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Self-Reported Masticatory Dysfunction and Mortality in Community Dwelling Elderly Adults: A 9-Year Follow-Up

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Abstract

OBJECTIVES: To evaluate the association, if any, between masticatory dysfunction (MD) and mortality in older adults.

DESIGN: The Invecchiare in Chianti (InCHIANTI) Study, a cohort study with 9-year follow-up.

SETTING: Tuscany, Italy.

PARTICIPANTS: Individuals aged 65 and older (N = 1,155).

MEASUREMENTS: MD was self-reported; Cox regression was used to assess the association between self-reported MD and 9-year all-cause mortality. This association was also evaluated after stratifying according to use of dentures. Analyses were adjusted for potential confounders, including demographic characteristics, lifestyle habits, comorbidities, nutrient intake, medications, and objective parameters.

RESULTS: Four hundred five (35%) participants reported MD. Over the 9-year follow-up, 475 (41%) subjects died. According to Cox regression analysis, self-reported MD was associated with higher mortality (relative risk (RR) = 1.23, 95% confidence interval (CI) = 1.02–1.48), after adjusting for potential confounders. In participants with self-reported MD, uncorrected edentulism was the condition associated with the greatest risk of mortality (RR = 2.10, 95% CI = 1.07–4.14); use of dentures seemed to blunt this association (RR = 1.12, 95% CI = 0.87–1.44).

CONCLUSION: Self-reported MD, chiefly when due to uncorrected edentulism, is associated with 9-year all-cause mortality in community-dwelling elderly adults. Further studies are needed

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to evaluate whether the timely correction of MD using adequate dentures can increase the survival of older adults. **J Am Geriatr Soc 64:2503–2510, 2016.**

Keywords

masticatory dysfunction; mortality; community-dwelling elderly adults; epidemiology

Masticatory dysfunction (MD) is defined as a self-reported symptom or an objective deficit in chewing selected foods.¹ Because of the greater prevalence of disorders of the oral mucosa, impairment of masticatory muscles, xerostomia, nervous system disorders, and edentulism, MD is a common condition in older populations, with prevalence rates ranging from 24% in individuals aged 64 and older to 34% in those aged 70 and older.² Two kinds of assessment are used to explore masticatory function: objective methods, based upon laboratory results and chewing tests, and subjective methods, based upon specific questionnaires and interviews. Although objective methods can generate more-accurate information, they require greater manpower, time and special equipment, as well as participant willingness and ability to perform the tests.² Such tests are therefore difficult to perform in large populations; subjective methods are simpler, easier to administer, and less costly. Most importantly, masticatory ability is not completely objective because it includes subjective components (e.g., pain, masticatory fatigue, xerostomia), which objective tests do not detect.^{3–9}

The rate of self-reported impairment of masticatory ability increases with age, especially after the age of 75. In addition, poor general health, poor dental status, and masticatory disability are closely related.¹⁰ MD is also associated with functional ability and mood.^{4,5} All these conditions, in turn, are known to be associated with adverse outcomes, including mortality; in a general sense, MD is thus related to health status. At least in some cases, MD is a cause of malnutrition in older populations yet is potentially reversible with adequate oral care and, when appropriate, prosthetic treatment.¹¹

Only a few studies have investigated the association between MD and mortality. In a cohort study of 1,124 elderly adults, MD (defined according to objective dental examination) was associated with 10-year mortality, but multimorbidity and medication use were not included in the analyses.¹² In a retrospective cohort study of 2,755 elderly adults, MD was associated with 1-year mortality. In this study, MD was self-reported, and participants received home care service; the analyses targeted multimorbidity and the number of drugs taken, with no mention of specific medications. Nutritional and lifestyle habits were not included in the analyses.⁶ In another cohort of 1,245 elderly adults, MD was associated with greater risk of 9-year mortality.⁷ MD was self-reported, and this study recruited Asian participants, but multimorbidity and medication use were not included in the analyses.

The current study aimed to assess whether self-reported MD is associated with mortality in community-dwelling elderly adults and, if so, whether different causes of MD have different risks. Whether use of well-functioning dentures might affect this association was also assessed.

