



## UvA-DARE (Digital Academic Repository)

### Every smile matters

*Oral health and orofacial pain in older people with dementia in UK care settings*

van de Rijt, L.J.M.

#### Publication date

2020

#### Document Version

Other version

#### License

Other

[Link to publication](#)

#### Citation for published version (APA):

van de Rijt, L. J. M. (2020). *Every smile matters: Oral health and orofacial pain in older people with dementia in UK care settings*.

#### General rights

It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

#### Disclaimer/Complaints regulations

If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: <https://uba.uva.nl/en/contact>, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.

# 6

Oral function and its association with nutrition and quality of life in nursing home residents with and without dementia

*A cross-sectional study*

SUBMITTED TO Journal of Oral Rehabilitation

## Abstract

### Background

Oral health problems increase with age and are common in nursing home residents, especially in those with dementia. Oral health problems can lead to tooth loss, diminished oral function, and malnutrition.

### Objectives

To compare oral function, nutritional status, and quality of life between residents with and without dementia, and to examine associations between oral function, nutritional status, and quality of life.

### Methods

This cross-sectional study was carried out in four UK nursing homes. Residents aged 65 years or older with and without dementia were included. Information was collected on demographics, dental status, quality of swallowing, quality of chewing, xerostomia, and orofacial pain. During a brief oral examination, information was collected on number of teeth, number of occlusal units (OU), and functional categories (e.g., OU combined with dentures). The Mini Nutritional Assessment Short Form (MNA-SF) was used to determine nutritional status. Chi-square tests, independent sample t-test, and Mann-Whitney U-tests were used to compare outcomes between residents with and without dementia. Multiple linear regression was used to evaluate the relationship between oral function and nutritional status.

### Results

Residents with dementia had significantly fewer teeth ( $p=0.021$ ), fewer OU ( $p=0.001$ ), and poorer functional categories ( $p=0.001$ ), and nutritional status was significantly poorer than those without ( $p=0.002$ ). In the regression model, quality of chewing ( $p=0.010$ ) was significantly correlated with nutritional status.

### Conclusion

Almost half of residents had insufficient oral function, which was negatively associated with quality of life and nutritional status. To improve oral function in residents, routine dental care should be provided.

### Keywords

Dementia; Nursing Home; Quality of life; Oral function; Nutrition; Oral health

## Introduction

Oral health problems increase with age, and are even more common in nursing home residents, especially in those with dementia [1-5]. Although the number of edentate persons increases with age, many nursing home residents have remaining natural teeth [6]. When admitted to a nursing home, oral hygiene becomes challenging, due to physical or cognitive disabilities, and residents may be dependent on care home staff [2]. Oral health problems, like caries and periodontal diseases, can lead to the loss of teeth and therefore diminish oral function [7]. Besides the number of natural teeth, the distribution of remaining teeth is critical [7]. The number of occlusal units (OU), namely the number of contacts between upper- and lower (pre) molars, can be used as an indicator of objective chewing ability [7, 8]. Previous studies reported that shortened dental arches of 3-5 OU are sufficient to maintain proper chewing ability [9-11]. Oral function can also be influenced by swallowing difficulties, xerostomia, and orofacial pain [12-14]. In older people, having a functional dentition (either natural or prosthetic) is important for a good oral health-related quality of life (OHQoL), whereas pain in the orofacial area or functional complaints can lead to impaired OHQoL [15].

An adequate diet is necessary to maintain a healthy nutritional status [16]. Reduced oral function can lead to nursing home residents avoiding food, due to difficulty in chewing and swallowing [17]. Dementia itself has been described as a risk factor for malnutrition [18]. Decreased food intake and diminished nutritional status can increase mortality and morbidity risk [19]. Furthermore, decreased chewing ability and a poor nutritional status are both associated with poor quality of life [15, 20].

Diminished chewing ability is also associated with impaired cognition [21]. This association can partly be explained by the negative influence of nutritional deficiencies on cognitive function [22]. Another possible link is the increased middle cerebral arterial blood flow velocity during masticatory activity [23]. Sufficient oral function may restore cognitive functioning after cerebrovascular damage [24]. There has been little research on the association between oral function, nutritional status, and quality of life in nursing home residents with dementia, a population at increased risk of diminished oral function and malnutrition. Furthermore, this population may benefit most from the positive influence of proper oral function on cognitive functioning. Therefore, the aim of this study was to compare the oral function, nutritional status, and quality of life between nursing home residents with and without dementia. Moreover, the association between oral function, nutritional status, and quality of life were examined.

## Methods

### Study design, setting and participants

This study was conducted in four nursing homes across London, UK. All data was collected cross-sectionally during one single assessment. Nursing home residents with and without dementia, aged 65 years or above, were included. Residents who indicated that they did not wish to participate, either verbally or non-verbally were excluded. Residents with clinical concerns or delirium were excluded as well. The study protocol was reviewed and approved by the London Queen Square Research Ethical Committee (19/LO/0100). From all participants, informed consent was obtained. If they did not have capacity, a personal or professional consultee was asked to give agreement for the person's participation, and sign his/her agreement. This procedure complied with capacity legislation governing England and Wales (Mental Capacity Act 2005, Sections 30-34).

