UvA-DARE (Digital Academic Repository)

Oral function of older people with mild cognitive impairment or dementia

Delwel, S.; Scherder, E.J.A.; Perez, R.S.G.M.; Hertogh, C.M.P.M.; Maier, A.B.; Lobbezoo, F.

Link to publication

Citation for published version (APA):

ORIGINAL ARTICLE

WILEY | *Journal of* Oral Rehabilitation

Oral function of older people with mild cognitive impairment or dementia

Suzanne Delwel[1,2] (iD) | Erik J. A. Scherder[2] | Roberto S. G. M. Perez[3] |
Cees M. P. M. Hertogh[4] | Andrea B. Maier[5,6] | Frank Lobbezoo[1] (iD)

[1]Department of Oral Kinesiology, Academic Centre for Dentistry Amsterdam (ACTA), University of Amsterdam and Vrije Universiteit Amsterdam, Amsterdam, The Netherlands

[2]Department of Clinical Neuropsychology, Faculty of Behavioral and Movement Sciences, Vrije Universiteit Amsterdam, Amsterdam, The Netherlands

[3]Department of Anesthesiology, Amsterdam Public Health Research Institute, VU University Medical Center, Amsterdam, The Netherlands

[4]Department of Elderly Care Medicine, Faculty of Medicine, VU University Medical Center Amsterdam, Amsterdam, The Netherlands

[5]Department of Medicine and Aged Care @ AgeMelbourne, The Royal Melbourne Hospital, University of Melbourne, Melbourne, Australia

[6]Department of Human Movement Sciences @AgeAmsterdam, Faculty of Behavioural and Movement Sciences, Amsterdam Movement Sciences, Vrije Universiteit, Amsterdam, The Netherlands

Correspondence
Suzanne Delwel, Department of Oral Kinesiology, Academic Centre for Dentistry Amsterdam (ACTA), University of Amsterdam and Vrije Universiteit Amsterdam, Amsterdam, The Netherlands.
Email: s.delwel@vu.nl

Summary

Objectives: The aim of this study was to examine and compare the oral function of older people with mild cognitive impairment (MCI) or dementia.

Methods: This cross-sectional observational study included participants with MCI or dementia aged 60 years or older. Global cognitive functioning was evaluated with the Mini Mental State Examination (MMSE) and the oral function was evaluated with subjective and objective assessments, including the perceived quality of chewing and swallowing, the function of the prostheses, the number of occluding pairs (OP), the degree of tooth wear and the active and passive maximum mouth opening.

Results: The quality of chewing and swallowing was perceived as good in, respectively, 86.0% and 90.9% of the participants. Full or partial prostheses were worn by 63.8% of the participants, and the retention was good in 58.4% of the upper and 50.0% of the lower prostheses. Participants with MCI had a median of 3.0 (Inter Quartile Range [IQR] 0.0-7.5) occluding pairs, while participants with dementia had a median of 0.0 (IQR 0.0-1.0) occluding pairs, $U = 3838.50$, $P < 0.001$. There was a weak positive correlation between the number of occluding pairs and the MMSE score, $r = 0.267$, also when adjusted for age, $r = 0.230$. The median tooth wear score was 2.0 (IQR 2.0-2.0) in participants with MCI or dementia. The active maximum mouth opening was 45.8 (SD 9.3) mm in participants with dementia, while it was 49.8 (SD 8.1) mm in those with MCI, $t(253) = 2.67$, $P = 0.008$.

Conclusion: For most participants with MCI or dementia, the swallowing ability and chewing ability were perceived as good. In addition, more than half of the prostheses had good retention and occlusion. Participants with more severe cognitive impairment had fewer occluding pairs and a smaller active mouth opening. The degree of tooth wear was less than one-third of the clinical crown in most participants with MCI or dementia.

KEYWORDS
aged, cognitive dysfunction, deglutition, dental prosthesis, dentures, geriatric dentistry, mastication, neurocognitive disorder, oral health, temporomandibular joint, tooth wear

Roberto S. G. M. Perez: Co-author deceased. He passed away on 7 September 2017, during the period of manuscript writing and revising.

1. | INTRODUCTION

The term "oral function" encompasses all normal and disturbed functions of the human masticatory system, such as eating and psychosocial well-being.[1] Various aspects play a role in oral function, such as the number of functional teeth, the presence and quality of dental prostheses, the temporomandibular function, the degree of tooth wear and swallowing.