METHODS

Study Design and Participants

This study is based upon data from the Invecchiare in Chianti study, a prospective population-based study of older persons in Tuscany, Italy, that aims to identify risk factors for late-life disability.

The Italian National Research Council on Aging Ethical Committee ratified the study protocol, and participants provided written consent to participate. At baseline, analyses for the present study included all 1,155 participants aged 65 and older.

Mortality

Data on 9-year mortality were collected using from the Mortality General Registry maintained by the Tuscany Region and from death certificates delivered immediately after death to the registry office of the municipality of residence.

Masticatory Dysfunction and Oral Health-Related Variables

MD was assessed as a self-reported symptom, based upon answers to the questions: “Do you experience difficulty chewing?” and “Has the amount of food you usually eat decreased in the last year because of chewing problems?” MD was diagnosed if either of these questions was answered affirmatively. Several previous studies have adopted a similar approach using subjective rather than objective evaluation.^{3–9}

Information regarding use of dentures was collected for the whole population according to the answer to the question: “Do you usually use dentures?” Possible answers were no, complete, and partial.

Participants with MD were asked to provide details about the main reason they had difficulty chewing: no teeth (uncorrected partial or total edentulism), defective dentures, or no problems with teeth.

Covariates

Education was expressed as years of school attendance. Smoking was self-reported and expressed as lifetime pack-years. Current alcohol consumption was evaluated as glasses of wine per week. Adjudicated disease diagnoses were based on self-reported history, clinical documentation, and medication use, as well as standardized criteria derived from the Women’s Health and Aging Study protocol.¹³ Comorbidity was quantified using the Charlson Comorbidity Index score by adding scores assigned to specific diagnoses. A score of 1 was attributed to myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, dementia, chronic pulmonary disease, rheumatological disease, peptic ulcer disease, mild liver disease, and diabetes mellitus. A score of 2 was given for the presence of each of the following conditions: diabetes mellitus with chronic complications, hemiplegia or paraplegia, renal disease, and any malignancy, including leukemia and lymphoma; a score of 3 for moderate to severe liver disease; and a score of 6

for metastatic solid tumors.¹⁴ All medications that participants were taking were coded according to the Anatomical Therapeutic Chemical classification codes.¹⁵

Data on dietary intake were collected using the food-frequency questionnaire created for the European Prospective Investigation into Cancer and Nutrition (EPIC) Study.¹⁶ The EPIC questionnaire is divided into two parts that explore general dietary pattern and frequency of meals consumed and the frequency of 236 specific foods, along with the average size of servings. The information derived from the questionnaire was automatically converted into data on energy and micro- and macronutrient intake using software specifically designed for the EPIC Study.

Depression was assessed using the original 20-item Italian version of the Center for Epidemiologic Studies Depression Scale (CES-D); The CES-D is a self-report scale with a score ranging from 0 to 60 that has been proven to be a valid instrument for identifying depressive symptoms in older community-dwelling adults, including a representative Italian sample; a CES-D score of 20 or greater was used to define depressed mood.¹⁷

Cognitive performance was evaluated using the 30-item Mini Mental State Examination, which is a widely used tool for the measurement of cognitive function and has been proven to be an effective screening instrument for cognitive impairment in general populations. MMSE scores range from 0 to 30, with lower scores reflecting worse cognitive function. Cognitive impairment was defined as a MMSE score less than 24.¹⁸

Self-reported functional ability was estimated using the Katz activity of daily living (ADL) questionnaire. This tool is most commonly used to assess functional independence for clinical and epidemiological purposes. The ADL questionnaire explores independence in bathing, dressing, toileting, transferring, continence, and feeding.¹⁹ Functional impairment was defined as need of assistance in 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 physiological fluctuations in functional performance.²⁰

Blood samples were obtained from participants after a 12-hour fast and after resting for at least 15 minutes. Aliquots of serum were stored at -80°C and were not thawed until analyzed. Glomerular filtration rate was estimated using the Cockcroft-Gault equation.

