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Frailty and its association with Mediterranean diet, life-space and social participation in community-dwelling older people

Abstract

Objectives: The objectives of this study was to examine 1) the association of frailty with Mediterranean diet, life-space, and social participation in the community-dwelling older people; and 2) the association of each of the five frailty phenotypic components with Mediterranean diet, life-space, and social participation in the same population.

Design: A cross-sectional and observational design was employed.

Setting and Participants: Community-dwelling older people without dementia or severe depressive symptoms were recruited from three community centers for older people in Hong Kong. Quota sampling was adopted to recruit 60-120 subjects in each frailty status category (i.e., robust, pre-frail, and frail).

Measures: Frailty, Mediterranean diet adherence, life-space and social participation were measured with Fried Frailty Index, MedDietScore, Life-space Assessment, and Reintegration to Normal Living Index respectively.

Results: 263 participants (robust=85, pre-frail=120, frail=58) completed the study. Their mean age was 77.1±7.5 years and they were mainly female (83.7%). The regression model (R^2=0.521) adjusted for demographics and confounders showed that Mediterranean diet (OR=0.25, 95%CI=0.14-0.45), life-space (OR=0.23, 95%CI=0.12-0.45), and social participation (OR=0.16, 95%CI=0.09-0.32) were associated with frailty. All factors were preferentially associated with

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slowness. Mediterranean diet and social participation were additionally associated with weakness and low activity respectively.

Conclusions/Implications: High adherence to the Mediterranean diet is necessary for exerting its protective effect. Culturally adjusted Mediterranean diet should be advocated for diverse populations. In addition to promoting social event participation, older adults' satisfaction with social participation should be considered as it is critical to reducing frailty risk. In policy making, environmental design which can accommodate slow-walking older people is important to maximize their life-space.

Keywords

Frailty, Mediterranean diet, life-space, social participation, older people

Introduction

Background

Frailty is a geriatric syndrome manifested as a reduced strength and physiologic malfunctioning that increases susceptibility to dependency, vulnerability, and death [1]. Frailty comprises five phenotypical components: weight loss, exhaustion, low physical activity, slowness, and weakness. Frailty is a progressive status wherein more components are indicative of greater frailty severity, which can be staged from being robust, pre-frail, and frail [2]. Frailty progress is slow, thus transitioning between stages of frailty is reversible [3]. Among community-dwelling older people, frailty has a prevalence rate of 10.7% globally [4], 7% in China [5], and 16.6% in Hong Kong [6]. Increased severity of frailty is associated with higher mortality [7], morbidity (e.g., dementia) [8], and informal care cost [9].

Previous studies showed that sociodemographic factors (e.g., age and socioeconomic status), physical factors (e.g., body mass index [BMI], functional status), biological factors (e.g., hormones, inflammation), lifestyle factors (e.g., dietary pattern, drinking), and psychological factors (e.g., depression, cognition) can moderate frailty progression and transition [10]. However, many of these factors are either non-modifiable or perceived as unimportant by older people to prevent frailty. Understanding the social and lifestyle factors that are most salient to older people is important in developing effective interventions, and shaping future health policy.

A study demonstrate that a Mediterranean diet is associated with lower frailty risk [11]. However, traditional Chinese diets includes relatively smaller amounts of beneficial food (e.g., dairy products, legumes, nuts, and olive oil) [12] and these items are less commonly consumed by the Chinese. Nevertheless, Chinese dietary patterns have changed in recent decades to more

closely resemble the Mediterranean diet [13]. It is therefore critical to examine the potentially protective effect of the Mediterranean diet in the Chinese population. Such data may inform dietary recommendations to combat frailty in populations whose traditional dietary patterns are unlike the Mediterranean.

Life-space refers to the spatial area in which a person moves in daily life [14]. It is associated with many health outcomes in older people, including cognitive function [15], and frailty [16]. However, there is a dearth of studies reporting which phenotypic frailty component(s) are preferentially associated with life-space. Knowledge of these associations is necessary for developing specific environmental-design strategies to help frail older people maximize their life-space.