Oral function is important for food intake and quality of life, especially in older adults.[2,3] However, oral function might be compromised as a result of tooth loss, primarily caused by caries and periodontitis.[4] Although the number of teeth is of interest, it is even more important how the remaining teeth are distributed and how many posterior teeth form functional pairs or occluding pairs (OP).[5,6] Shortened dental arches of 3-5 occluding pairs are not significantly different from complete dental arches concerning several functional indicators,[7,8] while, in case of extremely shortened dental arches, masticatory function might be reduced by 30%-40%.[7,9] Another constraint in oral function might be mouth opening, although on average this was sufficient in a study of the prevalence of signs and symptoms of temporomandibular disorders in older people.[10] In addition, tooth wear can compromise oral function, and its prevalence increases with age.[11-13] A review on the prevalence of tooth wear in adults indicated severe tooth wear in 17% of 70-year-old people.[11] Another important factor in oral function is swallowing, which is negatively affected by tooth loss[14] and is influenced by the quality of dentures.[15] Moreover, swallowing dysfunction can result from hyposalivation, which is highly prevalent in older people.[14,16,17] In sum, many older people have compromised oral function, as a result of multiple factors.

Some aspects of oral function are known to be even more negatively affected in older people who developed dementia, such as the quality of swallowing and the number of teeth present.[18-21] Swallowing dysfunction or dysphagia is present in 13%-57% of people with dementia, with a higher prevalence of 84%-93% in people with moderate to severe Alzheimer's dementia (AD), the most prevalent subtype of dementia.[19,22] The number of teeth present in older people with dementia ranges widely between studies, viz., from 2 to 20 elements.[20] Concerning dental prostheses, both the utilisation and the quality were studied in people with dementia.[20,21] Denture utilisation varied from 5% to 100%, with the lowest utilisation in people with severe dementia.[20] The stability or retention of the dentures was considered poor in 5%-17%, and the occlusion was considered poor in 27%-36%.[21] Furthermore, a previous study found that temporomandibular joint abnormalities, such as disc displacement and osteoarthrosis, were present significantly more often in participants with AD than in participants without AD, while the mean maximum mouth opening was normal and not significantly different from participants without AD.[23] However, the last mentioned study included only 29 people with AD and no other subtypes of dementia.

Other aspects of oral function, such as occlusion and tooth wear, are scarcely studied in older people with dementia. It is important to address the less studied, yet clinically relevant aspects of oral function in people with cognitive impairment or dementia, to better preserve the food intake and quality of life in this group. Therefore, the aim of the present study was to examine and compare the oral function in a large sample of older people with mild cognitive impairment (MCI) or dementia. The research questions were as follows: (a) What is the perceived quality of chewing and swallowing in older people with MCI or dementia? (b) Which percentage of the participants wore prostheses and what was the quality of the retention and occlusion of the prostheses that were worn? (c) How many occluding pairs did the participants have? (c) What was the degree of tooth wear of the participants? (d) What was the active and passive mouth opening of the participants?

2. | METHODS

2.1. | Study design, setting and participants

This is an observational cross-sectional study on the oral function in a group of older participants with MCI or dementia. The data for this study were collected in two outpatient clinics for geriatric patients (viz., that of the VU Medical Center and of the Amstelland Hospital) and ten nursing homes in the Netherlands, between April 2014 and December 2015, as part of the PainDemiA study.[24] The study protocol was approved by the Medical Ethics Review Committee of the VUmc (approval number NL 43861.029.13) and was previously published.[24] The study was performed in accordance with the STrengthening the Reporting of OBservational Studies in Epidemiology (STROBE) statement. In the study protocol, the inclusion and exclusion criteria, power calculation for the PainDemiA study and procedure to establish the MCI or dementia diagnosis were described.[24] The number of participants at each stage of the dentistry part of the PainDemiA study, including reasons for non-participation and a flow chart of inclusion, was also reported in a previous article.[25]

The global cognitive functioning of the participant was measured with the Mini Mental State Examination (MMSE)[26] by a nurse at the VU Medical Center and a neuropsychologist at the Amstelland Hospital and the nursing homes. The MMSE tests verbal and nonverbal episodic memory, orientation in time and place, visuoconstructive capacities and has a maximum score of 30.[26]

2.2. | Demographic characteristics and perceived oral function

The demographic characteristics, gender, date of birth and educational status, were recorded from the medical records. The subjective oral function was assessed with a short questionnaire with the participants in the hospitals and with the care providers in the nursing homes. The interview included questions about the dental status (eg, dentate or edentate), quality of swallowing (eg, good, moderate, bad or impossible), quality of chewing (eg, good, moderate, bad or

impossible) and food consistency (eg, normal or adjusted, for example grinded food).

