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Masticatory dysfunction is associated with worse functional ability: a population-based study

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Abstract

Aim: Because of the ageing of populations, disability has become an emergent problem from the clinical, social, and economic perspectives. Nevertheless, the determinants of disability in older subjects are still unclear. We assessed the association between self-assessed masticatory dysfunction (MD) and functional ability in older subjects.

Materials and Methods: We analysed data of all 350 subjects aged 75+ living in Tuscania (Italy). Functional ability was estimated using the Katz' activities of daily living (ADLs), and the Lawton and Brody instrumental activities of daily living (IADLs) scales.

Results: MD was reported by 145 (41%) participants. Disability in the ADLs and IADLs was found in 37 (25%) and 53 (37%) of participants with MD, respectively, but only in 11 (5%) and 30 (15%) of the other participants ($p < 0.001$). MD was associated with disability in the ADLs [odds ratio (OR) = 2.40, 95% confidence interval (CI) = 1.05–5.51], and IADLs (OR = 2.77, 95% CI = 1.07–7.16) in logistic regression, after adjusting. The association of MD with disability was stronger among subjects aged 80+.

Conclusions: MD is independently associated with disability in community-dwelling elderly. Further studies are needed to evaluate the impact of early detection and correction of MD on the preservation of functional status in older populations.

Key words: elderly; functional ability; masticatory dysfunction; nutrition; population-based study

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Disability is thought to affect 20% of older subjects (Freedman et al. 2002). Functional status is a predictor of several outcomes in older populations, including mortality and hospitalization (Fried et al. 2001); in addition, disability has been associated with an increased risk of institutionalization (Gaugler et al. 2001), and the use of home healthcare services (Karlsson et al. 2008). Older disabled persons account for almost half of the total healthcare expenditure in the United States (Freedman et al. 2002).

Masticatory dysfunction (MD) is generally defined as a self-reported symptom, or an objective deficit in chewing selected foods (Salleh et al. 2007). Because of the increased prevalence of conditions such as disorders of the oral mucosa, impairment of masticatory muscles, xerostomia, nervous system disorders, and chiefly of periodontal disease with ensuing edentulia and tooth mobility, MD is a common condition in older populations, whose prevalence ranges from 24% in subjects aged 64+ to 34% in persons over 70 (Locker 2002). Objective assessment of MD requires time and special equipment; thus, it is difficult to perform in population-based studies. On the other hand, self-reported masticatory function has been proven to provide reliable information. MD, that is potentially reversible by adequate oral care and, when appropriate, by implant treatment, is a relevant cause of malnutrition in older populations (Feldblum et al. 2007). Malnutrition, in turn, is associated with incident disability (Sergi et al. 2007). Also, periodontal disease is associated with increased serum levels of proinflammatory markers (Loos et al. 2000, Slade et al. 2003, Schwahn et al. 2004).

Conflict of interest and sources of funding statement

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Increased circulating levels of inflammatory cytokines, in turn, have been associated with incident disability in epidemiological studies of elderly populations (Ferrucci et al. 2002).

We aimed to assess whether self-reported MD is associated with functional ability in community-dwelling elderly.

Materials and Methods

Participants

The study involved all subjects aged $\geqslant 75$ living in Tuscania (Italy) on 1 January 2004, in the setting of a study of the genetic determinants of health status in six Italian towns. No exclusion criteria were applied. These participants were enrolled and visited by the study researchers between 1 January and 1 June, 2004. Among 387 participants enrolled in Tuscania, we excluded 37 subjects with missing data for the study variables; of these, 31 refused venipuncture, and six were not able to stand up for weight measurement. Data were recorded using dedicated software. All participants underwent ambulatory or home visits by the study physicians, who performed physical examination, electrocardiography, Doppler echocardiography, ultrasonographic bone densitometry, and collected medical history and blood samples for serum chemistry and genomic analyses. Also, they completed a questionnaire, which included participants' data on socio-economic status and lifestyle habits. Appointments dedicated to blood sample collection were given early in the morning.

The Institutional Review Board approved the protocol of the present study, and all patients provided written informed consent.