Social participation is the extent that people participate in daily activities and engage in social roles [17]. It is associated with better cognitive function [18] and more physical activity [19]. Previous study shows that infrequent social participation (e.g., volunteer work) is associated with worsening frailty[20]. However, social participation extends beyond attending social activities; it also involves how engaged a person feels towards both daily activities (e.g., leisure activities, personal care) and social events (e.g., recreational activities) in fulfilling their basic social needs [20]. There is a lack of understanding on how perceived satisfaction on social participation is associated with frailty.

Objectives

This study aimed to examine 1) the association of frailty with Mediterranean diet, life-space, and social participation among community-dwelling older people in Hong Kong; and 2)

the association of each of the five frailty phenotypic components with Mediterranean diet, life-space, and social participation in the same population.

Methods

Study design

A cross-sectional and observational design was employed.

Setting

From May 2017 – May 2018, subjects were recruited from three non-government community centers serving for around 4000 older people in Hong Kong. The community centers' primary function was to provide various social and recreational activities for community-dwelling older people.

Participants

All community center members were invited to participate in this study through different methods (e.g., posters and announcement in regular member meetings). Interested members were enrolled through the centers. They were subsequently screened by a trained research assistant according to the eligibility criteria below:

1. Age ≥ 60 years (also entitled to receive services from the community centres),
2. Community-dwelling and non-institutionalized,
3. Cognitively intact as defined by the age- and education-adjusted Montreal Cognitive Assessment (MoCA) score [21], and
4. No severe depressive symptoms, as defined by the 15-item Geriatric Depression Scale (GDS-15) < 8. [22]

Variables and measurement

Outcome

Frailty, as a dependent variable, was measured by Fried Frailty Index (FFI) [2], which quantifies frailty phenotype by five components: weight loss, exhaustion, low physical activity, slow gait, and weakness. FFI has been validated to show good predictive validity for incidence of major geriatric outcomes over three to seven years including fall, worsening mobility, hospitalization, and death (HR=1.82-4.46) [2]. FFI scores range from 0 to 5 with one point assigned for the presence of one component. A higher FFI score indicates a higher frailty level. Those with 0, 1-2, or 3-5 point(s) are classified respectively as robust, pre-frail, or frail. [2] As there are no methods endorsed to operationalize each phenotype. This study operationally defined each phenotype by the following measurement methods:

1. Weight loss was defined as unintentional loss of 5% of the body weight in the preceding year as reported by the subject.
2. Exhaustion was identified by two questions from the Center for Epidemiological Studies Depression (CES-D) scale [23].
3. Low physical activity was defined by using Chinese version of Physical Activity Scale for the Elderly (PASE) scale [24] following the cut points in a large population of older people in Hong Kong [25].
4. Slowness was defined by slower than the maximum gender-adjusted walking speed of the lowest quintile in the population of older people in Hong Kong (i.e., 0.89 m/s for men and 0.79 m/s for women) [25] measured in a 5 meter walk test.

5. Weakness was identified by the handgrip strength of the dominant hand measured by Jamar dynamometer [26] lower than the maximum age- and-gender-adjusted handgrip strength of the lowest quintile in the population of older people in Hong Kong [25].

Factors

Mediterranean diet adherence, as an independent variable, was measured by the MedDietScore (MDS) [27]. MDS comprises two categories of items: beneficial food items (i.e., non-refined cereals, potatoes, fruits, vegetables, legumes, fish, and olive oil) and detrimental food items (i.e., red meat and products, poultry, full fat dairy products and alcohol). MDS demonstrates good criterion validity, showing strong association with plasma and dietary fatty acids [28], and cardiovascular risks [27]. Each MDS item is scored on a Likert scale from 0 to 5 to indicate consumption frequency which ranges from "never" to "daily". Summed MDS scores range from 0 to 55. A higher MDS indicates a higher adherence to the Mediterranean diet. [27]

Life-space was measured as an independent variable by the Life-Space Assessment (LSA)[29]. LSA measures life-space at five specific levels by proximity from level 1 (inside the home) to level 5 (outside a district). At each level of life-space, visit frequency and activity independence are rated on Likert scales. LSA has been validated to have good test-retest reliability (ICC=0.76) [30] and good criterion validity, where LSA showed strong association with physical performance (r=0.595) and function (r=0.567) [29]. The total score is the multiple of life-space level, visit frequency, and activity independency. LSA ranges from 0 to 120. Higher LSA scores indicate a larger life-space in which a person lives.

