

- 1 **Habitual yogurt consumption and health-related quality of life: A prospective**
- 2 **cohort study**
- 3 **Short title: Yogurt consumption and health-related quality of life.**
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ABSTRACT

Background: Health-related quality of life (HRQL) is a global indicator of perceived health status, which includes physical and mental domains. Several biological mechanisms might support an association between consumption of yogurt and better HRQL.

Objective: To assess the association between habitual yogurt consumption and HRQL in the general adult population.

Design: Prospective study with 4445 individuals aged ≥ 18 years who were recruited in 2008-2010 and followed-up to 2012. Habitual yogurt consumption was assessed at baseline with a validated diet history. HRQL was measured with the physical composite summary (PCS) and the mental composite summary (MCS) of the Spanish version of the SF-12 questionnaire. The analysis of the association between baseline yogurt consumption and HRQL at 2012 was performed with linear regression and adjusted for the main confounders, including baseline HRQL.

Results: The mean follow-up was 3.5 (standard deviation: 0.6) years. Compared to non-consumers of yogurt, the PCS scores were similar in habitual consumers of ≤ 6 servings/week (beta: 0.40; p value= 0.20) and in consumers of ≥ 1 serving/day (beta: 0.25; p value= 0.45). A suggestion of tendency towards a lower MCS score was found among daily yogurt consumers (beta: -0.65, p value= 0.09; p for trend across categories= 0.07). The results were similar among individuals without morbidity, never smokers and persons with higher adherence to the Mediterranean diet.

Conclusion: Habitual yogurt consumption did not show an association with improved HRQL.

INTRODUCTION

Health-related quality of life (HRQL) is a global indicator of perceived health status, which includes physical and mental domains. Poor HRQL has been associated with greater use of health-care services^{1,2} and with higher short- and long-term mortality, particularly among older adults.³

The main dietary guidelines in Spain and other countries support the consumption of dairy products as part of a healthy diet.^{4,5} Because most studies have focused on the effect of total dairy, it is interesting to assess the independent association between each type of dairy and global indicators of health, such as HRQL. Several biological mechanisms suggest that there is pathway whereby yogurt consumption may influence, directly or indirectly, the HRQL. Specifically, yogurt consumption has been associated with lower weight gain,^{6,7} which in turn may lead to improved HRQL.⁸ Moreover, the consumption of dairy products has been linked to lower blood pressure,^{9,10} and hypertension awareness and treatment are related to impaired HRQL.¹¹ Also, yogurt is rich in calcium, which is bone protective, and it is known that osteomuscular disease is one of the health disorders with the greatest negative impact on HRQL.¹² In addition, it has been suggested that probiotics found in yogurt may improve gastrointestinal disorders¹³ and also affect activity of brain regions that control central processing of emotion and sensation.¹⁴ Lastly, in specific patient samples, there is some evidence that administration of probiotics reduced lower gastrointestinal symptoms and led to improvement in quality of life.^{15,16}

Assessing the association between individual foods and HRQL is important because both the food industry and the population as a whole are interested in knowing whether general well-being could be improved by consuming specific foods. To our knowledge,

53 however, the effect of yogurt on HRQL has not yet been studied in epidemiological
54 investigations in the general population. Thus, the objective of this article was to
55 examine the prospective association between habitual yogurt consumption and the
56 physical and mental components of HRQL among the general adult population.

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METHODS

Study design and participants

Data were taken from a cohort of 6,207 Caucasian individuals aged 18 years and older. Cohort members were selected through random sampling of participants in the ENRICA study¹⁷ with over-representation of older adults. Baseline information was obtained in 2008-2010 in three stages: a phone interview to collect information on health status, lifestyle, morbidity and health services use; a first home visit to obtain samples of blood and urine; and a second home visit to perform a physical examination and to record habitual diet. In 2012, a phone interview was conducted to update information on lifestyles other than diet, HRQL and morbidity in a subsample of 4,887 (78.7%) participants. All interviewers at baseline and at follow-up received specific training in the study procedures.