2.3. | Oral functional outcomes

In all participants, a standardised oral functional examination took place by a dentist experienced in geriatric dentistry (SD). The examination consisted of the assessment of the function of prostheses in denture wearers, the assessment of the number of occluding pairs and the amount of tooth wear, as well as a mandibular examination in dentate participants. The retention and occlusion of the prostheses were assessed with a qualitative assessment (viz., good, moderate or bad). The number of occluding pairs was counted, with a premolar contact counting as one occluding pair and a full molar contact as two occluding pairs, resulting in a minimum of 0 and a maximum of 14 occluding pairs.[27] In this respect, prostheses did not add to the number of occluding pairs. Tooth wear was quantified according to the system described by Wetselaar, with a score of 0 indicating no visible wear, a score of 1 indicating visible wear only in the enamel, a score of 2 indicating exposed dentin and loss of <1/3 of the clinical length of the crown, a score of 3 indicating loss of 1/3-2/3 of the clinical length of the crown and a score of 4 indicating loss of more than 2/3 of the clinical length of the crown.[28] The highest score of tooth wear for each sextant was scored. The mandibular examination consisted of measurement of overbite, active maximal mouth opening and passive maximal mouth opening.[29] The overbite is the vertical distance between the incisal edges of the upper and lower front teeth. The active maximal mouth opening was calculated by adding the overbite and the mouth opening on request, and the passive maximal mouth opening was calculated by adding the overbite and the mouth opening guided by the dentist.

2.4. | Procedure

In the hospital setting, the examination took place after the regular screening at the memory clinic within the outpatient geriatric clinic, while nursing home residents were examined at their nursing homes. In the hospital, the cognitive screening by a nurse took place at the same day as the oral health examination by the dentist. In the nursing homes, the cognitive screening by the neuropsychologist took place in the same week, but not on the same day as the oral health examination by the dentist, in order to spread the burden on this group of vulnerable participants. In both settings, the cognitive and oral health screening took place independent of each other.

2.5. | Statistical methods

The data were analysed with IBM Statistics SPSS 23 (SPSS Inc., Chicago, IL, USA). The continuous variables were expressed as means and standard deviations (SD) for normally distributed data and as medians and Inter Quartile Range (IQR) for data that were not normally distributed. The categorical variables were expressed

as numbers and percentages. The association between continuous dependent and categorical independent variables was analysed with an independent *t* test for normally distributed data and a Mann-Whitney *U* test for data that were not normally distributed. The association between two categorical variables was analysed with the Pearson chi-square test if all expected frequencies were greater than five or the Fisher's exact test if there were expected frequencies below five. The association between three continuous variables that did not meet the assumptions for normally distributed testing was analysed with a Spearman's rho partial correlation. For all tests, a *P*-value <0.05 was considered statistically significant. Outliers with a *z*-score 3.29 or higher were considered significant outliers and were replaced by a score three times the standard deviation to the mean for a sensitivity analysis.

3. | RESULTS

Table 1 shows the characteristics of the participants. The median age was significantly higher in participants with dementia than in those with MCI, $U = 9072.50$, $P < 0.001$. Concerning setting, 153 (=43.7%) were examined at the outpatient clinics and 197 (=56.3%) at the nursing homes. The median MMSE score was significantly higher in participants with MCI, than in those with dementia, $U = 572.50$, $P < 0.001$. In addition, the MCI group was dentate significantly more often than the dementia group, $U = 2170.50$, $P = 0.001$, independent of age. There were no significant differences regarding swallowing, chewing and food consistency between the MCI and the dementia group.

Table 2 shows that, of the 348 participants, 222 (=63.8%) wore upper and 182 (=52.3%) wore lower prosthesis. Most of the prostheses that were worn by the participants were full prostheses: 86.5% of the prostheses in the upper jaw and 80.8% of the prostheses in the lower jaw. Most of the prostheses in the upper jaw had good retention (58.4%), while this was the case in only 50.0% for the lower jaw. The occlusion was good in 74.8% of the participants. There were no significant differences between the MCI and the dementia group concerning prostheses, except for the type of lower prostheses. Among the participants wearing lower prostheses, significantly more participants with dementia wore full prostheses (84.0%) than participants with MCI (52.6%), who wore partial or frame prostheses more often; Fisher's exact test = 11.73, $P = 0.006$.