Statistical analyses

Statistical analyses were performed using the SPSS for Mac version 20.0 (IBM Corp., Armonk, NY); differences were considered significant at the $P < .05$ level. The covariates to be entered into analyses were chosen as explanatory according to available reviews and metaanalyses from the electronic databases of PubMed (MEDLINE) and the Cochrane Library and based upon their efficiency and economy. Data for continuous variables are presented as means $\pm$ standard deviations. Analysis of variance (ANOVA) for normally distributed variables according to survival status was performed using ANOVA comparisons. Median values and interquartile ranges were provided for nonnormally distributed variables, and the nonparametric Mann-Whitney U test was used. The two-tailed Fisher exact test was

used for dichotomous variables. Serum interleukin 6 (IL-6) levels were analyzed after log transformation.

Cox proportional hazards regression analysis was used to estimate the associations between the variables of interest, including MD, and mortality. To assess independent correlates of reduced survival that might confound the association between MD and mortality, groups of variables (demographic characteristics, comorbid conditions, medications, objective tests; Table 2) were examined using separate age- and sex-adjusted Cox regression models. All variables significant at the $P < .05$ level in these initial models were simultaneously entered into a summary model.

Also, in participants with MD, Cox regression was used to evaluate the association between mortality and absence of dental problems, denture malfunctioning, and uncorrected edentulism. The fully adjusted Cox regression model was used to assess the association between MD and mortality after stratifying for use of dentures (complete or partial).

The association was then tested between MD and single causes of death, coded according to *International Classification of Diseases, Ninth Edition, Clinical Modification* codes.

RESULTS

Four hundred five participants (35%) reported MD. Use of dentures was recorded in 735 (64%) subjects, 389 (34%) of whom wore complete dentures and 346 (30%) partial dentures. Participants who died had reported less-frequent use of dentures (278/475, 58%) than survivors (457/680, 67%) ($P = .003$).

The main characteristics of participants are compared according to the presence of MD in Table 1. Of subjects with MD, 389 (34%) wore complete dentures, and 346 (30%) used partial dentures. Of 405 subjects with MD, 244 (60%) reported malfunctioning of dentures as the subjective cause of MD, 138 (34%) reported uncorrected edentulism, and 21 (5%) reported no problems with teeth. Use of dentures (partial or complete) was less prevalent in subjects with MD ($n = 239$, 59%) than controls ($n = 496$, 66%) ($P = .02$).

Over the 9 years of follow-up, 475 (41%) participants died. The main characteristics of participants are depicted in Table 2 according to survival status. Participants who died reported MD more frequently (205/475, 43%) than surviving participants (200/680, 29%) ($P < .001$).

Multivariable Analyses

In the initial age- and sex-adjusted Cox regression models (Table 3), MD, diagnosis of heart failure, and use of loop diuretics were associated with all-cause mortality at a $P < .05$ level. In the summary model, simultaneously adjusting for age, sex, and diagnosis of heart failure, MD was still associated with mortality (relative risk (RR)=1.23, 95% confidence interval (CI)=1.02–1.48, $P = .03$) (Table 3).

When the single conditions defining masticatory status were analyzed using the same regression model (adjusted for age, sex, heart failure), uncorrected edentulism was

associated with the greatest risk of 9-year mortality, followed by malfunctioning of dentures and no problem with teeth (Figure 1).

In the same fully adjusted Cox regression model (adjusted for age, sex, and heart failure), after stratifying for use of dentures (complete or partial), MD was associated with all-cause mortality only in participants who did not wear dentures (RR = 1.50, 95% CI = 1.02–2.19, $P = .04$). No association was found (RR = 1.12; 95% CI = 0.87–1.44, $P = .38$) in participants who used partial or complete dentures (Figure 2). Eventually, none of the single causes of death were associated with MD (all $P \geq .05$).

DISCUSSION

Self-reported MD was associated with greater risk of 9-year all-cause mortality in an older community-dwelling population. This association was independent of several potential confounders, including comorbid conditions, medication use, and lifestyle habits. Subjects who reported uncorrected edentulism (partial or complete) as the subjective cause of MD were at greatest risk. Regular use of dentures seemed to blunt the risk of death associated with MD, despite the high prevalence (60%) of subjects who indicated defective dentures as the subjective cause of MD.