Study participants gave informed written consent. The Clinical Research Ethics Committee of the 'La Paz' University Hospital in Madrid approved both the baseline and follow-up studies.

Yogurt consumption

Habitual food consumption in the previous year was assessed at baseline with a validated computerized diet history, developed from the one used in the EPIC-Spain cohort study.^{18,19} Yogurt consumption (including fermented milk) was recorded in detail by asking the participants whether they consumed whole milk or reduced-fat type. We considered that the average serving of yogurt was 125 g and defined the following three categories of consumption: no consumption, 1-3 servings/month up to 6 servings/week, and ≥ 1 serving/day. In addition, calcium, sugar, and saturated fat (important nutrients in

yogurt) and total energy intake were estimated using standard food composition tables.^{20,21}

Health-related quality of life

HRQL represents the individual perception of the impact of a disease or a risk factor (e.g., yogurt consumption) on different spheres of life, including physical, mental and social aspects. HRQL was measured at baseline and at the end of follow-up using the SF-12 v.2 questionnaire, which has been validated in Spain.²² This is a reduced version of the SF-36 questionnaire, one of the most widely used instruments to evaluate HRQL. This shorter version was obtained by selecting 12 items whose responses are coded and analyzed to reproduce the physical composite summary (PCS) and the mental composite summary (MCS) from the longer version. The PCS and MCS scores are standardized to a national norm with a mean of 50.0 and a standard deviation of 10.0. A zero score in PCS or MCS indicates the lowest level of health, and a score of 100 indicates the highest level.

Despite being a short version of the SF-36 questionnaire, the SF-12 has excellent criterion validity because it explained over 90% of the variability in the PCS and MCS scores on the SF-36. The SF-12 has also shown good reliability for group comparisons.²²

Potential confounders of the study association

Study participants reported their age, educational level, smoking habit, and the total amount of hours of sleep per day. Information on physical activity during leisure time was obtained with the questionnaire developed for the EPIC-Spain cohort, and was expressed in METs h/week.²³ The above information was obtained at baseline and updated at the end of the follow-up.

Accordance with the Mediterranean diet was evaluated at baseline with the Mediterranean Diet Adherence Screener (MEDAS).²⁴ The MEDAS consists of 12 items with targets for food consumption and another 2 items with targets for food intake habits characteristic of the Mediterranean diet in Spain. One point is given for each target achieved. The scale ranges from 0 to 13 (without including alcohol consumption, which was considered an independent potential confounder). We considered that a MEDAS score ≥ 6 represented moderate accordance.

Baseline weight and height were measured in each subject under standardized conditions. Body mass index (BMI) was calculated as weight in kg divided by squared height in m. Blood pressure (BP) was determined with a validated sphygmomanometer, and glucose and cholesterol levels were measured in serum samples, using standard protocols at baseline.²⁵⁻²⁷ Hypertension was defined as systolic BP ≥ 140 mm Hg, diastolic BP ≥ 90 mm Hg, or being under antihypertensive drug treatment. Type 2 diabetes was defined as fasting serum glucose ≥ 126 mg/dl or being treated with oral drugs or insulin, and hypercholesterolemia as serum total cholesterol ≥ 200 mg/dl or receiving lipid-lowering drugs. Finally, participants also reported if in the year prior to the baseline and follow-up interviews they had suffered any of the following physician-diagnosed diseases: asthma or chronic bronchitis, cardiovascular disease, sleep apnea, osteoarthritis, rheumatoid arthritis, hip fracture, gallstones, intestinal polyps, cirrhosis of the liver, peptic ulcer, cataracts, cancer at any site, Parkinson disease, and Alzheimer disease.

Statistical analysis

Of the individuals followed up to 2012, 4780 were alive at the time of the interview. Of these, 4445 provided complete information on the study variables and formed the

analytical sample. Individuals excluded from the analyses were less educated, performed less leisure-time physical activity and had higher BMI; they also showed a higher prevalence of hypertension, diabetes, hypercholesterolemia and other chronic diseases.