### Measurement instruments

Demographic information on age, gender, ethnicity, marital status, number of years in schooling in general education, and highest completed level of education was collected of all participants. For participants with dementia, the severity of dementia was determined using the Clinical Dementia Rating (CDR) score [25]. For all participants, the following information was collected; Charlson Comorbidity Index (CCI), Barthel Index, 5-level EQ-5D (EQ-5D-5L), Oral Health Impact Profile 14 (OHIP-14), and medication usage [26-30].

### Oral function

Subjective oral function was assessed via interview. Depending on whether the residents with dementia were still able to communicate, residents or their carers were asked about the residents' dental status (e.g., dentate or edentate, denture usage), quality of swallowing, quality of chewing, and whether the resident was on a normal or soft diet. To determine xerostomia in verbal participants, the Summated Xerostomia Inventory (SXI) was used [31].

During a brief oral examination, performed by a dentist (LR), information was collected on objective oral function. The number of teeth present and the number of occlusal units (i.e., number of contacts between upper- and lower (pre)molars) were counted. We used the Orofacial-Pain Scale for Non-Verbal Individuals (OPS-NVI) to identify orofacial pain in residents with dementia [32]. To identify orofacial pain in residents without dementia, the Numeric Rating Scale (NRS) was used [33]. Methods regarding identification of orofacial pain are reported in full in a previous chapter (Chapter 5).

### Nutritional status

We used the Mini Nutritional Assessment Short Form (MNA-SF) to determine residents' nutritional status [34]. The MNA-SF consists of six categories:

- A. decline in food intake
- B. weight loss in the last 3 months
- C. mobility
- D. psychological stress or acute disease in the past three months
- E. neuropsychological problems
- F. body mass index (BMI) (weight in kg/height in m<sup>2</sup>)

The complete MNA-SF is shown in *Appendix 1*. We calculated the MNA-SF score using the outcome of these six categories (max. 14 points). Based on the total score, we determined a screening score; normal nutritional status (12-14 points), at risk of malnutrition (8-11 points), or malnourished (0-7 points).

### Data analysis

To analyse data, we used IBM Statistics SPSS 25 (SPSS Inc., Chicago, IL, USA). We used descriptive statistics to report the demographic features of the cohort. We used chi square tests, independent sample t-tests, and Mann-Whitney U-tests (depending on the distribution of data) to compare outcomes between the dementia and non-dementia groups. To determine the correlation between oral function, nutritional status, and quality of life, we used the Spearman correlation coefficients, independent sample t-tests, chi square tests, and Mann-Whitney U-tests, depending on type of variable and distribution of data. We used univariate and multiple linear regression to evaluate the relationship between nutritional status and multiple oral function factors. Oral function factors that were significantly associated with nutritional status ( $p < 0.10$ ) in the univariate regression, were included in the final multivariable regression model.

## Results

In total, 111 nursing home residents participated in this study, of which 84 had dementia and 27 were without dementia. The recruitment flowchart is reported in *Figure 1*. Descriptive characteristics of all participants and of residents with and without dementia separately are given in *Table 1*. Of the total sample, 62.2% were female and the average age was 83.9 (SD 7.95) years old.

TABLE 1 | Descriptive characteristics of all participants and of residents with and without dementia separately.

		Total (n=111)	Dementia (n=84)	No Dementia (n=27)	Test value	P-value		
Gender [n (%)]	Female	69 (62.2%)	52 (61.9%)	17 (63.0%)	X2(1) = 0.010	0.921		
	Male	42 (37.8%)	32 (38.1%)	10 (37.0%)				
Age M, SD (range)		83.9, 7.95 (65-101)	84.5, 7.62 (65-101)	82.3, 8.86 (66-99)	t (109) = 1.229	0.222		
Ethnicity [n (%)]	White	70 (63.1%)	54 (64.3%)	16 (59.3%)	X2(3) = 4.195	0.241		
	Asian/Asian British	9 (8.1%)	8 (9.5%)	1 (3.7%)				
	Black/African/Caribbean/Black British	28 (25.2%)	18 (21.4%)	10 (37.0%)				
	Other ethnic group	4 (3.6%)	4 (4.8%)	0 (0.0%)				
Marital status [n (%)]	Married	28 (25.7%)	21 (25.3%)	7 (26.9%)	X2(3) = 2.827	0.419		
	Divorced	9 (8.3%)	5 (6.0%)	4 (15.4%)				
	Widowed	48 (44.0%)	37 (44.6%)	11 (42.3%)				
	Single	24 (22.0%)	20 (24.1%)	4 (15.4%)				
Years in general education M, SD (range)		9.69, 3.78 (0-18)	9.12, 3.61 (0-16)	10.6, 3.94 (0-18)	t (52) = -1.388	0.171		
Highest completed level of education [n (%)]	Degree	1 (0.9%)	1 (1.2%)	0 (0.0%)	X2(4) = 4.133	0.388		
	GCSE (or equivalent)	9 (8.2%)	5 (6.0%)	4 (14.8%)				
	No qualification	50 (45.5%)	36 (43.4%)	14 (51.9%)				
	Other	3 (2.7%)	2 (2.4%)	1 (3.7%)				
	Unknown	47 (42.7%)	39 (47.0%)	8 (29.6%)				
CDR [n (%)]	None	0 (0%)	0 (0%)	-	N/A	N/A		
	Questionable	1 (1.2%)	1 (1.2%)					
	Mild	8 (9.5%)	8 (9.5%)					
	Moderate	22 (26.2%)	22 (26.2%)					
	Severe	53 (63.1%)	53 (63.1%)					
CCI median (IQR)		4 (3-5)	4 (3-5)	4 (2-5)	Z = -0.807	0.420		
Barthel Index median (IQR)		15 (10-35)	10 (10-30)	30 (15-40)	Z = -2.936	0.003*		
EQ-5D Index M, SD (range)		0.105, 0.299 (-0.352-0.906)	0.075, 0.279 (-0.352-0.806)	0.199, 0.344 (-0.256-0.906)	t (109) = -1.899	0.060		
OHIP-14 median (IQR)		1 (0-5)	1 (0-4)	2 (0-5.5)	Z = -0.969	0.333		
Medication [n (%)]	Analgesics	92 (82.9%)	69 (82.1%)	23 (85.2%)	X2(1) = 1.33	0.715		
	Regular	54 (58.1%)	36 (51.4%)	18 (78.3%)			X2(2) = 5.625	0.060
	PRN	34 (36.6%)	29 (41.4%)	5 (21.7%)				
	Regular + PRN	5 (5.4%)	5 (7.1%)	0 (0.0%)				
	Antidepressants	29 (26.1%)	20 (23.8%)	9 (33.3%)	X2(1) = 0.960	0.327		
	Anti-epileptics	19 (17.1%)	11 (13.1%)	8 (29.6%)	X2(1) = 3.937	0.047*		
	Anti-psychotics	18 (16.2%)	14 (16.7%)	4 (14.8%)	X2(1) = 0.052	0.820		