Covariates

Education was expressed as years of school attendance. Alcohol consumption was defined by consuming at least two drinks per week. Drinks were considered as wine units (100 ml), because this beverage represents by far the major form of alcohol consumption in Italy, independently of any seasonal variations (Ferraroni et al. 1996). A conversion table was used for other alcoholic beverages; each litre of wine was assumed to contain 80 g of alcohol (Zuccalà et al. 2001).

Smoking was calculated [(number of daily cigarettes $\times$ 365/20) $\times$ years of smoking] as total lifetime pack-years for current, as well as former smokers. Nutritional parameters were assessed by the study physicians using a validated questionnaire, already adopted in large Italian populations (Gaddi et al. 2001). According to this questionnaire, participants were asked to detail the consumption (as services) of a complete series of foods over the week preceding the study visit. Protein, sugar, and fat consumption were calculated by merging individual foods (Gaddi et al. 2001). The occurrence of unintentional weight loss was defined as a decrease in body weight exceeding 5 kg over the last year.

Depressive symptoms were evaluated using the validated 30-item Italian version of the Geriatric Depression Scale, a self-reported scale based upon yes or no questions regarding mood over the previous week. The test yields 84% sensitivity and 95% specificity for the diagnosis of depression (Yesavage et al. 1982–1983). Cognitive performance was assessed using the Hodkinson Abbreviated Mental Test, that has been validated for the detection of cognitive impairment in Italian populations (Rocca et al. 1992). Participants' diagnoses and treatments were obtained by their general practitioners, and further confirmed by the study physicians, who received specific training and whose concordance had been tested.

All drugs assumed by participants were coded according to the Anatomical Therapeutic and Chemical codes (Pahor et al. 1994). Diagnoses were coded according to the International Classification of Diseases, 9th edition, Clinical Modification codes (Public Health Service–Health Care Financing Administration 1980).

Blood samples were obtained after overnight fast; the processed specimens were aliquoted into cryovials, frozen at -70°C, and shipped to the Department of Experimental Pathology, University of Bologna. Measures for interleukin-6 (IL-6) and high-sensitivity C-reactive protein (CRP), were measured in duplicate by enzyme-linked immunosorbent assay.

Functional ability

Functional ability was estimated using the Katz' activities of daily living (ADLs) (Katz et al. 1963), and the Lawton and Brody scale for instrumental activities of daily living (IADLs) (Lawton & Brody 1969). These scales are most commonly adopted for assessing functional independency for clinical and epidemiological purposes. The ADLs scale explores independency in bathing, dressing, toileting, transferring, continence, and feeding. A point is given for independence in each area, up to a maximum score of 6 for independence in all the domains (Katz et al. 1963). The IADLs rate independency in using the telephone, shopping, food preparation, housekeeping, laundering, travelling, taking medications, and handling finances. A point is given for independence in each area, with a total score of 8 for independence in all domains (Lawton & Brody 1969). Disability in the ADLs was defined as a need of assistance for performing two or more ADLs. The reason for not choosing a single-point decline is that impairment in two ADLs is less likely to capture fluctuations in functional performance (Bennett et al. 2002). Impairment in IADL function was identified by a score <5; this higher cutoff level is generally adopted to avoid a ''floor effect'' (Weiner et al. 2006).

Masticatory dysfunction

MD was tested as a self-reported symptom ''Do you experience difficulties in chewing?''; ''Did you change your alimentary habits because of such difficulties?''. MD was diagnosed if both questions were answered affirmatively (Laudisio et al. 2007).

Statistical analyses

Data of continuous variables are presented as mean values $\pm$ standard deviation (SD). Statistical analyses were performed using the statistical package for the social sciences (SPSS for Windows version 13.0, 2004, SPSS Inc., Chicago, IL, USA); differences were considered significant at the $p<0.05$ level. Analysis of variance (ANOVA) for normally distributed variables according to MD were performed by ANOVA comparisons; otherwise, the non-parametric Kruskal–Wallis *H*-test was adopted. χ^2 analysis was used for dichotomous variables. Serum IL-6 and CRP levels were analysed after log transformation.