Differences in baseline characteristics and changes from baseline to the end of follow-up across yogurt consumption categories were examined with the use of analysis of variance and the chi-square test. We used linear regression to examine the association between baseline yogurt consumption and the SF-12 summaries in 2012; the main results were expressed as beta coefficients for the SF-12 summaries across categories of yogurt consumption. The analyses were adjusted for baseline HRQL, age, sex, education, change in smoking status, baseline and change in physical activity and sleep duration, the baseline MEDAS score and alcohol intake, and for BMI, hypertension, diabetes, hypercholesterolemia, and reported prevalent and incident chronic diseases. We also studied whether adjustment for important nutrients (in tertiles) in yogurt could modify the results. All variables were modeled as categorical by using dummy terms, except baseline HRQL which was modeled as a continuous variable. To test for linear trends across categories, we modeled yogurt consumption as a continuous variable in the models with the median value of each level of yogurt consumption.

Finally, to assess the robustness of the results, we conducted stratified analyses by categories of disease status, smoking status, and accordance with the Mediterranean diet. To examine whether the results varied between strata we used the Wald test for the interaction term, defined as the product of yogurt consumption by each stratification variable.

152 Given that we found no sex interactions ($p=0.88$ for the PCS and 0.81 for the MCS), our
153 results are presented for the total study sample. Statistical significance was set at 2
154 tailed $p < 0.05$. The analyses were performed with SAS (version 9.2, SAS Institute Inc.,
155 Cary, NC) statistical software.

RESULTS

Among study participants, 65% were yogurt consumers. The reported mean and standard deviation (SD) of yogurt consumption were 0.58 (0.64) servings/day; of this amount, 0.27 (0.50) servings/day corresponded to whole-milk yogurt and 0.30 (0.53) servings/day to reduced-fat yogurt. The characteristics of the study population by categories of yogurt consumption are shown in **Table 1**. Compared to non-consumers of yogurt, those with the highest consumption were mostly women, with lower education level; they were also less likely to smoke and drank less alcohol. Calcium and sugar intake were higher among participants in the highest category of consumption, but saturated fat and total energy intake were similar in all three categories. Lastly, the prevalence of hypertension and osteomuscular disease was higher among yogurt consumers at baseline and in 2012.

The mean (SD) follow-up was 3.5 (0.6) years. Multivariable linear regression models showed that compared to non-consumers of yogurt, the PCS scores at follow-up were similar in consumers of ≤ 6 servings/week (beta: 0.40, p value= 0.20) and in consumers of ≥ 1 serving/day (beta: 0.25, p value= 0.45) (**Table 2**). A tendency towards a lower MCS at follow-up was found among daily yogurt consumers (beta: -0.65, p value= 0.09; p for trend across categories of consumption= 0.07) (**Table 2**). These results held after additional adjustment for calcium, saturated fat and sugar intake, and for total energy intake. When the analysis was disaggregated by type of yogurt, the consumption of reduced-fat yogurt seemed to account for the inverse association observed with MCS (beta: -0.95, p=0.02) (**Table 2**).

We also stratified the analyses by categories of disease status, smoking consumption and adherence to the Mediterranean diet. No association between yogurt consumption

180 and the PCS or MCS scores was found in any of the stratification variables (**Table 3**).

DISCUSSION

In this study, we found no association between yogurt consumption and the physical and mental components of HRQL after 3.5 years of follow-up of a population-based cohort. The results also held for whole-milk and reduced-fat yogurt. According to the European Food Safety Authority (No. 1924/2006), health claims in food products must be scientifically evaluated. In addition, the U.S. Department of Agriculture revises health claims proposed by the food industry in light of the current scientific evidence to allow or reject the use of those claims for marketing purposes.²⁸ Therefore, our results add a new piece of information to evaluate health claims from the dairy industry.

