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Original article

Alcohol drinking patterns and risk of functional limitations in two cohorts of older adults

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SUMMARY

Background & aims: Several studies have found that moderate alcohol intake is associated with lower risk of functional limitations in older adults. However, no previous investigation has assessed this association in older adults from Mediterranean countries, who show characteristic drinking patterns.

Methods: Data were taken from the UAM and the Seniors-ENRICA cohorts in Spain, comprising community-dwelling people aged ≥60 years. At baseline, participants in both cohorts were classified as non-drinkers, ex-drinkers, moderate drinkers and heavy drinkers (the threshold between moderate and heavy intake was ≥40 g/day in men and ≥24 g/day in women). The Seniors-ENRICA cohort allowed assessment of a Mediterranean Drinking Pattern (MDP), defined as moderate alcohol intake, with wine preference (≥80% of alcohol consumed as wine) and drinking only with meals. The incidence of limitation in mobility, agility, and instrumental activities of daily living (IADL) was ascertained in each cohort at the end of a 3.5-year follow-up. Analyses were adjusted for sex, age, education, lifestyle, BMI, chronic conditions, and functional limitations at baseline others than the studied limitation.

Results: Compared with non-drinkers, ex-drinkers showed a higher risk of IADL limitation (pooled adjusted odds ratio [paOR]: 1.63; 95% confidence interval [CI]: 1.04–2.21). By contrast, moderate drinkers had a lower risk of limitations in mobility (paOR: 0.80; 95% CI: 0.63–0.97), agility (paOR: 0.82; 95% CI: 0.65–0.99) and IADL (paOR: 0.54; 95% CI: 0.39–0.69). Among individuals reporting poor or fair health, the MDP was associated with lower risk of mobility limitation (aOR: 0.51; 95% CI: 0.27–0.97).

Conclusion: In older adults, moderate alcohol consumption, as well as the MDP in specific subgroups, is associated with lower risk of functional limitation. These results should not serve to promote alcohol intake, because older adults are particularly vulnerable to its harmful effects.

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1. Introduction

Due to the progressive aging of the population, health and social care systems are facing a growing burden of chronic disease and disability [1]. Alcohol consumption is a major cause of disease burden worldwide, mostly from liver disease, cancer, and injuries [2]. However, certain drinking patterns may have beneficial health effects. Specifically, moderate and regular alcohol consumption has been consistently associated with lower risk of cardiovascular disease [3], diabetes [4], and cognitive decline [5].

With regards to disability, in some studies alcohol intake has been linked to lower frequency of limitations in activities of daily living (ADL) [6–9], instrumental activities of daily living (IADL) [10] and in walking 2–3 blocks and climbing stairs [10], but one

Abbreviations: MDP, Mediterranean Drinking Pattern; IADL, Instrumental activities of daily living.

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investigation found an increased risk of IADL and ADL limitation, particularly among heavy drinkers [11]. Moreover, one study has shown that the inverse association between moderate alcohol consumption and physical limitations could be largely explained by poor health of former drinkers, and that the apparently protective effect of heavier drinking was partly due to less healthy former heavy drinkers who moved to lower drinking categories [12]. However, the cross-sectional design of these studies did not allow for causal inference. Only a few prospective studies on this issue have been conducted among older adults [13–18]. Most of them have found a protective effect of alcohol on disability, although in one study the health effects of alcohol were mostly explained by the associated health behaviors [16], whereas in another study the protection of alcohol was observed only in those reporting good health [17], and in yet another the benefits of alcohol were restricted to relatively young individuals [18].

None of the investigations mentioned above has been carried out in older adults from Mediterranean countries. This is important because in these populations there is a traditional drinking pattern characterized by a moderate alcohol intake, mainly from wine and with meals [19]. This pattern, called the Mediterranean drinking pattern (MDP), has been progressively abandoned by young adults but is still common in older individuals [20,21]. Moreover, the MDP has recently been associated with lower risk of frailty [22] and mortality [23]. However, we are not aware of any previous study on the association between the MDP and functional limitation in older adults.

Therefore, we analyzed data from two prospective cohorts of people aged 60 years and older in Spain to assess the association between drinking patterns, including the MDP, and the risk of functional limitation. We also assessed if the study associations varied with the age and health status of the study participants.