The occurrence of unintentional weight loss exceeding 5 kg over the last year according to the MD reported was assessed by χ^2 analysis. Also, differences in the consumption of fibre, vita-

mins, and antioxidant-rich foods according to MD were calculated by ANOVA.

Logistic regression analysis was used to estimate the association of variables of interest, including MD, with the ADLs and IADLs scores. To assess independent correlates of disability, which might confound the association between the ADLs and IADLs scores and MD, groups of variables (demographics, comorbid conditions, medications, and objective tests, as depicted in Table 1) were first examined using separate age- and sex-adjusted regression models. Those variables, significant at the $p<0.05$ level in these initial models (Tables 2 and 3), were simultaneously entered into a summary model (Tables 2 and 3). These final models were also analysed after entering protein consumption. Analysis of the interaction term ''MD × sex'' was also performed to assess whether the association of MD with disability in ADLs and IADLs varied according to sex.

Eventually, the association between MD and ability in the ADLs and IADLs was assessed in sex-adjusted regression models after stratifying for age below or above the median value (80 years), adjusting for sex.

Results

The main characteristics of participants according to the presence of MD are depicted in Table 1. Excluded participants did not differ from those included in the study by age, sex, or prevalent MD.

MD was found in 145/350 (41%) participants. Participants with MD, as compared with remaining subjects, were more often dependent in the ADLs [37/145 (25%) *versus* 11/205 (5%), $p<0.0001$], and in the IADLs [53/145 (37%) *versus* 30/205 (15%), $p<0.0001$].

Table 1. Characteristics of participants according to masticatory dysfunction

	n (%) or mean ± standard deviation		*p*
	Participants with masticatory dysfunction ($n=145$)	Participants without masticatory dysfunction ($n=205$)	
Demographics and lifestyle habits			
Age (years)	81 ± 5	78 ± 5	<0.0001
Sex (female)	91 (63%)	99 (48%)	0.009
Education (years)	4 ± 2	5 ± 3	0.002
Current alcohol consumption	100 (69%)	148 (72%)	0.162
Smoking*	3412 ± 7189	6018 ± 11,285	0.015
Protein consumption†	9 ± 3	10 ± 3	0.001
Sugar consumption†	24 ± 6	24 ± 7	0.714
Fat consumption†	14 ± 4	13 ± 3	0.081
Comorbid conditions			
Chronic pulmonary disease	42 (29%)	49 (24%)	0.323
Diabetes	25 (17%)	52 (25%)	0.088
Hypertension	95 (65%)	143 (70%)	0.417
Heart failure	34 (23%)	32 (16%)	0.072
Coronary disease	34 (23%)	31 (15%)	0.051
Stroke	22 (15%)	22 (11%)	0.253
Renal disease	10 (7%)	4 (2%)	0.026
Cancer	12 (8%)	21 (10%)	0.582
Parkinson's disease	8 (5%)	4 (2%)	0.082
Arthritis	118 (81%)	156 (76%)	0.292
Medications			
β-blockers	7 (5%)	9 (4%)	1.000
Corticosteroids	8 (5%)	5 (2%)	0.157
ACE inhibitors	10 (7%)	23 (11%)	0.197
Loop diuretics	27 (19%)	41 (20%)	0.785
Objective tests			
Glucose (mg/dl)	103 ± 39	108 ± 36	0.180
Total cholesterol (mg/dl)	210 ± 44	216 ± 41	0.174
Serum albumin (g/dl)	4.1 ± 0.6	4.3 ± 0.6	0.001
Serum creatinine (mg/dl)	1.0 ± 0.3	1.0 ± 0.4	0.685
Serum sodium (mEq/l)	143 ± 3	143 ± 3	0.796
Serum potassium (mEq/l)	4.3 ± 0.5	4.2 ± 0.4	0.016
Interleukin-6 (pg/ml)	1.50 ± 1.42	1.15 ± 1.36	0.040
C-reactive protein (mg/dl)	0.83 ± 1.78	0.65 ± 1.23	0.352
Haemoglobin (g/dl)	14.0 ± 1.7	14.4 ± 1.6	0.002
Body mass index	28 ± 5	29 ± 5	0.041
Hodkinson's Abbreviated Mental Test	7 ± 2	8 ± 1	<0.0001
Geriatric Depression Scale	13 ± 7	10 ± 7	<0.0001
Dependency in the ADLs	37 (25%)	11 (5%)	<0.0001
Dependency in the IADLs	53 (37%)	30 (15%)	<0.0001