Given that yogurt is a nutrient-dense milk product, most research in nutritional epidemiology has included this food within a large category of dairy products. Thus, few studies have specifically examined the effect of yogurt consumption on health. Mozaffarian et al.,⁶ using two large cohort studies, found that an increase in the intake of yogurt (1 serving/day) was associated with losing 0.82 lb. over a 4-year period. Also, Wang et al.⁷ have recently reported that individuals with a habitual intake of 3 servings/week had a smaller annual weight gain (-0.10 ± 0.04 kg) than those consuming <1 serving/week. Moreover, yogurt consumption has been associated with better diet quality.²⁹ Lastly, in a meta-analysis of 5 cohort studies,⁹ the consumption of yogurt and milk for the highest versus the lowest intake category was associated with a reduced risk of hypertension (relative risk: 0.92, 95% CI: 0.87-0.98); however, a more recent meta-analysis¹⁰ including 9 cohort studies found a null association (relative risk: 0.99; 95% CI: 0.96-1.01, per 50 g/day of yogurt).

Although the available evidence suggests an inverse association between total dairy consumption and cardiovascular disease,³⁰ no specific effect of yogurt on cardiovascular

endpoints has been found.^{31,32} Similarly, the inverse association found between total dairy products and risk of type 2 diabetes³³ has not been observed consistently for yogurt.^{34,35} Finally, yogurt consumption has been associated with other health outcomes, including lower risk of colorectal cancer,³⁶ reduced anxiety and depression,³⁷ and greater lean body mass and better physical performance.³⁸

Potential health effects of yogurt can be related to its nutrient content, including saturated fat, protein, sugar and calcium, as well as probiotics. Whole-milk yogurt is an important source of saturated fat in the diet, and higher consumption of high-fat dairy products has been linked to increased risk of coronary heart disease.³⁹ However, another study found that high consumption of yogurt was not associated with increased risk of all-cause or cardiovascular mortality, in contrast with other foods rich in saturated fat.⁴⁰ In our study, no differences were found between whole-milk and reduced-fat yogurt; however, this should not be taken as an indication that saturated fat does not exert a negative effect on HRQL, because in our study fat from yogurt represented only a tiny fraction of all saturated fat in the diet.⁴¹ Moreover, yogurt has been identified as one of the foods that most contributed to added sugar intake in the diet of the hypertensive and diabetic individuals in our cohort.⁴¹ We were unable to evaluate separately sugary and non-sugary yogurt, but most of the yogurt consumed in this cohort was sugar-sweetened, thus any yogurt-related health claim should account for the detrimental health effects of added sugars.⁴²

There is consistent evidence of a key role of calcium and vitamin D in skeletal health. Results from meta-analyses of clinical trials^{43,44} and large prospective studies⁴⁵ suggest that low levels of calcium are associated with higher risk of bone fractures, although it seems that this effect has a threshold because an increased intake does not reduce

fracture risk. None of the above studies examined the effect of each specific source of calcium intake. Nevertheless, a recent prospective study investigated the association between types of dairy products and bone mineral density and hip fracture risk over 12 years of follow-up;⁴⁶ yogurt was the only dairy product that showed a marginally protective effect on fracture risk. On the other hand, high levels of total calcium intake have been associated with increased all-cause and cardiovascular mortality in some⁴⁷ but not all studies.⁴⁸³ Thus, recommendations to increase dairy consumption based on their calcium contribution to the diet should be made with caution.

Yogurt also provides potassium and B vitamins, in particular vitamins B₁ and B₂. There is some evidence of the association between potassium intake and blood pressure reduction in adults, which in turn influences the risk of stroke and coronary heart disease.⁴⁹ Evidence is also accumulating of the protective effect of adequate dietary potassium on age-related bone loss and reduction of kidney stones.⁴⁹ As regards vitamins B₁ and B₂, they may be effective in cataract prevention.⁵⁰