2. Methods

2.1. Study participants and design

2.1.1. UAM (Universidad Autónoma de Madrid) cohort

The methods of this cohort have been published elsewhere [24]. This cohort was established in 2001 with 4008 people representative of the Spanish non-institutionalized population aged ≥60 years. Data were collected at the participants' homes through a health interview and a physical examination conducted by trained personnel. In 2003 we contacted 3249 (80.9%) of the initial participants; of these, 243 were deceased (7.5%), and the remaining 3006 provided updated information. For the purpose of this study, we excluded the individuals with baseline limitation in mobility (n = 1553), agility (n = 1764) or IADL (n = 1076). Additionally, we excluded subjects without data on functional limitations at baseline or at the end of follow-up, as well those lacking information on potential confounders. Thus, the analyses on limitations in disability, agility and IADL were conducted, respectively, among 1225, 1031 and 1811 subjects.

All participants of the UAM cohort gave informed consent. The Ethics Committee of the *La Paz* University Hospital in Madrid approved the study.

2.1.2. Seniors-ENRICA cohort

The study methods have been described previously [22,25]. This cohort comprised 2614 community-dwelling Spanish individuals aged ≥60 years, who were recruited in 2008–2010. Information was collected at study enrollment in three stages. First, a phone interview was used to obtain data on socio-demographic factors, lifestyle, morbidity and disability. Then, two home visits were performed. In the first visit, nurses collected blood and urine samples, while in the second lay personnel conducted a physical examination, recorded a diet history and obtained information on prescribed medications and functional limitations. In 2012, we performed a new wave of data collection to obtain updated information. Among the 2614 cohort participants in 2008–10, 115 were lost and 95 had died during follow-up. From the 2404 remaining subjects, we excluded 790 with limited mobility, 865 with agility limitation, and 271 with IADL disability at baseline. Moreover, we excluded subjects without data on functional limitations and other study variables, so that the analyses on limitations in mobility, agility or IADL were performed, respectively, with 1506, 1426 and 1644 subjects.

Study participants consented in writing to take part in the investigation, after receiving appropriate information. The study obtained the approval of the Ethics Committee of *the La Paz* University Hospital in Madrid.

2.2. Study variables

2.2.1. Alcohol consumption

In the UAM cohort, alcohol consumption in the previous year was assessed with a semi-quantitative food frequency questionnaire at baseline. The average alcohol intake (g/d) was calculated according to the alcohol content of each type of alcoholic beverage (spirits, sweet liquors, wine, beer and cider). Study participants were classified as non-drinkers, ex-drinkers, moderate drinkers, and heavy drinkers (the threshold between moderate and heavy intake was ≥40 g/d in men and ≥24 g/d in women) [26].

In the Seniors-ENRICA cohort, consumption of alcoholic beverages at baseline was estimated with a validated diet history [21,27]. This diet history collects data on the consumption of 34 alcoholic beverages in the preceding year, and the alcohol intake is estimated using standard composition tables. According to the average alcohol intake, individuals were classified as non-drinkers (including occasional drinkers with average intake close to zero), ex-drinkers (those reporting having stopped drinking at least a year before the interview), moderate drinkers, and heavy drinkers (using the same threshold of moderate-heavy drinking as above) [26]. Among drinkers, preference for a particular alcoholic beverage (e.g., wine) was defined as >80% of an individual's total alcohol intake consumed as that beverage [28]. Drinkers were also grouped into three categories: those who drank only with meals (lunch and dinner), those who drank only outside of meals, and those who drank at any time [28]. Finally, the MDP was defined as moderate consumption of alcohol (without binge-drinking), with preference for wine and only during meals [20–22]. Binge-drinking was considered to be an intake of ≥80 g of alcohol in men (≥60 g in women) during any drinking occasion in the previous month [29].

2.2.2. Functional limitations

Limitations in mobility, agility, and the IADL were ascertained at baseline and at the end of follow-up, using the same procedures in both cohorts. Mobility limitation was defined as an affirmative response to any of the three following questions: (i) “Do you experience any difficulty in picking up or carrying a shopping bag?”; (ii) “Do you experience any difficulty in climbing one flight of stairs?”; and (iii) “Do you experience any difficulty in walking several city blocks (a few hundred meters)?” [30] Agility limitation was ascertained as a positive answer to the question: “Do you experience any difficulty in bending or kneeling” [24]. Finally, disability in IADL was assessed with the Lawton and Brody Scale [31]. This scale evaluates the individual's ability to use the telephone, go shopping, prepare meals, do housework, do laundry, use different means of transportation, take medication, and manage

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Table 1
Baseline characteristics of participants in the UAM cohort, by incident functional limitations.