NOTE | M=mean, SD=standard deviation, IQR=interquartile range, CDR=Clinical Dementia Rating, CCI=Charlson Comorbidity Index, EQ-5D=Euroqol 5 Dimension, OHIP=Oral Health Impact Profile, PRN=Pro Re Nata, X2=chi square test, t=independent sample t-test, Z=Mann-Whitney U-test, N/A=Not Applicable, \*=p<0.05.

TABLE 2 | Oral function and nutritional status of all participants and of residents with and without dementia separately.

		Total (n=111)	Dementia (n=84)	No Dementia (n=27)	Test value	P-value
Dental status, dentate [n (%)]		77 (69.4%)	59 (70.2%)	18 (66.7%)	X <sup>2</sup> (1) = 0.123	0.726
Present teeth median (IQR)		16 (7-22)	14 (6-21)	22 (12.75-24.25)	Z = -2.302	0.021*
OU median (IQR)		0 (0-4)	0 (0-3)	4 (0-7)	Z = -2.625	0.009**
Functional categories [n (%)]	0-2 OU no dentures	54 (48.6%)	48 (57.1%)	6 (22.2%)	Z = -3.283	0.001**
	0-2 OU + dentures	31 (27.9%)	21 (25.0%)	10 (37.0%)		
	3-5 OU	13 (11.7%)	8 (9.5%)	5 (18.5%)		
	≥ 6 OU	13 (11.7%)	7 (8.3%)	6 (22.2%)		
Subjective swallowing quality [n (%)]	Good	81 (73.0%)	59 (70.2%)	22 (81.5%)	X <sup>2</sup> (2) = 3.084	0.214
	Moderate	25 (22.5%)	22 (26.2%)	3 (11.1%)		
	Bad	5 (4.5%)	3 (3.6%)	2 (7.4%)		
Subjective chewing quality [n (%)]	Good	58 (52.3%)	40 (47.6%)	18 (66.7%)	X <sup>2</sup> (2) = 4.180	0.124
	Moderate	38 (34.2%)	30 (35.7%)	8 (29.6%)		
	Bad	15 (13.5%)	14 (16.7%)	1 (3.7%)		
Orofacial pain [n (%)]		45 (40.5%)	41 (48.8%)	4 (14.8%)	X <sup>2</sup> (1) = 9.796	0.002**
SXI median (IQR)		6 (5-11.75)	7 (5.5-13)	6 (5-10)	Z = -1.220	0.222
Soft diet [n (%)]		39 (35.8%)	35 (42.7%)	4 (14.8%)	X <sup>2</sup> (1) = 6.865	0.009**
Weight in kg M, SD (range)		61.5, 16.9 (31.4-114)	59.9, 16.5 (31.4-114)	66.5, 17.3 (38.9-99.1)	t (109) = -1.805	0.074
BMI M, SD (range)		22.5, 5.2 (12-37)	22.0, 5.0 (12-37)	24.0, 5.6 (14-37)	t (109) = -1.787	0.077
Decline in food intake [n (%)]	Severe decrease	2 (1.8%)	2 (2.4%)	0 (0.0%)	Z = -1.651	0.099
	Moderate decrease	37 (33.3%)	31 (36.9%)	6 (22.2%)		
	No decrease	72 (64.9%)	51 (60.7%)	21 (77.8%)		
Weight loss last 3 months [n (%)]	> 3 kg	8 (7.2%)	5 (6.0%)	3 (11.1%)	Z = -0.303	0.762
	1-3 kg	28 (25.2%)	22 (26.2%)	6 (22.2%)		
	No weight loss	63 (56.8%)	48 (57.1%)	15 (55.6%)		
	Unknown	12 (10.8%)	9 (10.7%)	3 (11.1%)		
MNA-SF Total score M, SD (range)		8.7, 2.7 (2-14)	8.3, 2.7 (2-13)	10.4, 2.0 (6-14)	t (109) = -3.128	0.002**
MNA-SF [n (%)]	Normal nutritional status	21 (18.9%)	12 (14.3%)	9 (33.3%)	X <sup>2</sup> (1) = 8.382	0.015*
	At risk of malnutrition	51 (45.9%)	37 (44.0%)	14 (51.9%)		
	Malnourished	39 (35.1%)	35 (41.7%)	4 (14.8%)		