This study confirms a previous finding of an association between inadequate dental status and 10-year mortality in individuals aged 70 to 75 living in northern Italy.¹² This study also supports the finding of self-assessed masticatory disability as a significant predictor of 9-year mortality in an Asian population of individuals aged 65 and older⁶ and the finding of greater 1-year risk of death in older adults (mean age 82) with self-assessed chewing problems who received homecare service across Europe.⁶ The concordance of results from such different populations and settings seems to reflect a sound pathophysiological basis for the association between MD and shorter survival. This study offers some methodological advantages over previous reports, because it included a representative community-dwelling population; had a high participation rate and extensive information regarding risk factors and comorbid conditions; and involved thorough functional, physical, and laboratory investigation. In addition, detailed information regarding drug treatment was available.

This study suggests that regular use of dentures might improve survival; in the subset of participants with MD, uncorrected edentulism was associated with the greatest risk of mortality.

Several factors might explain the shorter survival of elderly adults with MD. MD is strongly related to malnutrition and undernutrition, which in turn are associated with mortality.²¹ Subjects with MD often eat less and avoid hard-to-chew food such as vegetables and fruits, as well as protein- and vitamin-rich foods, favoring those that are soft and rich in fats.²² Such nutritional habits might promote the development of cardiovascular and cerebrovascular diseases, as well as malignancy—all conditions that are associated with mortality. In addition, subjects with MD often soften food by overcooking it, diminishing its nutritional properties.⁶

MD might also reflect the presence of periodontal disease, which is associated with higher proinflammatory cytokine serum levels.^{23,24} Inflammation in turn is a well-known risk factor for adverse outcomes, including mortality. Individuals with inflammatory periodontal diseases usually have higher serum proinflammatory cytokine levels. Because of the predominant role of gram-negative anaerobic bacteria in periodontal infections, the ulcerated pocket epithelium turns into a chronic source of systemic challenge from bacteria, bacterial products, and locally produced inflammatory mediators. Furthermore, as a consequence of high vascularity, the inflamed periodontium may act as an endocrine-like source of inflammatory mediators, which are significant in periodontal inflammation and may also have systemic influence. A metaanalysis demonstrated higher serum high-sensitivity C-reactive protein levels in individuals with periodontitis than in healthy controls. This may be clinically relevant, because high C-reactive protein serum levels are associated with greater risk of cardiovascular events.²⁵

Preserved chewing ability has also been associated with regular use of screening health programs, which can strongly affect survival.¹² MD has also been associated with cognitive impairment, depression, and functional disability, which are well-known risk factors for poor survival in older populations.^{4,5,26}

In line with previous studies, these results support the hypothesis that regular use of dentures might blunt the risk of earlier mortality associated with MD.^{12,27} Thus, it would be advisable to include the provision of dentures as a preventive intervention in healthcare programs. Most elderly adults with dentures reported malfunctioning of the prosthesis as the cause of MD. This finding indicates that regular oral health inspections should be planned in individuals who wear dentures.

When the single causes of MD were compared, the highest risk of poorer survival was found in participants with uncorrected edentulism. This finding is in line with previous studies that found an association between edentulism and several adverse outcomes, including cognitive and functional impairment and mortality.^{26–29} Edentulism is a robust and irreversible marker of poor oral health, representing total tooth loss and reflecting longstanding, severe oral disease.

MD was not associated with specific causes of death. This could be due to insufficient statistical power, although as highlighted by results in Table 2, MD was associated with several pathological conditions and risk factors, which overall indicated poor health. MD might thus result from several conditions; in turn, MD worsens the prognosis of underlying pathologies.

Limitations of the Study

MD was self-assessed in the present study. Self-evaluation of masticatory function might underestimate MD, compared with objective evaluation.²⁹ Nevertheless, this would represent a conservative bias, which further supports the finding of an association between MD and all-cause mortality. Also, self-assessment allows detection of the effect of several factors that are not always measurable on chewing ability, such as functional deficiencies of the tongue, painful disorders of the oral mucosa, dysgeusia, xerostomia, and nervous system

disorders.³⁰ Focusing on the outcomes of subjective, rather than objective, health status is in accordance with the Institute of Medicine's promotion of person-centered care and is necessary for formal cost-effectiveness calculations in health care.³¹

Information regarding uncorrected edentulism was recorded, but no information was available on the number of remaining teeth, and there was no objective assessment of defective dentures. Nutrient intake was adjusted for body weight, which might underestimate the role of metabolically active tissues in obese individuals, whose fat mass is metabolically less active than their other tissues are. This would, again, make the analyses more conservative.