	Incident limitation					
	Mobility (N = 1255)		Agility (N = 1031)		IADL (N = 1811)	
	No (n = 806)	Yes (n = 449)	No (n = 582)	Yes (n = 449)	No (n = 1303)	Yes (n = 508)
Socio-demographic factors						
Men, %	50.0	31.2*	51.7	37.2*	42.3	34.3*
Age, mean (SD)	68.5 (5.9)	70.1 (6.6)*	68.3 (6.0)	69.8 (6.9)*	68.5 (5.9)	72.3 (6.9)*
Educational level, %						
≤Primary	78.0	87.3*	77.0	82.6*	81.4	89.4*
Secondary	15.1	8.0	15.8	10.2	12.6	6.7
University	6.8	4.7	7.2	7.4	6.0	3.9
Lifestyle						
Smoking, %						
Never	61.7	74.4*	59.1	71.1*	65.8	71.7*
Former	25.9	17.2	28.2	18.9	22.5	20.3
Current	12.4	8.5	12.7	10.0	11.7	8.1
Physical activity, %						
Sedentary	28.9	37.0*	27.3	37.4*	30.9	39.4*
Occasional activity	64.5	58.6	64.6	59.0	63.6	57.5
Regular activity	6.6	4.5	8.1	3.6	5.5	3.2
Body mass index, %						
<25 kg/m^2	17.4	18.7*	22.2	18.0*	16.2	16.7
25–29.9 kg/m^2	53.6	43.2	53.6	43.4	49.1	43.5
≥30 kg/m^2	29.0	38.1	24.2	38.5	34.7	39.8
Morbidity						
Cardiovascular disease[a], %	4.5	8.0*	6.5	7.4	5.9	10.8*
Diabetes, %	11.0	15.4*	10.0	14.7*	12.7	18.5*
Cancer, %	1.0	2.0	0.3	2.2*	1.3	2.0
Asthma or chronic bronchitis, %	8.8	9.4	9.5	9.8	10.7	14.8*
Osteomuscular disease[b],%	44.5	56.4*	35.7	53.9*	51.1	60.8*
Depression, %	7.3	9.1	5.8	8.7	8.8	10.4
Fair or poor self-rated health, %	20.1	42.1*	18.2	35.4*	31.3	50.0*
Baseline functional limitation						
Mobility, %	–	–	13.2	28.3*	31.2	49.4*
Agility, %	26.5	46.5*	–	–	43.0	62.8*
IADL, %	10.9	19.9*	12.0	22.7*	–	–
Incident limitation during follow-up						
Mobility, %	–	–	15.8	53.9*	33.0	74.9*
Agility, %	34.3	77.9*	–	–	50.7	78.3*
IADL, %	11.2	42.7*	12.0	30.9*	–	–

*P < 0.05.
IADL: Instrumental activities of daily living.
[a] Ischemic heart disease, stroke or heart failure.
[b] Osteoarthritis, arthritis or hip fracture.

finances. Due to cultural issues, the questions on meal preparation, housework and laundry were excluded in men; thus summary scores ranged from 0 (no disability) to 5 in men, and from 0 to 8 in women, and a score of 1 or higher corresponds to an IADL disability.

2.2.3. Other variables

In both cohorts, information was gathered at baseline on variables that may confound the studied associations because they were related to both alcohol and functional limitation. These variables were age, sex, educational (primary or less, secondary, university), tobacco smoking (never-, former-, current-smoker) and physical activity in leisure time (expressed as sedentary, occasional activity, and regular activity in the UAM cohort, and in MET-h/week in the Seniors-ENRICA cohort). Weight and height were measured in standardized conditions; body mass index (BMI) was calculated as weight in kg divided by square height in m, and classified into <25, 25–29.9, and ≥30 kg/m^2. Also, individuals reported if they had been diagnosed with any of the following diseases: cardiovascular disease, diabetes mellitus, cancer, chronic bronchitis or asthma, osteomuscular disease, and depression requiring treatment. Finally, self-rated health was assessed with the question "In general how would you rate your health?" In accordance with the possible replies, health was classified as optimal (excellent, very good or good) or suboptimal (fair or poor).

2.3. Statistical analysis

In each cohort, the association between drinking patterns and each functional limitation was estimated by odds ratios (OR) and their 95% confidence interval (CI), calculated from logistic regression. We built two models. The first model adjusted for age, sex, and education. And the second model further adjusted for smoking, physical activity, BMI, morbidity, and functional limitations other than that included as the dependent variable in the model. The analyses of wine preference, drinking with meals and the MDP were conducted solely in the Seniors-ENRICA cohort, since such information was collected only in this cohort.