NOTE | IQR=interquartile range, M=mean, SD=standard deviation, OU=Occlusal Units, SXI=Summated Xerostomia Inventory, BMI = Body Mass Index in kg/m<sup>2</sup>, MNA-SF=Mini Nutritional Assessment Short Form, X<sup>2</sup>=chi square test, t=independent sample t-test, Z=Mann-Whitney U-test, N/A=Not Applicable, \*=p<0.05, \*\*=p<0.01.

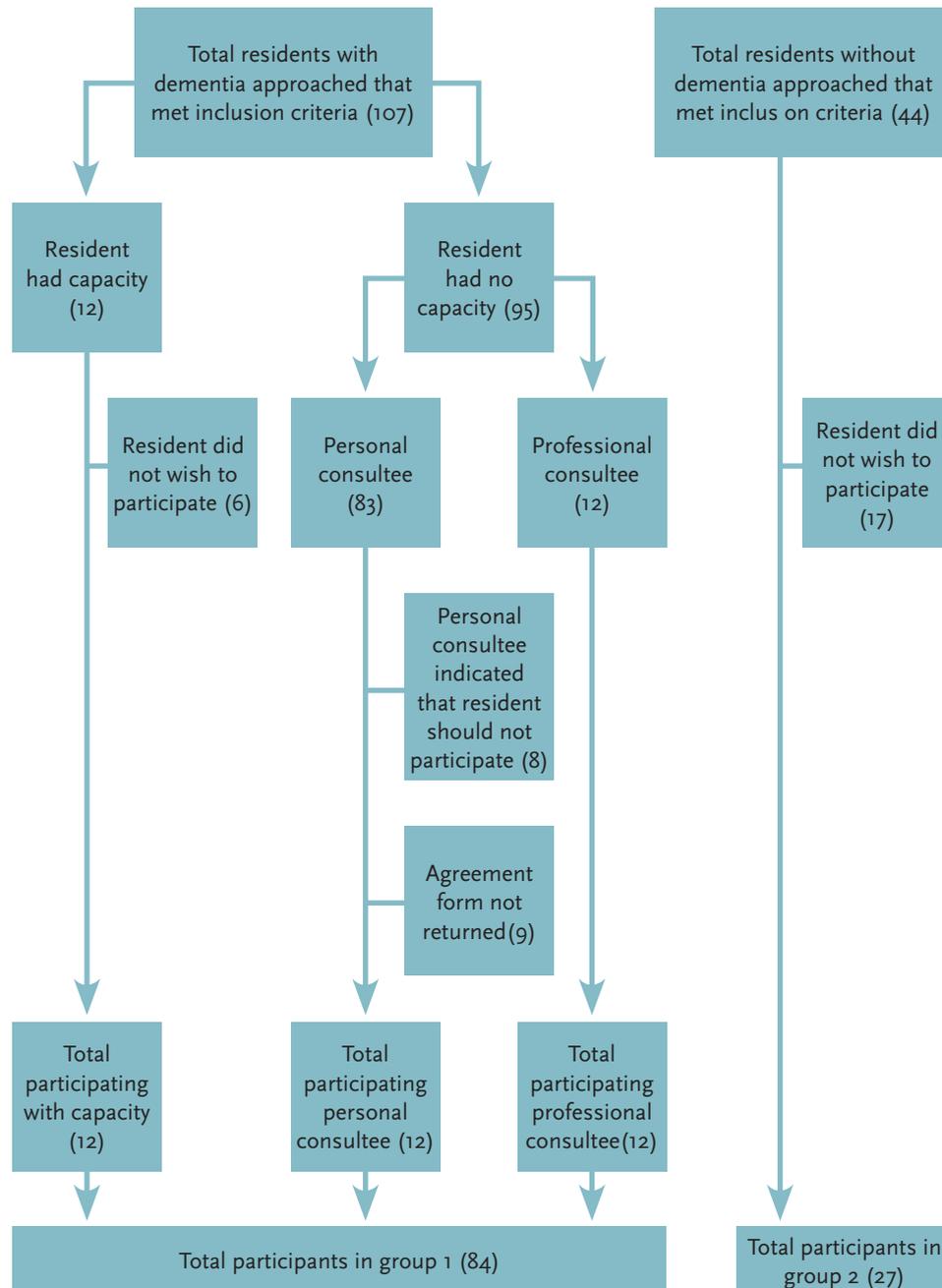


FIGURE 1 | Recruitment flowchart residents with and without dementia.