Table 3 shows the number of occluding pairs. Participants with dementia had significantly fewer occluding pairs (median = 0.0, IQR 0.0-1.0) than participants with MCI (median = 3.0, IQR 0.0-7.5), $U = 3838.50$, $P < 0.001$. In addition, 13.0% of the participants with dementia had 0-2 occluding pairs and no prostheses, while this was 0.0% in those with MCI.

Table 4 shows that the Spearman's rho correlation indicated a weak positive association between number of occluding pairs and the MMSE score, $r = 0.267$, $P < 0.001$ for all participants and $r = 0.206$, $P = 0.009$ for dentate participants only. When adjusted

TABLE 1 Characteristics of the participants

	Total (N = 348)	MCI (N = 45)	Dementia (N = 303)
Age in years, median (IQR)	83.0 (79.0-87.0)	80.0 (76.0-84.5)[***]	84.0 (80.0-88.0)[***]
Women, N (%)	230 (65.7)	25 (55.6)	205 (67.2)
Setting			
Outpatient clinic (%)	153 (43.7)	45 (29.4)[***]	108 (70.6)[***]
Nursing home (%)	197 (56.3)	0 (0.0)[***]	197 (100.0)[***]
Education, mean years (SD)	10.8 (3.8)	11.5 (3.6)	10.5 (3.9)
MMSE score			
Median (IQR)	18.0 (10.0-24.0)	27.0 (25.5-28.0)[***]	17.0 (6.0-22.0)[***]
Dental status			
Dentate, N (%)	210 (60.5)	35 (77.8)[**]	157 (51.5)[**]
Number of present teeth			
All, Median (IQR)	5.0 (0.0-19.0)	18.0 (5.5-24.0)[***]	2.0 (0.0-18.0)[***]
Dentate, Median (IQR)	18.0 (9.0-24.0)	22.0 (10.0-26.0)	18.0 (9.0-24.0)
Swallowing, N (%)			
Good	311 (90.9)	39 (86.7)	272 (91.6)
Moderate	25 (7.3)	6 (13.3)	19 (6.4)
Bad	5 (1.5)	0 (0.0)	5 (1.7)
Impossible	1 (0.3)	0 (0.0)	1 (0.3)
Chewing, N (%)			
Good	294 (86.0)	42 (93.3)	252 (84.8)
Moderate	38 (11.1)	1 (2.2)	37 (12.5)
Bad	7 (2.0)	2 (4.4)	5 (1.7)
Impossible	3 (0.9)	0 (0.0)	3 (1.0)
Food consistency, N (%)			
Normal	291 (84.8)	42 (93.3)	249 (83.6)
Adjusted	52 (15.2)	3 (6.7)	49 (16.4)

MCI, mild cognitive impairment; MMSE, Mini Mental State Examination.
*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

for age with a Spearman's rho partial correlation, the correlation decreased to $r = 0.230$, $P < 0.001$ for all participants and $r = 0.184$, $P = 0.020$ for dentate participants.

Table 5 shows that the median tooth wear score was 2.0 (IQR 2.0-2.0) in the MCI and the dementia group. There were no significant differences concerning the degree of tooth wear between both groups, $U = 2461.50$, $P = 0.127$.

Table 6 shows the results of the mandibular examination. The active maximum mouth opening was significantly larger in participants with MCI (Mean = 49.8, SD 8.1 mm) than in those with dementia (Mean = 45.8, SD 9.3 mm), $t(253) = 2.67$, $P = 0.008$. Furthermore, the difference between active and passive maximum mouth opening was significantly smaller in participants with MCI (Median = 2.0, IQR 1.0-4.0) than in those with dementia (Median = 4.0, IQR= 2.0-6.0), $U = 5822.00$, $P < 0.001$. There was a significant relation between the active maximum mouth opening and the MMSE score, $r = 0.320$,

$P < 0.001$. The active maximum mouth opening was <40 mm in 13.6% of the participants with MCI and 27.0% of those with dementia, $U = 3845.00$, $P = 0.027$.

4. | DISCUSSION

The aim of this study was to examine and compare the oral function of older people with MCI or dementia. In summary, for most participants with MCI or dementia, the swallowing ability and chewing ability were perceived as good. In addition, more than half of the prostheses had good retention and occlusion. Participants with more severe cognitive impairment had significantly fewer occluding pairs and a significantly smaller active mouth opening. The degree of tooth wear was less than one-third of the clinical crown in most participants with MCI or dementia.