In summary, the results of this study confirm in a representative sample of community-dwelling elderly adults that MD is a potentially modifiable risk factor for poor survival in advanced age, independent of its determinants and coexisting risk factors.

CONCLUSION

MD is independently associated with 9-year all-cause mortality, which indicates a public health concern. Uncorrected edentulism as the cause of MD is associated with the greatest risk, which use of dentures might decrease. Further studies are needed to assess whether timely detection and correction of MD might increase the survival of older populations, as well as whether such interventions might be cost-effective in the context of national healthcare policies.

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Figure 1.

Nine-year survival curves of participants with self-reported masticatory dysfunction who reported edentulism, malfunctioning dentures, or no problems with teeth as possible explanatory causes. The model was simultaneously adjusted for age, sex, and diagnosis of heart failure.

Figure 2. Nine-year survival curves of participants with self-reported masticatory dysfunction, stratified according to denture use. The model was simultaneously adjusted for age, sex, and diagnosis of heart failure.

Table 1.

Participant Characteristics According to Self-Reported Masticatory Dysfunction (N = 1,155)

Characteristic	Masticatory Dysfunction, n = 405	No Masticatory Dysfunction, n = 750	P-Value
Cause of masticatory dysfunction, n (%)			
Malfunctioning of denture	244 (60)		
Uncorrected edentulism	138 (34)		
No problems with teeth	21 (5)		
Not declared	2 (1)		
Type of denture, n (%)	239 (59)	496 (66)	.02
Complete	124 (31)	265 (35)	.18
Partial	115 (28)	231 (31)	.42
Demographic characteristics and lifestyle habits			
Age, mean $\pm$ SD	77.7 $\pm$ 8.1	74.2 $\pm$ 7.0	<.001
Female, n (%)	255 (63)	399 (53)	.001
Education, years, mean $\pm$ SD	4 $\pm$ 3	6 $\pm$ 3	<.001
Pack-years of smoking, median (IQR)	28 (0–43)	19 (0–42)	.01
Alcohol consumption, median (IQR) ^a	7 (4–14)	14 (7–21)	.12
Living alone, n (%)	208 (52)	263 (35)	<.001
Self-perceived insufficient income, n (%)	213 (54)	356 (48)	.05
Died, n (%)	205 (51)	270 (36)	<.001
Daily nutrient intake, mean $\pm$ SD			
Protein intake, g/kg	1.11 $\pm$ 0.31	1.12 $\pm$ 0.32	.67
Energy, kcal/kg	28.4 $\pm$ 8.3	28.8 $\pm$ 8.3	.50
Comorbid conditions, n (%)			
Chronic pulmonary disease	34 (8)	55 (7)	.56
Diabetes mellitus	42 (10)	83 (11)	.77
Heart failure	28 (7)	31 (4)	.049
Stroke	24 (6)	36 (5)	.41
Coronary disease	19 (5)	29 (4)	.54
Parkinson's disease	6 (2)	10 (1)	.80
Malignancy	22 (5)	42 (5)	>.99
Peripheral arterial disease	45 (11)	79 (10)	.76
Charlson Comorbidity Index score, median (IQR)	1 (0–2)	0 (0–1)	.01
Medication, n (%)			
Angiotensin-converting enzyme inhibitor	59 (15)	100 (13)	.53
Loop diuretic	47 (12)	58 (8)	.03
Beta-blocker	8 (2)	19 (3)	.68
Antiplatelet	45 (11)	81 (11)	.84
Anticoagulant	8 (2)	8 (1)	.31
Selective serotonin reuptake inhibitor	7 (2)	10 (1)	.61
Digoxin	48 (12)	45 (6)	.001