Finally, it has been suggested that probiotics contained in yogurt are able to reduce mucosal inflammation of the digestive tract and alterations in gut microflora.⁵¹ In fact, some clinical trials support the effect of fermented milks in reducing digestive symptoms in patients with irritable bowel syndrome.⁵² However, the evidence is still weak because, in a review of the literature on this topic, 11 of the 16 clinical trials included had a suboptimal design.¹³ In addition, it is not yet clear if yogurt consumption improves gastrointestinal transit time.⁵³

Given the variety of potential effects of yogurt consumption described above, which affect the cardiovascular, digestive, central nervous and osteomuscular systems, it would be reasonable to expect an association between yogurt and HRQL, because the

latter represents a global health indicator. However, the evidence on several effects of yogurt is still preliminary, because for some disorders it is not fully consistent (e.g., reduced risk of diabetes mellitus) or does not have a high quality (e.g., improved symptoms in irritable bowel syndrome). Also, in some cases the magnitude of the effect does not seem to be strong (e.g., reduced weight gain) and in another cases the potential effect is asymptomatic (e.g. on blood pressure), thus it may not translate into better health perception. Therefore, the available organ/system-specific evidence is insufficient either to ensure a benefit of yogurt on HRQL or to entirely rule it out.

Among the strengths of this study was that yogurt consumption was ascertained using a validated diet history that distinguished between whole-milk and reduced-fat varieties. Another strength was the relatively large sample size, which allowed performance of stratified analyses. Lastly, the analyses were adjusted for a number of well measured potential confounders including accordance with the Mediterranean diet.

Among the limitations is the assumption that yogurt intake was stable over the follow-up, which may underestimate the study associations; however, the effect estimates were very small and, in particular, fell far short of achieving clinical relevance (e.g., a change in ≥ 3 points in PCS or MCS)²⁰ so it is unlikely that this limitation can fully explain the lack of association between yogurt and HRQL. Also, yogurt consumption was relatively low even in the highest category, which precluded assessment of the impact of high amounts of yogurt on HRQL. Of note is that mean yogurt consumption in our cohort was somewhat higher than in the national study of food consumption conducted in 2008 (0.58 servings/day vs. 0.38).⁵⁴ Moreover, the relatively short follow-up may not have sufficed to accrue some potential benefits of yogurt, such as reduced fractures; thus, our results should be confirmed in prospective studies with longer duration. Lastly, HRQL has been obtained by self-report. Moreover, the SF-12 does not include sleep quality or

278 cognitive function. Thus, future research should examine the influence of yogurt on
279 these important health dimensions. Also, the SF-12 questionnaire is a generic tool to
280 assess HRQL and may not capture the potential benefits of yogurt on specific domains,
281 such as digestive or bone health.

282 In conclusion, habitual yogurt consumption did not show an association with improved
283 HRQL in a Caucasian population. Future population-based research should use disease-
284 specific instruments to assess HRQL, in addition to generic instruments, because it may
285 increase the likelihood of finding a potential benefit of yogurt on HRQL.

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Table 1. Age-adjusted characteristics of study participants according to categories of total yogurt consumption. N=4445