*Total lifetime pack years.
†Servings per week.
ACE, angiotensin-converting enzyme; ADLs, activities of daily living; IADLs, instrumental activities of daily living.

Main characteristics of participants with and without MD

The main participants' differences according to MD are depicted in Table 1. Noticeably, participants with MD reported less frequent protein consumption, and had lower serum albumin and haemoglobin levels, and lower body mass indices, as compared with remaining subjects. No participants reported the use of oestrogens, androgens, or antiandrogens. Unintentional weight loss was reported by 28/145 (19%) participants with MD, and by 19/205 (9%) subjects without MD (Fisher's exact $p=0.010$). Participants with MD reported less frequent consumption of meals rich in fibre (19 ± 7 *versus* 22 ± 7; $p<.0001$), and in vitamins and antioxidants (17 ± 6 *versus* 20 ± 7; $p<.0001$), as compared with other subjects.

Multivariable analyses

MD was associated with disability in the ADLs [odds ratio (OR) = 2.40, 95% confidence interval (CI) = 1.05–5.51] after simultaneously adjusting for those variables that were associated with disability in the ADLs at a $p<0.05$ level in the initial regression models (Table 2). Also, MD was associated with disability in the IADLs (OR = 2.77, 95% CI = 1.07–7.16) after simultaneously adjusting for all the variables that in the initial regression models were associated with disability in the IADLs at a $p<0.05$ level (Table 3).

When the final models were reanalysed after introducing protein con-

Table 2. Association [odds ratios (OR) and 95% confidence intervals (CI)] of dependency in the activities of daily living with the variables of interest according to the initial (age- and sex-adjusted), and the summary logistic regression models

	Age- and sex-adjusted models			Multivariable model		
	OR	95% CI	*p*	OR	95% CI	*p*
Demographics and lifestyle habits						
Age (years)	1.15	1.08–1.23	<0.0001	1.20	1.03–1.22	0.009
Sex (female)	1.05	0.49–2.25	0.907	1.09	0.47–2.53	0.848
Education (years)	1.01	0.90–1.13	0.826			
Current alcohol consumption	1.46	0.97–2.18	0.067			
Smoking*	1.00	1.00–1.00	0.707			
Protein consumption†	0.95	0.86–1.05	0.308			
Sugar consumption†	1.01	0.96–1.06	0.655			
Fat consumption†	1.03	0.94–1.12	0.557			
Masticatory dysfunction	3.21	1.60–6.44	0.001	2.40	1.05–5.51	0.039
Comorbid conditions						
Chronic pulmonary disease	0.49	0.24–1.00	0.051			
Diabetes	0.68	0.33–1.42	0.310			
Hypertension	1.37	0.66–2.85	0.398			
Heart failure	1.31	1.13–1.69	0.004	0.45	0.18–1.11	0.082
Coronary disease	1.51	0.67–3.41	0.324			
Stroke	1.19	1.09–1.43	<0.0001	0.42	0.16–1.13	0.085
Renal disease	0.55	0.16–1.86	0.340			
Cancer	1.02	0.35–3.02	0.968			
Parkinson's disease	1.14	1.03–1.53	0.004	1.16	1.04–1.63	0.009
Arthritis	1.45	0.65–3.24	0.366			
Medications						
β–blockers	1.33	0.35–5.15	0.675			
Corticosteroids	3.27	0.94–11.35	0.063			
ACE inhibitors	0.34	0.08–1.57	0.168			
Loop diuretics	3.39	1.77–6.51	<0.0001	3.61	1.48–8.80	0.005
Objective tests						
Glucose (mg/dl)	1.00	0.99–1.01	0.635			
Total cholesterol (mg/dl)	1.00	0.99–1.01	0.938			
Serum albumin (g/dl)	0.54	0.21–1.36	0.190			
Serum creatinine (mg/dl)	0.75	0.25–2.20	0.597			
Serum sodium (mEq/l)	0.98	0.84–1.13	0.768			
Serum potassium (mEq/l)	1.04	0.33–3.29	0.950			
Interleukin-6 (pg/ml)‡	1.99	0.98–4.01	0.056			
C-reactive protein (mg/dl)‡	0.73	0.45–1.19	0.209			
Haemoglobin (g/dl)	0.78	0.55–1.10	0.160			
Body mass index	1.08	0.98–1.19	0.135			
AMT	0.71	0.56–0.90	0.004	0.75	0.63–0.90	0.001
Geriatric Depression Scale	1.18	1.07–1.29	0.001	1.14	1.06–1.21	<0.0001