Characteristic	Masticatory Dysfunction, n = 405	No Masticatory Dysfunction, n = 750	P-Value
Laboratory tests			
Hemoglobin, g/dL, mean $\pm$ SD	13.5 $\pm$ 1.4	13.8 $\pm$ 1.4	.005
Glomerular filtration rate, mL/min, mean $\pm$ SD	60.8 $\pm$ 19.2	66.9 $\pm$ 19.2	<.001
Total serum cholesterol, mg/dL, mean $\pm$ SD	215.3 $\pm$ 39.7	218.0 $\pm$ 39.9	.29
Total serum proteins, g/dL, mean $\pm$ SD	7.2 $\pm$ 0.5	7.1 $\pm$ 4.3	.06
Body mass index, kg/m ² , mean $\pm$ SD	27.5 $\pm$ 4.3	27.4 $\pm$ 4.0	.80
Cognitive impairment, n (%) ^b	162 (40)	205 (27)	<.001
Depression, n (%) ^c	115 (33)	126 (17)	<.001
Functional impairment, n (%) ^d	52 (13)	22 (3)	<.001
Serum interleukin 6, pg/mL, median (IQR)	1.65 (0.99–2.73)	1.38 (0.84–2.10)	.001

^aNumber of glasses of wine per week.

^bMini-Mental State Examination score <24.

^c20-item Center for Epidemiologic Studies Depression Scale score $\geq$ 20.

^dKatz activity of daily living scale score <5.

SD = standard deviation; IQR = interquartile range.

Table 2.

Participant Characteristics According to 9-Year Survival (N = 1,155)

Characteristic	Dead, n = 475	Alive, n = 680	P-Value
Demographic characteristics and lifestyle habits			
Age, mean $\pm$ SD	80.6 $\pm$ 7.5	71.8 $\pm$ 5.3	<.001
Female, n (%)	250 (53)	405 (60)	.02
Education, years, mean $\pm$ SD	4 $\pm$ 3	6 $\pm$ 3	<.001
Pack-years of smoking, median (IQR)	0 (0–29)	0 (0–16)	.03
Alcohol consumption, median (IQR) ^a	10 (7–21)	14 (4–14)	.14
Living alone	255 (54)	217 (32)	<.001
Self-perceived bad economic situation	57 (12)	57 (8)	.04
Use of dentures	278 (58)	457 (67)	.003
Daily nutrient intake, mean $\pm$ SD			
Protein intake, g/kg	1.14 $\pm$ 0.32	1.11 $\pm$ 0.32	.26
Energy, kcal/kg	29.1 $\pm$ 8.3	28.4 $\pm$ 8.4	.23
Comorbid conditions			
Chronic pulmonary disease	63 (13)	26 (4)	<.001
Diabetes mellitus	60 (13)	65 (10)	.10
Heart failure	46 (10)	13 (2)	<.001
Stroke	44 (9)	18 (2)	<.001
Coronary disease	36 (8)	45 (7)	.56
Parkinson's disease	14 (3)	2 (1)	<.001
Malignancy	28 (6)	36 (5)	.70
Peripheral arterial disease	90 (19)	35 (5)	<.001
Self-reported masticatory dysfunction	205 (43)	200 (29)	<.001
Charlson Comorbidity Index score	1 (0–2)	0 (0–1)	<.001
Medications			
Angiotensin-converting enzyme inhibitor	88 (18)	72 (11)	<.001
Loop diuretic	72 (15)	33 (5)	<.001
Beta-blocker	11 (2)	16 (2)	>.99
Antiplatelet	79 (17)	48 (7)	<.001
Anticoagulant	14 (3)	3 (1)	.001
Selective serotonin reuptake inhibitor	12 (3)	5 (1)	.02
Digoxin	81 (17)	13 (2)	<.001
Laboratory tests			
Hemoglobin, g/dL, mean $\pm$ SD	13.4 $\pm$ 1.6	13.9 $\pm$ 1.2	<.001
Glomerular filtration rate, mL/min, mean $\pm$ SD	56.4 $\pm$ 19.5	69.5 $\pm$ 17.8	<.001
Total serum cholesterol, mg/dL, mean $\pm$ SD	208.3 $\pm$ 42.0	222.7 $\pm$ 37.5	<.001
Total serum proteins, g/dL, mean $\pm$ SD	7.1 $\pm$ 0.5	7.1 $\pm$ 0.4	.80
Body mass index, kg/m ² , mean $\pm$ SD	27.0 $\pm$ 4.3	27.7 $\pm$ 4.0	.02
Cognitive impairment, n (%) ^b	239 (50)	130 (19)	<.001

Characteristic	Dead, n = 475	Alive, n = 680	P-Value
Depression, n (%) ^c	115 (29)	126 (19)	<.001
Functional impairment, n (%) ^d	73 (15)	3 (1)	<.001
Serum interleukin 6, pg/mL, median (IQR)	1.9 (1.1–3.3)	1.2 (0.8–1.8)	<.001

^aNumber of glasses of wine per week.