TABLE 2 Type and function of prostheses, by cognitive status

Prostheses	Total	MCI	Dementia
Type of upper	N = 222	N = 22	N = 200
Full (%)	192 (86.5)	18 (81.8)	174 (87.0)
Partial (%)	13 (5.9)	2 (9.1)	11 (5.5)
Frame (%)	17 (7.7)	2 (9.1)	15 (7.5)
Retention upper	N = 214	N = 22	N = 192
Good (%)	125 (58.4)	10 (45.5)	115 (59.9)
Moderate (%)	70 (32.7)	10 (45.5)	60 (31.3)
Bad (%)	19 (8.9)	2 (9.1)	17 (8.9)
Type of lower	N = 182	N = 19	N = 163
Full (%)	147 (80.8)	10 (52.6)	137 (84.0)
Partial (%)	26 (14.3)	2 (10.5)	7 (4.3)
Frame (%)	9 (4.9)	7 (36.8)	19 (11.7)
Retention lower	N = 172	N = 18	N = 154
Good (%)	86 (50.0)	13 (72.2)	73 (47.4)
Moderate (%)	73 (42.4)	4 (22.2)	69 (44.8)
Bad (%)	13 (7.6)	1 (5.6)	12 (7.8)
Occlusion	N = 202	N = 23	N = 179
Good (%)	151 (74.8)	21 (91.3)	130 (72.6)
Moderate (%)	47 (23.3)	2 (8.7)	45 (25.1)
Bad (%)	4 (2.0)	0 (0.0)	4 (2.2)

4.1. | Strengths and limitations

One of the strengths of this study was the large sample of participants with MCI or dementia. Furthermore, all participants were examined by one dentist with experience in geriatric dentistry, who was blinded for the MCI or dementia diagnosis in the outpatient clinic and blinded for the MMSE score in the outpatient clinics as well as in the nursing homes.

One of the limitations of this study was the cross-sectional observational design, which did not include older people without cognitive impairment and did not follow the participants in time, including their dental and prosthesis history. Furthermore, there was a potential risk of bias concerning the inclusion of a representative number of participants with severe cognitive impairment. At the same time, it became more complicated to perform a mandibular examination as the cognitive impairment increased.

4.2. | Interpretation and clinical implications

In the present study, the retention of prostheses was considered moderate or bad in 41.6% of the upper and 50.0% of the lower prostheses, compared to an unsatisfactory retention in 62.5% of the upper and 47.8% of the lower prostheses in participants with AD in a study by Ribeiro and colleagues.[30] Furthermore, Adam and Preston reported the denture retention as satisfactory in 76.7% of the participants with no or mild dementia and 76.0% of the participants with moderate or severe dementia, thus indicating lower percentages of around 24% for unsatisfactory retention of the dentures.[31] The differences between the studies might be explained by an actual difference in quality of the dentures or a difference in the subjective assessment of the quality.

Although the reported percentage of participants with impaired quality of swallowing was <10%, the quality of swallowing in this group might be improved by adjustments in the consistency of the

TABLE 3 Occluding pairs (OP), by cognitive status

	Total (n = 335)	MCI** (n = 41)	Dementia** (n = 292)
All participants			
Total occluding pairs, median (IQR)	0.0 (0.0-2.0)	3.0 (0.0-7.5)	0.0 (0.0-1.0)
Functional categories			
0-2 OP and no prostheses (%)	38 (11.4)	0 (0.0)	38 (13.0)
0-2 OP and prostheses (%)	213 (64.0)	19 (46.3)	194 (66.4)
3-5 OP (%)	23 (6.9)	5 (12.2)	18 (6.2)
≥6 OP (%)	59 (17.7)	17 (41.5)	42 (14.4)
Dentate participants	Total (n = 187)	MCI* (n = 35)	Dementia* (n = 157)
Total occluding pairs, median (IQR)	2.0 (0.0-7.0)	5.0 (0.0-9.0)	1.0 (0.0-6.0)

*P < 0.05, **P < 0.001.