*Total lifetime pack years.

†Servings per week.

‡Log-transformed.

All the covariates were entered simultaneously into the models.

ACE, angiotensin-converting enzyme; AMT, Hodkinson's Abbreviated Mental Test.

sumption, MD was still associated with disability in the ADLs (OR 2.41, 95% CI = 1.04–5.60) and the IADLs score (OR 2.70, 95% CI = 1.04–7.03). Analysis of the interaction term indicated that the sex did not affect the association between MD and disability in the ADLs ($p = 0.082$) or IADLs ($p = 0.110$).

Eventually, the adjusted probability of being disabled in the ADLs and the IADLs associated with MD was increased among subjects older than 80 (OR = 6.25, 95% CI = 2.43–16.10, Fig. 1), and (OR = 4.18, 95% CI = 2.07–8.43, Fig. 2), as compared with younger participants (OR = 2.67, 95% CI = 1.06–6.75, Fig. 1, and OR = 1.99, 95% CI = 0.94–4.22, Fig. 2).

Discussion

The results of the present study indicate that MD is independently associated with reduced functional ability in older populations. The ageing of Western populations is associated with an exponential increase in prevalent disability (Fried et al. 2001). This is expected to put at risk our health and social care systems. Older subjects who have stable functional dependence or become disabled show excess 2 years expenditures of approximately US$10,000 (Freedman et al. 2002). Also, functional impairment is associated with reduced quality of life and survival rates. Nevertheless, knowledge of the determinants of impaired functional ability in older populations is still poor. MD is associated with increased risk of malnutrition (Sergi et al. 2007). In turn, malnutrition is a risk factor for worsening functional and cognitive performance, and increased mortality and hospitalization rates (Onder et al. 2007, Sergi et al. 2007). Not surprisingly, tooth loss has been associated with disability and mortality in older populations (Holm-Pedersen et al. 2008). MD in advanced age is most frequently associated with periodontal disease with ensuing tooth loss; in fact, tooth loss is considered a proxy of periodontitis in epidemiological studies (Grabe et al. 2009). In addition, periodontitis often causes mobility of the remaining teeth, which contributes to development of MD in affected subjects. These observations indicate that early detection and treatment of oral diseases associated with MD might affect the development of disability, thus being relevant from the patients' and social perspectives. In fact, it has been demonstrated that adequate implant treatment might improve masticatory function (Ohkubo et al. 2006). Also, intensive treatment for periodontitis has been proven to decrease serum inflammatory markers and serum lipid abnormalities (D'Aiuto et al. 2005, Paraskevas et al. 2008).