	Total yogurt consumption, servings			P value ^a
	Never	1-3 per month up to 6/week	≥1 per day	
Participants, n	1549	1607	1289	
At baseline				
Age, y	55 (17)	53 (17)	56 (17)	
Men, %	56.7	47.0	42.3	<0.001
Education, primary or less, %	37.9	33.6	38.9	0.009
Sleep, hours/day	7.3 (0.03)	7.3 (0.03)	7.2 (0.04)	0.15
Leisure-time physical activity, METs-h/week	26.9 (0.5)	25.8 (0.5)	26.9 (0.5)	0.95
MEDAS score ^b	6.5 (0.04)	6.3 (0.04)	6.8 (0.05)	<0.001
Alcohol intake, g/day	14.5 (0.5)	11.4 (0.5)	10.6 (0.5)	<0.001
Calcium, mg/day	799 (8)	883 (8)	991 (9)	<0.001
Sugar, g/day	87 (0.9)	94 (0.9)	100 (1.0)	<0.001
Saturated fat, g/day	27 (0.3)	28 (0.3)	27 (0.3)	0.32
Total energy, kcal/day	2167 (15)	2197 (15)	2135 (17)	0.18
BMI, kg/m ²	27.3 (0.1)	27.3 (0.1)	27.5 (0.1)	0.26
Hypertension, %	44.9	39.7	47.6	<0.001
Diabetes, %	9.9	8.5	9.5	0.38
Hypercholesterolemia, %	58.9	57.7	60.3	0.37
Osteomuscular disease ^c , %	28.2	28.9	34.5	<0.001
Other chronic diseases ^d , %	35.0	33.4	36.7	0.21
PCS	49.1 (0.3)	49.1 (0.2)	48.4 (0.3)	0.07
MCS	51.2 (0.2)	51.1 (0.2)	51.1 (0.3)	0.74
Changes from baseline to the end of follow-up				
Smoker at baseline and at end of follow-up, %	51.4	47.2	39.1	<0.001
Not smoker at baseline but smoker at end of follow-up, %	3.5	3.9	4.7	<0.001
Smoker at baseline but not smoker at end of follow-up, %	4.7	4.3	4.4	<0.001
Change in sleeping time, hours/day	-0.3 (0.03)	-0.2 (0.03)	-0.2 (0.04)	0.34
Change in leisure time physical activity, METs-h/week	0.5 (0.5)	0.7 (0.5)	-0.3 (0.6)	0.27
Incident osteomuscular disease, %	29.9	31.0	34.2	0.04
Other incident chronic diseases, %	37.2	37.0	40.4	0.63
Change in PCS	-0.99 (0.2)	-0.77 (0.2)	-0.61 (0.3)	0.32
Change in MCS	0.61 (0.3)	0.68 (0.02)	-0.32 (0.3)	0.04

For continuous variables, reported values are mean (SE).

PCS: physical summary; MCS: mental summary.

^aObtained from ANOVA for continuous variables and from chi-square test for categorical variables.

^bMediterranean Diet Adherence Screener.

^cIncluding osteoarthritis, rheumatoid arthritis, and hip fractures.

^dIncluding asthma or chronic bronchitis, cardiovascular disease, sleep apnea, gallstones, intestinal polyps, cirrhosis of the liver, peptic ulcer, cataracts, cancer at any site, Parkinson disease, and Alzheimer disease.

Table 2. Beta coefficients (p value) for the association between categories of baseline yogurt consumption and follow-up SF-12 health questionnaire summaries.

	Consumption, servings			
	Never	1-3 per month up to 6/week	≥1 per day	P for trend
Total yogurt				
Participants, n	1549	1607	1289	
Median consumption, s/d	0	0.50	1.0	
PCS				
Age and sex-adjusted model	Ref.	0.44 (0.25)	0.02 (0.96)	0.95
Multivariable model ^a	Ref.	0.40 (0.20)	0.25 (0.45)	0.50
Multivariable model ^b	Ref.	0.32 (0.32)	0.09 (0.80)	0.85
MCS				
Age and sex-adjusted model	Ref.	0.31 (0.43)	-0.53 (0.19)	0.20
Multivariable model ^a	Ref.	0.19 (0.59)	-0.65 (0.09)	0.07
Multivariable model ^b	Ref.	0.19 (0.61)	-0.69 (0.09)	0.07
Whole-milk yogurt				
Participants, n	2877	998	570	
PCS				
Age and sex-adjusted model	Ref.	0.30 (0.45)	-0.18 (0.71)	0.93
Multivariable model ^a	Ref.	0.26 (0.42)	-0.24 (0.55)	0.70
MCS				
Age and sex-adjusted model	Ref.	-0.04 (0.91)	-0.12 (0.81)	0.81
Multivariable model ^a	Ref.	-0.04 (0.92)	-0.24 (0.60)	0.56
Reduced-fat yogurt				
Participants, n	2910	846	689	
PCS				
Age and sex-adjusted model	Ref.	0.18 (0.67)	-0.24 (0.60)	0.75
Multivariable model ^a	Ref.	0.23 (0.50)	0.21 (0.58)	0.49
MCS				
Age and sex-adjusted model	Ref.	0.45 (0.29)	-1.01 (0.03)	0.12
Multivariable model ^a	Ref.	0.29 (0.46)	-0.95 (0.03)	0.09

PCS: physical summary; MCS: mental summary.