We tested if the results varied with sex, age (<75 vs. ≥75 years) or self-rated health (optimal vs. suboptimal) by using interaction terms defined as the product of those variables by categories of alcohol drinking patterns. Statistical significance was assessed with likelihood ratio tests, which compared models with and without interactions. Since we found no significant interactions, the results were presented for both sexes and all ages combined. By contrast, the association between drinking patterns and mobility limitation

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Table 2
Baseline characteristics of participants in the Seniors-ENRICA cohort, by incident functional limitations.

	Incident limitation					
	Mobility (N = 1506)		Agility (N = 1426)		IADL (N = 1644)	
	No (n = 1051)	Yes (n = 455)	No (n = 775)	Yes (n = 651)	No (n = 1567)	Yes (n = 77)
Socio-demographic factors						
Men, %	62.5	35.0*	59.4	45.9*	49.7	39.0
Age, mean (SD)	67.0 (5.4)	68.7 (5.9)*	66.8 (5.4)	67.9 (5.7)*	67.7 (5.7)	73.5 (7.4)*
Educational level, %						
≤Primary	45.2	60.4*	42.8	56.1*	51.1	67.5*
Secondary	28.5	21.5	28.8	25.2	26.7	14.3
University	26.3	18.0	28.4	18.7	22.3	18.2
Lifestyle						
Smoking, %						
Never	51.2	65.3*	52.5	58.8	57.5	61.0
Former	34.9	25.1	33.0	28.9	30.4	28.6
Current	13.9	9.7	14.5	12.3	12.1	10.4
Physical activity (MET-h/week), mean (SD)	24.7 (16.4)	20.4 (14.0)*	24.9 (16.1)	21.5 (14.6)*	22.6 (15.4)	17.8 (14.8)*
Body mass index, %						
<25 kg/m^2	23.0	19.8*	27.7	17.8*	19.5	19.5
25–29.9 kg/m^2	52.2	47.9	53.3	51.3	50.6	45.5
≥30 kg/m^2	24.7	32.3	19.0	30.9	29.9	35.1
Morbidity						
Cardiovascular disease[a], %	3.1	5.7*	3.2	4.5	4.5	10.4*
Diabetes, %	9.9	12.3	8.5	12.9*	10.5	14.3
Cancer, %	1.0	1.8	0.7	2.3*	1.8	1.3
Asthma or chronic bronchitis, %	3.9	11.4*	4.8	8.9*	6.7	16.9*
Osteomuscular disease[b], %	32.5	62.9*	28.9	53.9*	45.9	57.1
Depression, %	4.1	9.7	4.0	7.8*	6.8	13.0*
Fair or poor self-rated health, %	15.7	53.6*	15.1	41.5*	30.6	67.5*
Baseline functional limitation						
Mobility, %	–	–	8.5	12.3*	24.1	48.1*
Agility, %	13.8	18.0*	–	–	28.6	48.1*
IADL, %	1.8	2.2	2.8	2.8	–	–
Incident limitation during follow-up						
Mobility, %	–	–	13.9	52.8*	37.2	79.2*
Agility, %	34.9	78.9*	–	–	52.7	80.5*
IADL, %	1.6	8.6*	1.8	6.5*	–	–

*P < 0.05.
IADL: Instrumental activities of daily living.
[a] Ischemic heart disease, stroke or heart failure.
[b] Osteoarthritis, arthritis or hip fracture.

was stratified by self-rated health, because an interaction with this variable was observed.

Heterogeneity between cohorts was tested with the DerSimonian-Laird chi-square-based Q statistic, and quantified using the I^2 statistic [32]. Since results in the UAM and Seniors-ENRICA cohorts were quite consistent (I^2 <30%), they were pooled using random-effects meta-analysis using the *metan* procedure in STATA [33].

Statistical significance was defined a bilateral $p < 0.05$. All analyses were performed with STATA, version 11.2.

3. Results

During the 3.5 years of follow-up in the UAM cohort, 35.8% of the participants developed limitation in mobility, 43.5% in agility, and 28% in IADL. The corresponding figures in the Seniors-ENRICA cohort were 30.2%, 45.6% and 4.7%.