Subjects with chewing problems often eat less and avoid food that is hard to chew, such as vegetables, fruits, and protein and vitamin-rich foods, favouring those which are soft and rich in fats (Ohkubo et al. 2006). Such nutritional habits might promote the development of cardiovascular and cerebrovascular diseases, as well as cancer. All these conditions are associated with disability. In addition, subjects with MD often overcook food, altering its nutritional properties (Ogawa et al. 2006). Elderly subjects are at risk of inadequate intake of calcium, fibres, and vitamins (Lichtenstein et al. 2008). In the present study, MD was associated with several indices of malnutrition. Accordingly,

Table 3. Association [odds ratios (OR), and 95% confidence intervals (CI)] between dependency in the instrumental activities of daily living and the study variables of interest according to the initial (age- and sex-adjusted), and the summary logistic regression models

	Age- and sex-adjusted models			Multivariable model		
	OR	95% CI	*p*	OR	95% CI	*p*
Demographics and lifestyle habits						
Age (years)	1.15	1.09–1.21	<0.0001	1.12	1.01–1.25	0.056
Sex (female)	0.37	0.20–0.71	0.002	0.41	0.15–1.07	0.069
Education (years)	0.94	0.85–1.03	0.201			
Current alcohol consumption	1.09	0.76–1.56	0.641			
Smoking*	1.00	1.00–1.00	0.104			
Protein consumption†	0.95	0.87–1.03	0.204			
Sugar consumption†	1.01	0.96–1.05	0.715			
Fat consumption†	0.95	0.88–1.02	0.156			
Masticatory dysfunction	2.41	1.39–4.17	0.002	2.77	1.07–7.16	0.035
Comorbid conditions						
Chronic pulmonary disease	1.46	1.25–1.83	0.011	0.45	0.18–1.12	0.087
Diabetes	0.82	0.43–1.55	0.535			
Hypertension	0.99	0.53–1.82	0.964			
Heart failure	1.27	1.13–1.55	<0.0001	0.74	0.25–2.19	0.583
Coronary disease	1.78	1.38–2.62	0.512			
Stroke	2.20	1.09–2.43	<0.0001	0.91	0.09–1.19	0.091
Renal disease	0.85	0.26–2.81	0.788			
Cancer	1.10	0.43–2.80	0.840			
Parkinson's disease	1.30	1.08–2.10	0.070			
Arthritis	2.22	1.17–4.23	0.015	3.39	1.19–9.65	0.022
Medications						
β–blockers	1.52	0.50–4.58	0.460			
Corticosteroids	1.57	0.45–5.42	0.478			
ACE inhibitors	0.56	0.20–1.58	0.275			
Loop diuretics	3.82	2.13–6.86	<0.0001	4.05	1.41–11.65	0.009
Objective tests						
Glucose (mg/dl)	1.00	0.99–1.01	0.982			
Total cholesterol (mg/dl)	0.99	0.98–1.00	0.073			
Serum albumin (g/dl)	0.37	0.17–0.82	0.014	0.38	0.18–0.80	0.011
Serum creatinine (mg/dl)	0.94	0.35–2.54	0.908			
Serum sodium (mEq/l)	0.95	0.83–1.08	0.448			
Serum potassium (mEq/l)	0.83	0.32–2.16	0.705			
Interleukin-6 (pg/ml)‡	2.00	1.09–3.65	0.025	1.92	1.11–3.32	0.019
C-reactive protein (mg/dl)‡	1.00	0.65–1.56	0.990			
Haemoglobin (g/dl)	0.84	0.63–1.13	0.260			
Body mass index	1.07	0.98–1.17	0.149			
AMT	0.60	0.47–0.77	<0.0001	0.68	0.54–0.85	0.001
Geriatric Depression Scale	1.11	1.03–1.19	0.004	1.12	1.04–1.21	0.003

*Total lifetime pack years.
†Servings per week.
‡Log-transformed.
All the covariates were entered simultaneously into the models.
ACE, angiotensin-converting enzyme; AMT, Hodkinson's Abbreviated Mental Test.

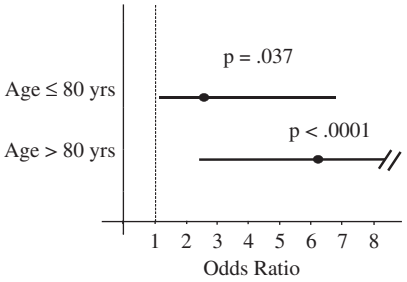

Fig. 1. Adjusted probability (logistic regression) of disability in the activities of daily living associated with masticatory dysfunction according to age.