Occluding pairs	Correlation with MMSE	P value	Correlation with MMSE, corrected for age	P value
All	0.267	<0.001	0.230	<0.001
Dentate	0.206	0.009	0.184	0.020

TABLE 4 Spearman's rho partial correlation between occluding pairs and MMSE, corrected for age

TABLE 5 Highest degree of tooth wear, by cognitive status

Tooth wear	Total (n = 169)	MCI (n = 34)	Dementia (n = 135)
Highest score, median (IQR)	2.0 (2.0-2.0)	2.0 (2.0-2.0)	2.0 (2.0-2.0)
Highest score, N (%)			
0	1 (0.6)	1 (2.9)	0 (0.0)
1	7 (4.1)	2 (5.9)	5 (3.7)
2	158 (93.5)	31 (91.2)	127 (94.1)
3	2 (1.2)	0 (0.0)	2 (1.5)
4	1 (0.6	0 (0.0)	1 (0.7)

food and drinks, body positioning and the use of specific equipment,[32] which can be supported by a speech therapist. The quality of chewing could be improved with removable prostheses in people with mild to moderate dementia, for example by manufacturing, adjustment or replacement of partial of full prostheses by a dentist or prosthodontist.[33]

In the present study, 13.0% of the participants with dementia had fewer than 3 occluding pairs and no prostheses. This might be due to malfunction or loss of previous prostheses, but could also be a result of the dementia and lack of acceptance, especially in more severe dementia.[31] The loss of teeth without replacement with prostheses implies severe loss of oral functioning.[34]

In a sample of 153 Dutch older adults (65-74 years), the mean tooth wear score was 2.1 (SD 2.1).[13] This was comparable with the median tooth wear score of 2.0 (IQR 2.0-2.0) in the present group of participants with MCI or dementia. From this study, there is no indication for an increase in bruxism or other parafunctions in participants with MCI or dementia, in contrast with people with other neurodegenerative diseases, such as Parkinson's disease (Verhoeff et al., submitted).

A study from Schmitter and colleagues about the prevalence of signs and symptoms of temporomandibular disorders in older people aged 68 to 96 found an active maximum mouth opening of 45.0 (SD 1.1) mm and a passive mouth opening of 46.9 (SD 1.1).[10] In the present sample of participants with MCI or dementia, a mean maximum of 46.5 (SD 9.2) mm for active mouth opening and of 50.8 (SD

8.6) for passive mouth opening was found. Both means fall within the range for the general population, and the active mouth opening seems comparable with the study from Schmitter, while the passive mouth opening seems larger in the present study. In the present study, 24.7% of the participants with MCI or dementia had an active maximum mouth opening <40 mm, which was considered limited.[35] In addition to myogenic or arthrogenic constraints, neurological and cognitive changes might play a role in limited mouth opening in people with dementia. In this study, it could be possible that not all participants were able to fully comprehend the instruction to open the mouth as far as possible, as a result of cognitive decline. This might also explain the significant difference between active and passive mouth opening in participants of the MCI and the dementia group.

Regarding the clinical implications that have been discussed in the present study, mainly the retention of prosthesis, maintenance of the occluding pairs and the mouth opening deserve the attention of clinicians, such as prosthodontists, dentists and speech therapists. These aspects of oral function are important for maintenance of the food intake and quality of life in older people with cognitive impairment. For the oral rehabilitation of people with advanced cognitive impairment, small changes are preferred, for example by relining or rebasing of existing prostheses. More extensive rehabilitation should be done with maximum caution to the abilities, perspective and oral hygiene of the patient.[36]

4.3. | Generalisability

The present study included a large sample of participants with MCI or dementia living in the Netherlands. The participants were living in the community, small-scale living and various nursing homes, and had mild, moderate and severe cognitive impairment. This sample thus seems representative for older people with MCI or dementia in high- to middle-income countries.

4.4. | Future research

This study describes the subjective and objective oral function, but does not include the objective chewing or mixing ability of the

TABLE 6 Mandibular examination, by cognitive status

Mandibular examination	Total (n = 255)	MCI (n = 44)	Dementia (n = 211)
Overbite, median (IQR) mm	2.0 (1.0-3.0)	3.0 (1.0-4.0)	2.0 (1.0-3.0)
Active maximum, mean (SD) mm	46.5 (9.2)	49.8 (8.1)*	45.8 (9.3)*
<40 mm, N (%)	63 (24.7)	6 (13.6)	57 (27.0)
40-60 mm, N (%)	176 (69.0)	33 (75.0)	143 (67.8)
>60 mm, N (%)	16 (6.3)	5 (11.4)	11 (5.2)
Passive maximum, mean (SD) mm	50.8 (8.6)	52.3 (7.7)	50.5 (8.7)
Difference active and passive, median (IQR) mm	3.0 (2.0-6.0)	2.0 (1.0-4.0)*	4.0 (2.0-6.0)*

*$P < 0.05$.

participants. This could be an interesting addition, because it is an objective measurement of masticatory performance.[37-39]

5. | CONCLUSION

For most of the participants with MCI or dementia, the swallowing ability and chewing ability were perceived as good by the participants and their caregivers. In addition, more than half of the prostheses had good retention and occlusion according to the examining dentist. Participants with more severe cognitive impairment had fewer occluding pairs and a smaller active mouth opening. The degree of tooth wear was smaller than one-third of the clinical crown in most participants with MCI or dementia.