TABLE 3 | Spearman correlation between oral function, nutritional status, and quality of life in nursing home residents.

	1	2	3	4	5	6	7	8	9
1 Present teeth	–								
2 OU	r=.78**	–							
3 Functional categories	r=.60**	r=.80**	–						
4 Swallowing quality	r=-.13	r=-.14	r=-.11	–					
5 Chewing quality	r=-.18	r=-.18	r=-.20*	r=.41**	–				
6 SXI	r=-.05	r=-.15	r=-.22	r=.41**	r=.37**	–			
7 MNA-SF	r=.42**	r=.44**	r=.35**	r=-.41**	r=-.54**	r=-.35**	–		
8 EQ-5D	r=.00	r=.02	r=.13	r=-.43**	r=-.43**	r=-.44**	r=.45**	–	
9 OHIP-14	r=-.22	r=-.23	r=-.26	r=.17	r=.42**	r=.37*	r=-.32*	r=-.31*	–

NOTE | n = 111, OU=Occlusal Units, SXI=Summated Xerostomia Inventory, MNA-SF=Mini Nutritional Assessment Short Form, EQ-5D=Euroqol 5 Dimension, OHIP=Oral Health Impact Profile, r = Spearman correlation coefficient, \*= $p < 0.05$ , \*\*= $p < 0.01$ .

There were no significant differences between people with and without dementia regarding demographics, comorbidity (CCI), quality of life (EQ-5D), and oral-health related quality of life (OHIP-14). Functional ability (Barthel Index) was significantly poorer in the dementia group (median (IQR) dementia group: 10 (10-30) vs non-dementia group: 30 (15-40);  $p=0.003$ ).

### Oral function

Factors regarding oral function of all participants and of residents with and without dementia separately are given in Table 2. Of all participants, 69.4% were dentate and the median number of OU was 0. Regarding functional categories, 48.6% had 0-2 OU without dentures, and only 23.4% had 3 OU or more. Residents with dementia had significantly less natural teeth ( $p=0.021$ ), less OU ( $p=0.009$ ), and poorer outcome regarding functional categories ( $p=0.001$ ). Subjective swallowing quality was indicated as good by 73% of the participants, while 52.3% indicated the subjective chewing quality as good. Orofacial pain was significantly more prevalent in residents with dementia (48.8%), than those without dementia (14.8%) ( $p=0.002$ ).

TABLE 4 | Association between dental status, orofacial pain, and being on a soft diet and oral function, nutritional status, and quality of life in nursing home residents.

	Dental status	Orofacial pain	Soft diet
	p-value	p-value	p-value
Dental status [X2]	–	–	–
Orofacial pain [X2]	0.015*	–	–
Soft diet [X2]	0.068	<0.001**	–
Present teeth [Z]	-	0.020*	0.215
OU [Z]	-	0.007**	0.747
Functional categories [Z]	0.159	0.012*	0.051
Swallowing quality [Z]	0.591	<0.001**	<0.001**
Chewing quality [Z]	0.122	<0.001**	<0.001**
SXI [Z]	0.697	0.008**	0.002**
MNA-SF [t]	0.687	0.001**	<0.001**
EQ-5D [t]	0.802	0.003**	<0.001**
OHIP-14 [t]	0.100	0.001**	0.481

NOTE | n = 111, OU=Occlusal Units, SXI=Summated Xerostomia Inventory, MNA-SF=Mini Nutritional Assessment Short Form, EQ-5D=Euroqol 5 Dimension, OHIP=Oral Health Impact Profile, t=independent sample t-test, X2=chi square test, Z=Mann-Whitney U-test \*= $p < 0.05$ , \*\*= $p < 0.01$ .

### Nutritional status

Information on nutritional status of all participants and of residents with and without dementia separately are shown in Table 2. Significantly more residents with dementia (42.7%) were on a soft diet, compared to residents without dementia (14.8%) ( $p = 0.009$ ). The mean outcome of the total score of the MNA-SF for residents with dementia was 8.3 (SD 2.7) and was significantly lower than the mean of 10.4 (SD 2.0) of residents without dementia ( $p = 0.002$ ). Residents with dementia scored significantly poorer on the screening score of the MNA-SF ( $p = 0.015$ ). According to the MNA-SF, of the residents with dementia, 41.7% were malnourished and 44.0% were at risk of malnutrition. In residents without dementia, 51.9% were at risk of malnutrition and 14.8% were malnourished.

In Table 3 and Table 4, the associations between oral function factors, nutritional status, and quality of life in nursing home residents are shown. Being dentate ( $p = 0.015$ ), lower number of teeth ( $p = 0.020$ ), lower number of OU ( $p = 0.007$ ), poorer functional

TABLE 5 | Univariate and multiple linear regression of the relationship between oral function factors and nutritional status (MNA-SF) in nursing home residents.