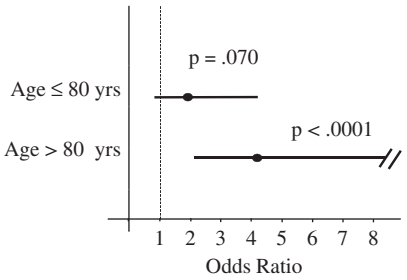

Fig. 2. Adjusted probability (logistic regression) of disability in the instrumental activities of daily living associated with masticatory dysfunction according to age.

unintentional weight loss over the last year was more frequently reported by subjects with MD (Table 1); weight loss is an acknowledged marker of ''frailty'', and thus of increased risk of disability in older populations (Miller & Wolfe 2008). Of notice, in the present study, participants with MD were ''frailer'', as indicated by worse renal function and increased IL-6 serum levels (Table 1). Periodontitis, like other chronic infectious/inflammatory conditions, is associated with subclinical systemic inflammation (Loos et al. 2000, Slade et al. 2003, Schwahn et al. 2004, Jepsen & Kuchel 2006, Li et al. 2009). In subjects with periodontal disease, bacteria or lipopolysaccharides can enter the bloodstream during brushing or common dental care interventions (Forner et al. 2006); in these patients, even gentle mastication can cause systemic release of endotoxins (Geerts et al. 2002). Interestingly in older populations, chronic subclinical inflammation, as evidenced by slight increases in IL-6 serum levels, is associated with metabolic abnormalities, sarcopenia, decreased physical performance and increased incidence of disability (Ferrucci et al. 2002). Indeed, our data seem to support the hypothesis of some role of inflammation in the development of disability among older subjects with MD, at least regarding the IADLs (Table 3). As suggested by our results (Figs. 1 and 2), the effect of malnutrition and chronic inflammation associated with MD might be amplified among the oldest individuals, in whom advanced age per se increases the risk of disability.

As a whole, the results of the present study indicate that appropriate nutritional counselling and intensive periodontal therapy might be helpful in preventing disability in older populations, following accurate screening and early detection of MD.

Limitations

A limitation of the study is represented by its cross-sectional design, which does not allow for the establishment of a cause-and-effect relationship. Thus, it cannot be excluded that MD might be a component of disability. Nevertheless,

even in this hypothesis, MD is likely to worsen health, and therefore, functional status. Also, this study did not include measurement of serum nutrients. In the present study, MD was self-assessed; self-assessed tools for evaluating masticatory function might underestimate chewing problems, as compared with a practitioner's evaluation (Holm-Pedersen et al. 2008). Nevertheless, this represents a conservative bias, which further supports our finding of an association between MD and disability. Also, self-assessment methods allow to detect the impact of several factors, not always measurable, on chewing ability, such as functional deficiencies of the tongue (Slagter et al. 1992). Focusing on the outcomes of subjective, rather than objective, health status is in accordance with the Institute of Medicine's promotion of patient-centred care (N'gom & Woda 2002), and it is needed for formal cost-effectiveness calculations in healthcare (Rich & Nease 1999).

Conclusions

MD, which is a prevalent finding in older subjects, is associated with worse nutritional status and might represent an independent cause of disability in elderly populations. As satisfying masticatory function is important to maintain adequate nutritional status, masticatory function should be systematically investigated in older patients; also, early and intensive correction of conditions associated with MD, such as periodontal disease, are to be considered as mandatory.

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Clinical Relevance

Scientific rationale for study: Disability is a major problem in older population and it is associated with poor prognosis and high medical costs.

Principal finding: The present study showed that MD is a common condition in older populations and it is associated with functional disability. Participants with MD had worse nutritional status as evinced by the lower body mass index, and haemoglobin and serum albumin levels, as compared with subjects without MD. The presence of MD is associated with reduced functional ability, chiefly in the oldest population.

Practical implications: Physicians should assess and pay attention to chewing problems in their older patients. Therefore, dentists, especially periodontists, should be consulted in the case of older subjects with functional disability to assess whether masticatory function has also deteriorated in order to prevent further loss of functional ability.