CONFLICT OF INTEREST

The other authors have stated explicitly that there is no conflict of interests in connection with this article.

ORCID

Suzanne Delwel https://orcid.org/0000-0002-6836-5394

Frank Lobbezoo https://orcid.org/0000-0001-9877-7640

REFERENCES

1. WHO Fact sheet Oral Health. Fact sheet No. 318. http://www.who.int/oral_health/publications/factsheet/en/. Published 2012. Accessed June 26, 2018.
2. Nguyen TC, Witter DJ, Bronkhorst EM, Gerritsen AE, Creugers NHJ. Chewing ability and dental functional status. *Int J Prosthodont*. 2011;24(5):428-436.
3. Crogan NL. Nutritional problems affecting older adults. *Nurs Clin North Am*. 2017;52(3):433-445.
4. Tonetti MS, Bottenberg P, Conrads G, et al. Dental caries and periodontal diseases in the ageing population: call to action to protect and enhance oral health and well-being as an essential component of healthy ageing - consensus report of group 4 of the joint EFP/ORCA workshop on the boundaries be. *J Clin Periodontol*. 2017;44(Suppl 1):S135-S144.
5. Gerritsen AE, Allen PF, Witter DJ, Bronkhorst EM, Creugers NH. Tooth loss and oral health-related quality of life: a systematic review and meta-analysis. *Health Qual Life Outcomes*. 2010;8(1):126.
6. Naka O, Anastassiadou V, Pissiotis A. Association between functional tooth units and chewing ability in older adults: a systematic review. *Gerodontology*. 2014;31(3):166-177.
7. Kanno T, Carlsson GE. A review of the shortened dental arch concept focusing on the work by the Käyser/Nijmegen group. *J Oral Rehabil*. 2006;33(11):850-862.
8. Gerritsen AE, Witter DJ, Bronkhorst EM, Creugers NHJ. An observational cohort study on shortened dental arches-clinical course during a period of 27-35 years. *Clin Oral Investig*. 2013;17(3):859-866.
9. Liang S, Zhang Q, Witter DJ, Wang Y, Creugers NHJ. Effects of removable dental prostheses on masticatory performance of subjects with shortened dental arches: a systematic review. *J Dent*. 2015;43(10):1185-1194.
10. Schmitter M, Rammelsberg P, Hassel A. The prevalence of signs and symptoms of temporomandibular disorders in very old subjects. *J Oral Rehabil*. 2005;32(7):467-473.
11. Van't Spijker A, Rodriguez JM, Kreulen CM, Bronkhorst EM, Bartlett DW, Creugers NHJ. Prevalence of tooth wear in adults. *Int J Prosthodont*. 2009;22(1):35-42.
12. Kreulen CM, Van't Spijker A, Rodriguez JM, Bronkhorst EM, Creugers NHJ, Bartlett DW. Systematic review of the prevalence of tooth wear in children and adolescents. *Caries Res*. 2010;44(2):151-159.
13. Wetselaar P, Vermaire JH, Visscher CM, Lobbezoo F, Schuller AA. The prevalence of tooth wear in the Dutch adult population. *Caries Res*. 2016;50(6):543-550.
14. Furuta M, Yamashita Y. Oral health and swallowing problems. *Curr Phys Med Rehabil Rep*. 2013;1(4):216-222.
15. Monaco A, Cattaneo R, Masci C, Spadaro A, Marzo G. Effect of ill-fitting dentures on the swallowing duration in patients using polygraphy. *Gerodontology*. 2012;29(2):e637-e644.
16. Liu B, Dion MR, Jurasic MM, Gibson G, Jones JA. Xerostomia and salivary hypofunction in vulnerable elders: prevalence and etiology. *Oral Surg Oral Med Oral Pathol Oral Radiol*. 2012;114(1):52-60.
17. Delwel S, Binnekade TT, Perez RSGM, Hertogh CMPM, Scherder EJA, Lobbezoo F. 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):93-108.
18. Wu B, Fillenbaum GG, Plassman BL, Guo L. Association between oral health and cognitive status: a systematic review. *J Am Geriatr Soc*. 2016;64(4):739-751.
19. Affoo RH, Foley N, Rosenbek J, Kevin Shoemaker J, Martin RE. Swallowing dysfunction and autonomic nervous system dysfunction in Alzheimer's disease: a scoping review of the evidence. *J Am Geriatr Soc*. 2013;61(12):2203-2213.
20. Delwel S, Binnekade TT, Perez RSGM, Hertogh CMPM, Scherder EJA, Lobbezoo F. 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):17-32.

