vegetables	Cooked carrots, squash, zucchini, spinach, kale or other greens, avocados, legumes, green beans, peas, vegetable soufflé, creamed corn, asparagus tips, beets, vegetable juice, cooked pumpkin	Lettuce, chopped tomatoes, fresh vegetables, such as carrots and celery
Protein Foods	Soft-cooked chicken or turkey with gravy, meatloaf, fish, deli meats, meatballs, slow cooked meats, tuna, chicken/tuna/egg/seafood salad (made without onion and celery), lox, eggs, tofu, fish sticks (battered, not crunchy), legumes, refried beans, baked beans, hummus, meat and pasta containing casseroles, quiche, refried beans, liverwurst, smooth nut butters	Fried eggs, fried meats with breading, hard-boiled eggs, nuts, and seeds
Soups	Cream-based soups, tomato soup, broth-based soups (Avoid stringy vegetables such as celery.)	Soup that contains celery, undercooked carrots, or rice (Some people can handle rice.)
Desserts	Soft cakes, cobblers and pies (without the crust), soft cookies without nuts or chunks dunked in milk to soften, ice cream (without nuts or chunks), frozen yogurt, sherbet, sorbet, gelato, milkshakes, cheesecake, puddings, custard, gelatin, nutritional drinks	Cakes, cookies, pies, and brownies that are hard and dry making them difficult to chew (Avoid baked goods that contains nuts, seeds, coconut, or pineapple.)

Tables

Table 1: participant demographic data

		Number N=85 (%)
Gender	Female	79 (92.9)
	Male	6 (7.1)
Race	White	77 (90.6)
	American Indian/ Alaskan Native	1 (1.2)
	Black or African American	5 (5.9)
	Native Hawaiian	1 (1.2)
	Asian	1 (1.2)
	USA	60 (70.6)

Country of residence	UK	14 (16.5)
	Norway	1 (1.2)
	Solano	1 (1.2)
	Cook Islands	1 (1.2)
	Ireland	2 (2.4)
	New Zealand	1 (1.2)
	Australia	1 (1.2)
	Canada	2 (2.4)
	Greece	1 (1.2)
	Denmark	1 (1.2)
Occupation	Administrative/Secretarial	18 (21.2)
	Professional	31 (36.5)
	Associate professional	7 (8.2)
	Caring/ leisure	5 (5.9)
	Skilled trade	3 (3.5)
	Manager/ director	7 (8.2)
	Elementary occupations	1 (1.2)
	Sales	3 (3.5)

Table 2: Graded chronic pain scale (GCPS) and patient health questionnaire 4 (PHQ-4) of participants

		Number N=85 (%)
GCPS	I	24 (28.2)
	II	27 (31.8)
	III	16 (18.8)
	IV	18 (21.2)

PHQ-4	Normal	37 (43.5)
	Mild	17 (20)
	Moderate	15 (17.6)
	Severe	16 (18.8)

Table 3:Modifications to food made by participants

		Number **N=85 (%)**
Modifications made to food due to TMD	Yes	66 (77.6)
	No	19 (22.4)
Type of modification made to food	Mash food	34 (40)
	Boil until soft	36 (42.4)
	Cut into small pieces	61 (71.8)
	Puree	21 (24.7)
	Other modification	14 (16.5)

Table 4: Surgical and non-surgical interventions reported by participants

		Number **N=85 (%)**
Non-surgical	None	4 (4.7)
	Diet advice	44 (51.8)
	Symptom-related advice	62 (72.9)
	Referral to nutritionist	10 (11.8)
	Splint	52 (61.2)
	Physiotherapy	52 (61.2)
	Occlusal adjustment	27 (31.8)

	Pharmacological therapy		56 (65.9)
Pharmacological intervention	Centrally acting analgesics		8 (9.4)
	Peripherally acting analgesics		2 (2.4)
	Membrane stabilising drugs		15 (17.6)
	Antidepressants		3 (3.5)
	Other		7 (8.2)
Surgical	None		51 (60)
	Bilateral	Closed	15 (17.6)
		Open	18 (21.2)
		TMJ replacement	8 (9.4)
	Unilateral	Closed	7 (8.2)
		Open	8 (9.4)
		TMJ replacement	5 (5.9)