Univariate regression						
	R	R <sup>2</sup>	coefficient	95% C.I.	t	p-value
Dental status	.04	.00	-.22	-1.32; .88	-.40	.687
Functional categories	.35	.12	.90	.44; 1.36	3.85	<.001 <sup>a</sup>
Quality of swallowing	.41	.17	-1.97	-2.81; -1.14	-4.67	<.001 <sup>a</sup>
Quality of chewing	.54	.29	-2.02	-2.62; -1.42	-6.66	<.001 <sup>a</sup>
Orofacial pain	.32	.10	-1.75	-2.73; -.77	-3.55	.001 <sup>a</sup>
SXI	.32	.10	-.13	-.23; -.03	-2.63	.011 <sup>a</sup>
Soft diet	.45	.20	-2.46	-3.40; -1.52	-5.17	<.001 <sup>a</sup>

Multiple regression						
	R	R <sup>2</sup>	coefficient	95% C.I.	t	p-value
	.53	.28				
Functional categories			.45	-.02; .92	1.93	.059
Quality of swallowing			-.83	-1.99; .33	-1.43	.159
Quality of chewing			-1.27	-2.22; -.31	-2.66	.010*
Orofacial pain			.68	-.59; 1.93	1.08	.285
SXI			-.04	-.16; .08	-.67	.508
Soft diet			.39	-1.17; 1.95	.50	.619

NOTE | n = 111, SXI=Summated Xerostomia Inventory, MNA-SF=Mini Nutritional Assessment Short Form, C.I. = confidence interval, a =  $p < 0.10$  and included in multivariable regression model, \*= $p < 0.05$ .

category ( $p = 0.012$ ), poorer swallowing quality ( $p < 0.001$ ), and poorer chewing quality ( $p < 0.001$ ) were significantly associated with the presence of orofacial pain.

Lower number of teeth ( $p < 0.001$ ), lower number of OU ( $p < 0.001$ ), poorer functional category ( $p < 0.001$ ), poorer swallowing quality ( $p < 0.001$ ), poorer chewing quality ( $p < 0.001$ ), presence of orofacial pain ( $p = 0.001$ ), xerostomia ( $p = 0.005$ ), and being on a soft diet ( $p < 0.001$ ) were significantly associated with a poorer nutritional status. A poorer quality of life, according to the EQ-5D, was significantly associated with poorer swallowing quality ( $p < 0.001$ ), poorer chewing quality ( $p < 0.001$ ), presence of orofacial pain ( $p = 0.003$ ), xerostomia ( $p < 0.001$ ), being on a soft diet ( $p < 0.001$ ),

and poorer nutritional status ( $p < 0.001$ ). A poorer oral health-related quality of life, according to the OHIP-14, was significantly associated with poorer chewing quality ( $p = 0.005$ ), presence of orofacial pain ( $p = 0.001$ ), xerostomia ( $p = 0.014$ ), and poorer nutritional status ( $p = 0.039$ ).

In *Table 5*, the univariate and multiple linear regression between oral function factors and nutritional status (MNA-SF) are reported. Functional categories, quality of swallowing, quality of chewing, orofacial pain, SXI, and being on a soft diet were eligible for the multivariable regression model ( $p < 0.10$ ). After adjusting for the other oral function factors, only quality of chewing ( $p = 0.010$ ) remained significantly associated with nutritional status. This model explained 28% ( $R^2 = 0.28$ ) of the variance in nutritional status.

## Discussion

Our aims were to compare the oral function, nutritional status, and quality of life between nursing home residents with and without dementia, and to examine the association between oral function, nutritional status, and quality of life. Almost half of nursing home residents had insufficient oral function, which was negatively associated with quality of life and nutritional status. The oral function and nutritional status of residents with dementia was poorer than of those without.

A previous study from the Netherlands reported that 13% of older people with dementia had less than 3 OU and no dentures, and that older people with dementia had fewer teeth and OU than older people with Mild Cognitive Impairment [35]. Poorer nutritional status in nursing home residents with dementia than in those without was reported previously [18]. These authors also found an association between malnutrition and edentulism [18]. A significant association between quality of chewing and nutritional status was found in a study conducted in Dutch nursing homes [36]. Another study confirms the association between poor oral function and poor oral health-related quality of life [11, 37].

### Strengths and limitations

This is the first study assessing the association between oral function and nutrition, including nursing home residents with dementia without capacity. Since some participants were no longer able to verbally communicate, several questions were answered by their carers. It is important to acknowledge the possibility of misinterpretation of subjective questions by the carers, which reduces the validity. How-

ever, without the use of information of carers we would have to exclude the very people, whose care we wish to improve. Furthermore, no sample size calculation was performed for these analysis, and we did not account for the number of tests performed. Therefore, we were at risk of not having enough power to perform the proposed tests. Fortunately, this was not the case. The MNA-SF was used for the assessment of the nutritional status, which is a screening tool. To establish a comprehensive overview of the nutritional status, a more extended interview, including a food diary, is required. Since this study was cross-sectional with a single assessment on one day, this was not possible.

### Implications

Almost half of the nursing home residents had insufficient objective chewing ability (<3 OU and no dentures), and 47.4% indicated their subjective quality of chewing as moderate or bad. Of all participants, 81% were at risk of malnutrition or were malnourished. Strikingly, malnutrition increases the mortality and morbidity risk and decreases quality of life [19, 20].