Tables 1 and 2 show the baseline characteristics of the participants in each cohort, according to incident functional limitations. Compared to individuals without incident limitation, those who developed a functional limitation (regardless of the specific type) during the follow-up were more frequently women, were older, and had lower education. They were also less physically active, had a higher proportion of never-smokers, more often suffered from chronic diseases (especially osteomuscular diseases), and reported worse health status. Lastly, they also had more frequent baseline functional limitations.

Table 3 presents the association between average alcohol consumption at baseline and risk of functional limitation during the 3.5 years of follow-up, in both separate and pooled cohorts. In the pooled analysis adjusted for sociodemographic variables, lifestyle, morbidity, and functional limitations (model 2), ex-drinkers showed a higher risk of IADL limitation than non-drinkers (pooled OR: 1.63; 95% CI: 1.04–2.21). By contrast, and compared with non-drinkers, moderate drinkers were less likely to develop a limitation in mobility (pooled OR: 0.80; 95% CI: 0.63–0.97), agility (pooled OR: 0.82; 95% CI: 0.65–0.99) or IADL (pooled OR: 0.54; 95% CI: 0.39–0.69). The results also suggested that self-rated health might modify some of the study associations; specifically, moderate consumption was associated with lower risk of mobility limitation in those with suboptimal health (pooled OR: 0.65; 95% CI: 0.38–0.91), but not in those with optimal health (pooled OR: 0.89; 95% CI: 0.66–1.13) (data not shown in Table 3). Lastly, in the pooled analysis heavy drinkers also had a reduced risk of limitation in mobility (pooled OR: 0.67; 95% CI: 0.40–0.94) and agility (pooled OR: 0.71; 95% CI: 0.44–0.98) (Table 3).

We performed a number of sensitivity analyses to check the robustness of results. First, we excluded the individuals with any type of limitation at baseline; the results were in the same direction, but statistical significance was lost due to a smaller number of incident limitations (Supplementary Table 1). Second, given the

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Table 3
Association between average alcohol consumption and risk of functional limitations in older adults.

	Average alcohol consumption			
	Non-drinker	Ex-drinker	Moderate drinker	Heavy drinker
UAM cohort				
Mobility limitation				
n cases/total	246/562	30/91	152/519	21/83
Model 1, OR (95% CI)	Ref.	0.80 (0.49–1.31)	0.72 (0.54–0.94)*	0.70 (0.40–1.22)
Model 2, OR (95% CI)	Ref.	0.79 (0.47–1.33)	0.72 (0.53–0.96)*	0.66 (0.36–1.19)
Agility limitation				
n cases/total	230/450	35/69	164/441	20/71
Model 1, OR (95% CI)	Ref.	1.11 (0.66–1.88)	0.69 (0.52–0.93)*	0.52 (0.29–0.92)*
Model 2, OR (95% CI)	Ref.	1.30 (0.73–2.34)	0.75 (0.54–1.03)	0.56 (0.30–1.05)
Limitation in IADL				
n cases/total	279/868	59/153	145/673	25/117
Model 1, OR (95% CI)	Ref.	1.54 (1.04–2.27)*	0.67 (0.52–0.88)**	0.81 (0.49–1.33)
Model 2, OR (95% CI)	Ref.	1.56 (1.04–2.33)*	0.73 (0.55–0.96)*	0.82 (0.49–1.38)
Seniors-ENRICA cohort				
Mobility limitation				
n cases/total	199/520	39/101	188/742	29/143
Model 1, OR (95% CI)	Ref.	1.28 (0.80–2.05)	0.89 (0.68–1.17)	0.72 (0.45–1.16)
Model 2, OR (95% CI)	Ref.	1.19 (0.72–1.95)	0.94 (0.70–1.25)	0.68 (0.41–1.13)
Agility limitation				
n cases/total	251/485	48/94	293/708	59/139
Model 1, OR (95% CI)	Ref.	1.07 (0.68–1.69)	0.82 (0.64–1.06)	0.91 (0.61–1.37)
Model 2, OR (95% CI)	Ref.	0.95 (0.58–1.55)	0.88 (0.67–1.15)	0.86 (0.56–1.32)
Limitation in IADL				
n cases/total	41/606	16/119	15/770	5/149
Model 1, OR (95% CI)	Ref.	1.94 (1.02–3.71)*	0.32 (0.17–0.62)**	0.57 (0.21–1.57)
Model 2, OR (95% CI)	Ref.	1.95 (0.99–3.83)	0.31 (0.16–0.60)**	0.57 (0.20–1.59)
Meta-analysis (random effects)				
Mobility limitation				
n cases/total	445/1082	69/192	340/1261	50/226
Model 1, pooled OR (95% CI)	Ref.	0.94 (0.60–1.29)[a]	0.79 (0.63–0.94)*	0.71 (0.44–0.98)*
Model 2, pooled OR (95% CI)	Ref.	0.92 (0.57–1.27)	0.80 (0.63–0.97)*,[a]	0.67 (0.40–0.94)*
Agility limitation				
n cases/total	481/935	83/163	457/1149	79/210
Model 1, pooled OR (95% CI)	Ref.	1.09 (0.70–1.48)	0.75 (0.61–0.90)*	0.68 (0.44–0.92)*,[a]
Model 2, pooled OR (95% CI)	Ref.	1.04 (0.63–1.46)	0.82 (0.65–0.99)*	0.71 (0.44–0.98)*
Limitation in IADL				
n cases/total	320/1474	75/272	160/1443	30/266
Model 1, pooled OR (95% CI)	Ref.	1.61 (1.05–2.17)*	0.53 (0.39–0.67)**,[a]	0.74 (0.39–1.10)
Model 2, pooled OR (95% CI)	Ref.	1.63 (1.04–2.21)*	0.54 (0.39–0.69)**,[a]	0.75 (0.37–1.12)