^aLinear regression model adjusted for age (18-44, 45-64 y), sex, SF-12 summary scores at baseline (continuous), educational level (primary or less, secondary, university), alcohol intake in 2008-10 (tertiles of g/d), Mediterranean Diet Adherence Screener in 2008 (<6, ≥6), change in smoking status (never smoker, smoker in 2008-10 and 2012, not smoker in 2008-10 but smoker in 2012, and smoker in 2008-10 but not smoker in 2012), baseline and change in physical activity during leisure time and sleep duration (tertiles), BMI in 2008-10 (<25, 25-30, ≥30 kg/m²), and hypertension, hypercholesterolemia, diabetes and chronic diseases in 2008-10 and in 2012.

^bLinear regression model with additional adjustment for calcium, saturated fat, sugar and total energy intake (in tertiles).

Table 3. Beta coefficients (p value) for the association between categories of baseline yogurt consumption and follow-up SF-12 health questionnaire summaries, stratified by diagnosed diseases, smoking, and the Mediterranean Diet Adherence Screener (MEDAS)^a

		Total yogurt consumption, servings				
		Never	1-3/month up to 6/week	≥1 per day	P for trend	P for interaction ^b
PCS						
Diagnosed diseases ^c						
No (n=1853)	Ref.	0.18 (0.50)	0.48 (0.21)	0.22	0.85	
Yes (n=2592)	Ref.	0.23 (0.64)	-0.06 (0.90)	0.90		
Smoking status						
Never (n=2011)	Ref.	0.30 (0.54)	0.04 (0.93)	0.96	0.07	
Past and current (n=2434)	Ref.	0.51 (0.21)	0.43 (0.34)	0.31		
MEDAS						
≥6 (n=3217)	Ref.	0.34 (0.36)	0.17 (0.66)	0.66	0.20	
<6 (n=1228)	Ref.	0.55 (0.86)	0.12 (0.86)	0.81		
MCS						
Diagnosed diseases						
No	Ref.	-0.09 (0.85)	-0.59 (0.26)	0.27	0.66	
Yes	Ref.	0.41 (0.43)	-0.70 (0.19)	0.20		
Smoking status						
Never	Ref.	-0.46 (0.41)	-0.78 (0.17)	0.17	0.69	
Past and current	Ref.	0.64 (0.17)	-0.81 (0.12)	0.16		
MEDAS						
≥6	Ref.	0.15 (0.72)	-0.61 (0.16)	0.16	0.35	
<6	Ref.	0.17 (0.80)	-0.99 (0.20)	0.23		

PCS: physical summary; MCS: mental summary.

^aAdjusted for age (18-44, 45-64 y), sex, SF-12 summary scores at baseline (continuous), educational level (primary or less, secondary, university), alcohol intake in 2008-10 (tertiles of g/d), Mediterranean Diet Adherence Screener in 2008-10 (<6, ≥6), change in smoking status (never smoker, smoker in 2008-10 and 2012, not smoker in 2008-10 but smoker in 2012, and smoker in 2008-10 but not smoker in 2012), baseline and change in physical activity during leisure time and sleep duration (tertiles), BMI in 2008-10 (<25, 25-30, ≥30 kg/m²), and hypertension, hypercholesterolemia, diabetes and chronic diseases in 2008-10 and in 2012, except for the stratification variable in each model.

^bp value from the Wald test calculated for the estimate of the interaction term between yogurt consumption and each stratification variable.

^cIncluding obesity, hypertension, hypercholesterolemia, diabetes, osteomuscular disease and other chronic diseases.