Orofacial pain was more prevalent in residents with dementia than those without, and it was significantly associated with poor OHQoL. In another chapter we elaborate more on these clinical results and we report on the validity testing of the observational tool (Chapter 5). Both oral function and nutritional status were poorer in residents with dementia than in those without, and poor nutritional status was associated with poor oral function and orofacial pain. These results highlight the need for routine dental care in nursing home residents, to maintain sufficient chewing ability and treat possible pain causing oral health problems. In case of an insufficient number of OU (<3), properly fitting dentures should be provided. In dentate residents, the Shortened Dental Arch (SDA) concept (e.g., dentition with intact front teeth and a reduction of OU of posterior teeth, starting posteriorly), instead of removable partial dentures, could be considered [38]. Previous studies showed promising results of the SDA concept regarding nutritional status and quality of life [11, 39]. Furthermore, in case of a SDA, providing oral care for the resident or for care home staff becomes easier.

In our study, the model regarding oral function explained 28% of the variance in nutritional status. The remaining variance in nutritional status could be explained by other possible risk factors for malnutrition in older people (e.g., excessive polypharmacy, poor appetite, institutionalization, etc.) [40]. We suggest future research should include those other possible risk factors for malnutrition and should use more extended information to determine nutritional status.

## Conclusion

Almost half of nursing home residents had insufficient oral function, which was negatively associated with quality of life and nutritional status. The oral function and nutritional status of residents with dementia was poorer than of those without. To improve oral function in care home residents, routine dental care should be provided.

## References

1. Zuluaga, D.J., et al., *Oral health in institutionalised elderly people in Oslo, Norway and its relationship with dependence and cognitive impairment*. *Gerodontology*, 2012. 29(2): p. e420-6.
2. Marchini, L., et al., *Oral health care for patients with Alzheimer's disease: An update*. *Spec Care Dentist*, 2019. 39(3): p. 262-273.
3. Moore, D. and G.M. Davies, *A summary of knowledge about the oral health of older people in England and Wales*. *Community Dent Health*, 2016. 33(4): p. 262-266.
4. Delwel, S., et al., *Oral health and orofacial pain in older people with dementia: a systematic review with focus on dental hard tissues*. *Clin Oral Investig*, 2017. 21(1): p. 17-32.
5. Delwel, S., et al., *Oral hygiene and oral health in older people with dementia: a comprehensive review with focus on oral soft tissues*. *Clin Oral Investig*, 2018. 22(1): p. 93-108.
6. Jones, J.A., et al., *Tooth loss and dentures: patients' perspectives*. *Int Dent J*, 2003. 53(5 Suppl): p. 327-34.
7. Gerritsen, A.E., et al., *Tooth loss and oral health-related quality of life: a systematic review and meta-analysis*. *Health Qual Life Outcomes*, 2010. 8: p. 126.
8. Naka, O., V. Anastassiadou, and A. Pissiotis, *Association between functional tooth units and chewing ability in older adults: a systematic review*. *Gerodontology*, 2014. 31(3): p. 166-77.
9. Gerritsen, A.E., et al., *An observational cohort study on shortened dental arches--clinical course during a period of 27-35 years*. *Clin Oral Investig*, 2013. 17(3): p. 859-66.
10. Wallace, S., et al., *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: p. 66-71.
11. McKenna, G., et al., *Impact of oral rehabilitation on the quality of life of partially dentate elders in a randomised controlled clinical trial: 2 year follow-up*. *PLoS One*, 2018. 13(10): p. e0203349.
12. Furuta, M. and Y. Yamashita, *Oral Health and Swallowing Problems*. *Curr Phys Med Rehabil Rep*, 2013. 1: p. 216-222.
13. Liu, B., et al., *Xerostomia and salivary hypofunction in vulnerable elders: prevalence and etiology*. *Oral Surg Oral Med Oral Pathol Oral Radiol*, 2012. 114(1): p. 52-60.
14. Lobbezoo, F., et al., *Orofacial Pain and Mastication in Dementia*. *Curr Alzheimer Res*, 2017. 14(5): p. 506-511.
15. van de Rijt, L.J.M., et al., *The Influence of Oral Health Factors on the Quality of Life in Older People: A Systematic Review*. *The Gerontologist*, 2019.
16. Roque, M., A. Salva, and B. Vellas, *Malnutrition in community-dwelling adults with dementia (NutriAlz Trial)*. *J Nutr Health Aging*, 2013. 17(4): p. 295-9.
17. Hildebrandt, G.H., et al., *Functional units, chewing, swallowing, and food avoidance among the elderly*. *J Prosthet Dent*, 1997. 77(6): p. 588-95.
18. Ziebolz, D., et al., *Oral Health and nutritional status in nursing home residents-results of an explorative cross-sectional pilot study*. *BMC Geriatr*, 2017. 17(1): p. 39.
19. Lesourd, B., *Protein undernutrition as the major cause of decreased immune function in the elderly: clinical and functional implications*. *Nutr Rev*, 1995. 53(4 Pt 2): p. S86-91; discussion S92-4.
20. Damayanthi, H., et al., *Health related quality of life and its associated factors among community-dwelling older people in Sri Lanka: A cross-sectional study*. *Arch Gerontol Geriatr*, 2018. 76: p. 215-220.