OR: Odds ratio. CI: Confidence interval. IADL: Instrumental activities of daily living. *p < 0.05; **p < 0.01.
Threshold between moderate and heavy drinking: 40 g ethanol/d in men and 24 g ethanol/d in women.
Model 1: Adjusted for sex, age, and educational level (≤primary, secondary, university).
Model 2: Adjusted as in model 1 and additionally for tobacco (never-, former-, current-smoker), physical activity in leisure time (UAM: sedentary, occasional activity, regular activity; ENRICA: METs-h/week), body mass index (<25, 25–29.9, ≥30 kg/m^2), cardiovascular disease, diabetes mellitus, cancer, asthma or chronic bronchitis, osteomuscular disease, depression requiring treatment, and functional limitations at baseline other than the studied limitation.
[a] $I^2 \geq 30\%$; Data should be interpreted with caution.

consistently reported association between moderate intake and lower risk of cardiovascular disease and diabetes, we reran the analysis after excluding the 239 participants with these diseases at baseline, and we obtained similar results (Supplementary Table 1). And third, to assess a certain dose–response within the moderate intake category, we sub-classified these individuals into two groups: >0–20 g/d and 20 to <40 g/d in men, and >0–10 g/d and 10 to <24 g/d in women. The results showed a tendency toward lower risk of each type of functional limitations with higher alcohol consumption within the range of moderate intake (Supplementary Table 2).

In the Seniors-ENRICA cohort, neither wine preference nor drinking exclusively with meals was associated with the risk of functional limitations (data not shown). Given that the association between the MDP and functional limitations varied with self-rated health (p for interaction <0.001, <0.001 and 0.04, respectively, for limitation in mobility, agility and IADL), Table 4 shows the results stratified by health status. In model 2, among subjects who reported poor or fair health, the MDP was linked with lower risk of mobility limitation (OR: 0.51; 95% CI: 0.27–0.97); conversely, this association was not observed in subjects with optimal health. The MDP, as well as drinking not in accordance with the MDP, also showed a protective association with IADL limitation, but the results were based on only 5 cases (Table 4).

4. Discussion

In two prospective cohorts of older adults in Spain, moderate alcohol consumption was associated with lower risk of limitations in mobility, agility and IADL. Heavy drinkers were also less likely to develop certain functional limitations. Finally, the MDP showed a reduced risk of mobility limitation in subjects with suboptimal health status.

Our results are in line with those of several cross-sectional and prospective studies, particularly for the protective association with moderate consumption, which is the most consistent finding in the literature [13–15]. However, unlike the study of Maraldi et al., [16] our results held after adjustment for lifestyle, morbidity and other functional limitations. Also, in our study the inverse association between moderate drinking and disability was observed

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Table 4
Association between the Mediterranean drinking pattern (MDP) and risk of functional limitations in older adults from the Seniors-ENRICA cohort, by self-reported health status.