^bMini-Mental State Examination score <24.

^c20-item Center for Epidemiologic Studies Depression Scale score ≥ 20.

^dKatz activity of daily living scale score <5.

SD = standard deviation; IQR = interquartile range.

Table 3.

Nine-Year Risk of Death According to Initial (Age- and Sex-Adjusted) and Summary (Fully Adjusted) Cox Regression Models

	Age- and Sex-Adjusted Model	Summary Model ^a
Characteristic	Relative Risk (95% Confidence Interval) <i>P</i> -Value	
Demographic characteristics and lifestyle habits		
Age	1.07 (1.03–1.12) .002	1.04 (1.03–1.05) <.001
Female	1.45 (0.52–4.00) .48	0.83 (0.69–0.99) .049
Education, years	1.00 (0.92–1.09) .96	
Pack-years of smoking	1.00 (0.99–1.01) .60	
Alcohol consumption ^b	0.99 (0.98–1.02) .92	
Living alone	0.92 (0.48–1.77) .81	
Self-perceived bad economic situation	1.46 (0.44–4.82) .53	
Daily nutrient intake		
Protein, g/kg	1.33 (0.64–2.74) .45	
Energy, kcal/kg	0.98 (0.96–1.01) .37	
Comorbid conditions		
Chronic pulmonary disease	0.89 (0.65–1.22) .45	
Diabetes mellitus	1.11 (0.80–1.55) .53	
Heart failure	1.50 (1.06–2.13) .02	1.60 (1.17–2.17) .003
Stroke	0.86 (0.60–1.24) .42	
Coronary disease	1.05 (0.76–1.44) .76	
Parkinson’s disease	0.76 (0.44–1.32) .34	
Malignancy	1.48 (0.93–2.33) .09	
Peripheral arterial disease	1.02 (0.78–1.34) .88	
Self-reported masticatory dysfunction	1.21 (1.01–1.46) .048	1.23 (1.02–1.48) .03
Charlson Comorbidity	1.05 (0.93–1.19) .41	
Index score		
Medication		
Angiotensin-converting enzyme inhibitor	1.12 (0.88–1.43) .36	
Loop diuretic	1.27 (0.95–1.70) .11	
Beta-blocker	0.85 (0.46–1.57) .61	
Antiplatelet	0.99 (0.77–1.26) .91	
Anticoagulant	0.91 (0.52–1.59) .74	
Selective serotonin reuptake inhibitor	1.32 (0.74–2.35) .35	

Characteristic	Age- and Sex- Adjusted Model	Summary Model ^a
	Relative Risk (95% Confidence Interval) <i>P</i> -Value	
Digoxin	1.32 (1.00–1.71)	.05
Laboratory tests		
Hemoglobin, g/dL	0.97 (0.88–1.06)	.46
Glomerular filtration rate	1.01 (0.99–1.11)	.96
Total cholesterol, mg/dL	1.01 (0.99–1.03)	.82
Total proteins, g/dL	0.96 (0.75–1.22)	.73
Body mass index, kg/m ²	1.03 (0.99–1.07)	.12
Cognitive impairment ^c	1.14 (0.89–1.47)	.29
Depression ^d	1.08 (0.83–1.42)	.56
Functional impairment ^e	1.09 (0.58–2.06)	.79
Interleukin 6, pg/mL ^f	0.96 (0.85–1.08)	.48

All covariates were entered simultaneously into the regression models.

^aAdjusted for age, sex, and diagnosis of heart failure.

^bNumber of glasses of wine per week.

^cMini-Mental State Examination <24.

^d20-item Center for Epidemiologic Studies Depression Scale score ≥ 20.

^eKatz activity of daily living scale score <5.

^fLog-transformed.