21. Weijenberg, R.A., E.J. Scherder, and F. Lobbezoo, *Mastication for the mind--the relationship between mastication and cognition in ageing and dementia*. *Neurosci Biobehav Rev*, 2011. 35(3): p. 483-97.
22. Del Parigi, A., et al., *Nutritional factors, cognitive decline, and dementia*. *Brain Res Bull*, 2006. 69(1): p. 1-19.
23. Hasegawa, Y., et al., *Influence of human jaw movement on cerebral blood flow*. *J Dent Res*, 2007. 86(1): p. 64-8.
24. Kawanishi, K., et al., *Effect of mastication on functional recoveries after permanent middle cerebral artery occlusion in rats*. *J Stroke Cerebrovasc Dis*, 2010. 19(5): p. 398-403.
25. Morris, J.C., *The Clinical Dementia Rating (CDR): current version and scoring rules*. *Neurology*, 1993. 43(11): p. 2412-4.
26. Charlson, M.E., et al., *A new method of classifying prognostic comorbidity in longitudinal studies: development and validation*. *J Chronic Dis*, 1987. 40(5): p. 373-83.
27. Koss, E., et al., *Assessing patterns of agitation in Alzheimer's disease patients with the Cohen-Mansfield Agitation Inventory*. *The Alzheimer's Disease Cooperative Study*. *Alzheimer Dis Assoc Disord*, 1997. 11 Suppl 2: p. S45-50.
28. Mahoney, F.I. and D.W. Barthel, *FUNCTIONAL EVALUATION: THE BARTHEL INDEX*. *Md State Med J*, 1965. 14: p. 61-5.
29. Hounscome, N., M. Orrell, and R.T. Edwards, *EQ-5D as a quality of life measure in people with dementia and their carers: evidence and key issues*. *Value Health*, 2011. 14(2): p. 390-9.
30. Allen, P.F. and D. Locker, *Do item weights matter? An assessment using the oral health impact profile*. *Community Dent Health*, 1997. 14(3): p. 133-8.
31. Villa, A., C.L. Connell, and S. Abati, *Diagnosis and management of xerostomia and hyposalivation*. *Ther Clin Risk Manag*, 2015. 11: p. 45-51.
32. van Kooten, J., et al., *Pain in dementia: prevalence and associated factors: protocol of a multi-disciplinary study*. *BMC Geriatr*, 2015. 15: p. 29.
33. Krebs, E.E., T.S. Carey, and M. Weinberger, *Accuracy of the pain numeric rating scale as a screening test in primary care*. *J Gen Intern Med*, 2007. 22(10): p. 1453-8.
34. Rubenstein, L.Z., et al., *Screening for undernutrition in geriatric practice: developing the short-form mini-nutritional assessment (MNA-SF)*. *J Gerontol A Biol Sci Med Sci*, 2001. 56(6): p. M366-72.
35. Delwel, S., et al., *Oral function of older people with mild cognitive impairment or dementia*. *J Oral Rehabil*, 2018. 45(12): p. 990-997.
36. Huppertz, V.A.L., et al., *Association Between Malnutrition and Oral Health in Dutch Nursing Home Residents: Results of the LPZ Study*. *J Am Med Dir Assoc*, 2017. 18(11): p. 948-954.
37. Nguyen, T.C., et al., *Chewing ability and dental functional status*. *Int J Prosthodont*, 2011. 24(5): p. 428-36.
38. Walther, W., *The concept of a shortened dental arch*. *Int J Prosthodont*, 2009. 22(5): p. 529-30.
39. McKenna, G., et al., *The impact of rehabilitation using removable partial dentures and functionally orientated treatment on oral health-related quality of life: a randomised controlled clinical trial*. *Journal of dentistry*, 2015. 43, 66-71.
40. Favaro-Moreira, N.C., et al., *Risk Factors for Malnutrition in Older Adults: A Systematic Review of the Literature Based on Longitudinal Data*. *Adv Nutr*, 2016. 7(3): p. 507-22.

## APPENDIX 1 | The Mini Nutritional Assessment Short Form (MNA-SF).

Category	Answers
A Decline in food intake	Severe decrease in food intake (0 points) Moderate decrease in food intake (1 point) No decrease in food intake (2 points)
B Weight loss in the last 3 months	Weight loss greater than 3 kg (0 points) Does not know (1 point) Weight loss between 1-3 kg (2 points) No weight loss (3 points)
C Mobility	Bed or chair bound (0 points) Able to get out of bed/chair, but does not go out (1 point) Goes out (2 points)
D Psychological stress or acute disease in the past three months	Yes (0 points) No (2 points)
E Neuropsychological problems	Severe dementia or depression (0 points) Mild dementia (1 point) No psychological problems (2 points)
T BMI	BMI less than 19 (0 points) BMI 19 to less than 21 (1 point) BMI 21 to less than 23 (2 points) BMI 23 or greater (3 points)

NOTE | BMI = Body Mass Index in kg/m<sup>2</sup>.