	Drinking pattern			
	Non-drinker	Ex-drinker	Drinker with no MDP	Drinker with MDP
Mobility limitation				
Self-rated health				
Excellent, very good, good (n = 1097)				
n cases/total	88/359	14/63	58/407	51/268
Model 1, OR (95% CI)	Ref.	1.08 (0.55–2.11)	0.85 (0.57–1.28)	1.04 (0.69–1.58)
Model 2, OR (95% CI)	Ref.	1.00 (0.50–2.00)	0.90 (0.59–1.37)	1.14 (0.74–1.75)
Fair, poor (n = 409)				
n cases/total	111/161	25/38	69/124	39/86
Model 1, OR (95% CI)	Ref.	1.20 (0.53–2.69)	0.93 (0.54–1.62)	0.56 (0.31–1.01)
Model 2, OR (95% CI)	Ref.	1.36 (0.56–3.30)	0.94 (0.52–1.71)	0.51 (0.27–0.97)*
Agility limitation				
Self-rated health				
Excellent, very good, good (n = 1039)				
n cases/total	133/330	25/59	129/388	94/262
Model 1, OR (95% CI)	Ref.	1.17 (0.66–2.08)	0.89 (0.64–1.25)	0.94 (0.64–1.34)
Model 2, OR (95% CI)	Ref.	1.13 (0.62–2.08)	0.92 (0.65–1.31)	1.04 (0.72–1.51)
Fair, poor (n = 387)				
n cases/total	118/155	23/35	75/115	54/82
Model 1, OR (95% CI)	Ref.	0.67 (0.29–1.53)	0.74 (0.41–1.33)	0.68 (0.36–1.28)
Model 2, OR (95% CI)	Ref.	0.50 (0.20–1.23)	0.69 (0.37–1.31)	0.69 (0.34–1.38)
Limitation in IADL				
Self-rated health				
Excellent, very good, good (n = 1113)				
n cases/total	12/378	3/62	7/406	3/267
Model 1, OR (95% CI)	Ref.	1.66 (0.42–6.52)	1.02 (0.35–2.94)	0.38 (0.10–1.45)
Model 2, OR (95% CI)	Ref.	1.59 (0.35–7.27)	1.14 (0.37–3.51)	0.44 (0.11–1.75)
Fair, poor (n = 531)				
n cases/total	29/228	13/57	5/140	5/106
Model 1, OR (95% CI)	Ref.	1.54 (0.71–3.37)	0.22 (0.07–0.63)**	0.22 (0.08–0.66)**
Model 2, OR (95% CI)	Ref.	1.95 (0.84–4.52)	0.21 (0.07–0.63)**	0.24 (0.08–0.77)*

OR: Odds ratio. CI: Confidence interval. IADL: Instrumental activities of daily living. *p < 0.05; **p < 0.01.
Mediterranean drinking pattern: moderate average intake of alcohol (and no binge drinking), with wine preference, and alcohol consumption only with meals. Threshold between moderate and heavy drinking: 40 g ethanol/d in men and 24 g ethanol/d in women.
Model 1: Adjusted as in model 1 in Table 3.
Model 2: Adjusted as in model 2 in Table 3.

regardless of age, in contrast with the results obtained by Lin et al. [18] Moreover, our results concur with those from a large sample, representative of the Canadian older population, where moderate drinking was linked to lower frequency of placement in long-term care facilities over 14 years of follow-up [34]. With regards to heavy drinking, previous longitudinal studies have used different definitions; however, when it was defined as intake of >14 drinks/week in men and >7 drinks/week in women, it did not show a association with functional limitations [16–18]. In our study, the number of incident limitations among heavy drinkers was relatively small and precluded a meaningful analysis of the association between alcohol and disability among specific categories of heavy drinkers. Thus, future research should establish if the potential protective effect of alcohol on frailty may be limited to the lower range of heavy drinking (e.g., <50 g/day).

As for the MDP, we found an inverse association with functional limitations only in those with suboptimal health. One possible explanation is that these subjects have a higher short-term risk of disability, which increases the likelihood of observing a potential association with alcohol intake. Given that no association was found between wine preference or drinking only with meals and functional limitations, the results for the MDP mostly reflect the effect of moderate alcohol intake. This was somewhat to be expected because moderate drinkers were 1.7 times more likely to prefer wine and 1.8 times more likely to drink only with meals than heavy drinkers.