21. Foley NC, Affoo RH, Siqueira WL, Martin RE. A systematic review examining the oral health status of persons with dementia. *JDR Clin Transl Res*. 2017;2(4):330-342.

22. Alagiakrishnan K, Bhanji RA, Kurian M. Evaluation and management of oropharyngeal dysphagia in different types of dementia: a systematic review. *Arch Gerontol Geriatr*. 2013;56(1):1-9.

23. de Souza RT, Fabri GMC, Nitrini R, et al. Oral infections and orofacial pain in Alzheimer's disease: a case-control study. *J Alzheimers Dis*. 2014;38(4):823-829.

24. van Kooten J, Delwel S, Binnekade TT, et al. Pain in dementia: prevalence and associated factors: protocol of a multidisciplinary study. *BMC Geriatr*. 2015;15(1):29.

25. Delwel S, Perez RSGM, Maier AB, et al. Psychometric evaluation of the Orofacial Pain Scale for non-verbal individuals as a screening tool for orofacial pain in people with dementia. *Gerodontology*. 2018;35:200-213.

26. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res*. 1975;12(3):189-198.

27. Käyser AF. Shortened dental arches and oral function. *J Oral Rehabil*. 1981;8(5):457-462.

28. Wetselaar P, Lobbezoo F, Koutris M, Visscher CM, Naeije M. Reliability of an occlusal and nonocclusal tooth wear grading system: clinical use versus dental cast assessment. *Int J Prosthodont*. 2009;22(4):388-390.

29. Lobbezoo F, van der Zaag J, Visscher CM, van der Meulen MJ, Becking AG, Naeije M. Multidisciplinary diagnosis and treatment of craniomandibular disorders. *Ned Tijdschr Tandheelkd*. 2000;107(11):471-475.

30. Ribeiro GR, Costa JLR, Ambrosano GMB, Garcia RCMR. Oral health of the elderly with Alzheimer's disease. *Oral Surg Oral Med Oral Pathol Oral Radiol*. 2012;114(3):338-343.

31. Adam H, Preston AJ. The oral health of individuals with dementia in nursing homes. *Gerodontology*. 2006;23(2):99-105.

32. Chadwick DD, Jolliffe J, Goldbart J. Adherence to eating and drinking guidelines for adults with intellectual disabilities and dysphagia. *Am J Ment Retard*. 2003;108(3):202-211.

33. Campos CH, Ribeiro GR, Rodrigues GR. Mastication and oral health-related quality of life in removable denture wearers with Alzheimer disease. *J Prosthet Dent*. 2018;119:764-768.

34. Petersen PE, Kandelman D, Arpin S, Ogawa H. Global oral health of older people–call for public health action. *Community Dent Health*. 2010;27(4 Suppl 2):257-267.

35. Knibbe W, Aarab G. Orale kinesiologie. In: Naeije M, Lobbezoo F, Visscher CM, eds.*Temporomandibulaire Disfuncties, Bruxisme, Gebitsattritie En Slaapapneu*. Houten, the Netherland: Bohn Stafleu van Loghum; 2015:147-167.

36. Foltyn P. Ageing, dementia and oral health. *Aust Dent J*. 2015;60(Suppl 1):86-94.

37. Schimmel M, Christou P, Herrmann F, Müller F. A two-colour chewing gum test for masticatory efficiency: development of different assessment methods. *J Oral Rehabil*. 2007;34(9):671-678.

38. Weijenberg RAF, Scherder EJ, Visscher CM, Gorissen T, Yoshida E, Lobbezoo F. Two-colour chewing gum mixing ability: digitalisation and spatial heterogeneity analysis. *J Oral Rehabil*. 2013;40(10):737-743.

39. Speksnijder CM, Abbink JH, Van Der Glas HW, Janssen NG, Van Der Bilt A. Mixing ability test compared with a comminution test in persons with normal and compromised masticatory performance. *Eur J Oral Sci*. 2009;117(5):580-586.