The protective effect of alcohol consumption against functional limitation might be due to the reported beneficial effects of alcohol on cardiovascular health [3], diabetes [4] and cognitive function [5], as these are good predictors of disability. In fact, alcohol intake of up to 50–60 g/day (well within the range of heavy drinking) has been associated with lower risk of ischemic heart disease and diabetes [3,4]. However, our results could also have overestimated the potential benefits of alcohol intake, for several reasons. First, the study findings could partly be due to survival bias, whereby drinkers who experienced adverse effects of alcohol died earlier, and the surviving drinkers might represent a subset of individuals who are more resistant to alcohol harm. This bias affects all cohorts of older adults, and is expected to increase with age. However, we did not find that the results varied between those aged under and over 75 years. Second, older drinkers could have reduced their alcohol intake or even stopped drinking because of health reasons. This tends to overestimate the benefits of drinking, and especially of heavy drinking, because individuals with better health status might be over-represented among drinkers with higher alcohol intake. To address this issue, we stratified some analyses by reported health status, but the association between heavy drinking and functional limitations did not vary with self-rated health. And third, residual cofounding, due to better health among drinkers, cannot be ruled out [35,36]. Although we adjusted for diagnosed disease, we did not control for either disease severity or the use of drug treatments that may interact with alcohol, such as warfarin, antidiabetics, and sedative or anxiolytic drugs, among others.

We also found that, compared to non-drinkers, the ex-drinkers showed a higher risk of limitation in IADL but not in mobility or

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agility. By contrast, Maraldi et al. reported a greater risk of mobility limitation in ex-drinkers [16]. Other studies, however, have found no clear association between being a former drinker and disability [17,18]. Quitting alcohol could be an indicator of poor health, because many people stop drinking due to a disease diagnosis or poor subjective health [37]. In fact, in the HAPPIE study the frequency of physical limitation was higher in older adults who stopped or reduced alcohol consumption for health reasons than in those who did it for other reasons [12].

This investigation has several strengths and limitations. Among the strengths are the prospective study design, the separate identification of non-drinkers and ex-drinkers, a detailed characterization of drinking patterns including the MDP, and the standardized assessment of functional limitations. Although functional limitations were obtained by self-report, its validity has been well established [30,38]. An additional strength was the consistency of the results in the two cohorts studied, despite using different instruments to assess alcohol consumption. Among the limitations is that alcohol consumption was self-reported, and may be affected by recall and social desirability biases. Moreover, functional limitations were evaluated at discrete time points, and development of impairments during the interval periods could not be ascertained. In addition, we did not assess the association between changes in drinking patterns from 2008–2010 to 2012 and incident limitation in 2012 because we cannot be sure if the change in drinking behavior preceded the incident limitation or not. Also, the small number of cases in certain health-status strata limited the statistical power to detect associations, and the follow-up was quite short in both cohorts (3.5 years), so that it is possible that the full range of effects of alcohol could not be observed. Furthermore, the analytical sample was younger and healthier than the total cohort, because loses to follow-up and deaths before the end-follow-up are more frequent in older and less healthy subjects, and because individuals with the studied limitations at baseline were excluded. Thus, the analytical sample is not representative of the entire cohort, so that the results might be subject to unknown biases and the generalizability may be limited, especially for the older and sicker segments of the older adult population. Lastly, as acknowledged above, certain confounding may persist despite having adjusted the analyses for a good number of covariates.

In conclusion, our results show that certain drinking patterns, particularly moderate alcohol consumption and the MDP, are associated with a reduced risk of functional limitation in older adults from a Mediterranean country. Future research should assess the dose–response between alcohol intake and frailty within the heavy drinking range, and should thoroughly address some of the potential limitations of our study as described above. Lastly, our results should not be used to promote alcohol intake among older adults, because they are particularly vulnerable to its harmful effects due to age-associated changes in body composition and function, the high prevalence of diseases aggravated by alcohol, and the frequent use of alcohol-interacting drugs. However, for the specific individuals free of such diseases and without alcohol-interacting treatments, who already have a moderate alcohol intake or MDP, our results suggest that keeping their drinking pattern is safe for physical function.

Conflict of interests

All authors declare that they have no conflict of interest.

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Contribution of the authors: LMLM and FRA had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: LMLM, PGC, EGE, IG, FRA. Acquisition of data: LMLM, PGC, FRA. Statistical analysis: LMLM and FRA. Interpretation of data: LMLM, PGC, EGE, IG, and FRA. Drafting the manuscript: LMLM and FRA. Critical revision of the manuscript for important intellectual content: LMLM, PGC, EGE, IG, and FRA. Obtained funding: FRA. Study supervision: FRA. All authors have read and approved the final manuscript.

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.clnu.2016.05.005.

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