Social participation, as an independent variable, was measured by the Reintegration to Normal Living Index (RNLI) [31]. RNLI measures social participation under the concept of

reintegration proposed by the World Health Organization's International Classification of Functioning, Disability and Health (WHO-ICF) framework [32]. There are 11 items categorized into two factors: physical and social. RNLI has been validated to have good test-retest reliability (Kappa=0.61), and good criterion validity, with that RNLI showing strong association with depression (r=-0.61), daily activity (r=0.69), and quality of life (r=-0.74) [33]. Each item of RNLI is rated on a Likert scale from 0 to 10 to indicate level of satisfaction on the social and physical activities involved in daily living. RNLI scores are summed and converted to a percentage. RNLS ranges from 0 to 100, where higher RNLI indicates a better social participation.

Confounders

Age, gender, education level, body mass index (BMI), nutrition, and comorbidity were considered as potential founders as reported in other studies. Education was classified at four levels: no formal education, primary, secondary, tertiary and above. BMI was classified according to Hong Kong Chinese population into underweight (<18.5 kg/m^2), normal (18.5-22.9 kg/m^2), overweight (23-24.9 kg/m^2) and obesity (≥25 kg/m^2) [34]. Comorbidities were measured by number of chronic illnesses listed on the Charlson Comorbidity Index [35].

Research assistants administered questionnaires by face-to-face interview. All interviews were conducted in private rooms in the community centers, and took an average of 45 minutes to complete. Regarding MDS questions, food pictures were shown to subjects to facilitate their understanding of food types and food portions as stated on the MDS. Nutrition was measured by the Mini Nutritional Assessment Short Form (MNA-SF) [36].

Bias

This study attempted to minimize the risk of common bias in cross-sectional study [37]. In particular, participants with cognitive impairment and severe depressive symptoms were screened out to avoid recall bias. To minimize the risk of confounding bias, common confounding factors were included in the regression model for adjustment. Use of validated instruments minimized the risk of measurement bias. All research assistants (RA) were either registered nurses or nursing students who completed repeated training and pilot-tested the study instruments with older volunteers. RAs were deemed qualified to collect data only after reaching an inter-rater reliability index of 1.0.

Study size

Previous work showed that the Mediterranean diet was associated with frailty moderately in community-dwelling older people in Spain (OR: 0.43-0.59) [11], which is mild-moderate strength of association [38]. The effect sizes of other factors (i.e., life-space and social participation) are not known. We assumed that all factors bore a similar strength of association with frailty. We conducted a power analysis - using G*Power employing linear multiple regression (fixed model, R^2 increase) test with a mild-moderate effect size (i.e., f^2= 0.05), significance set at 0.05 and power to be 0.8 – to determine a sample size of 223 subjects. Since a previous study showed a disproportionate representation of frailty states among those living the community[16], we employed a quota sampling method to equally represent subjects across each of the frailty categories (e.g. 60-120 subjects per frailty state).

Statistical methods

Statistical analysis was performed with IBM SPSS version 23.0. Descriptive statistics were used to characterize the study population. For the objective #1, an Ordinal regression

controlling for potential confounders was performed to calculated odds ratios with 95% confidence interval of the independent variables on the dependent variables. The independent variables (i.e., MDS, LSA, RNLI) were classified into tertiles and the lowest tertile was used as reference. Three logistic models were built: the first one was unadjusted, second one was adjusted for age, gender, and education, and the third was adjusted additionally for the rest of potential confounders described above. For objective #2, binary logistic regression models with the same set of independent variables and confounders were employed to identify if the independent variables significantly associated with any one of the five frailty phenotypic components. Missing data of variables if less than 5% were replaced by the mean value.

Ethics

All participants provided informed consent for study participation, and were informed of their rights as research participants. Participants were incentivized with cash coupons in compensation for their time and travel costs. This project was approved by the Instuitional Review Board of The Hong Kong Polytechnic University (reference number: HSEARS20170412004)

Results

Participants

As shown in the Figure 1, 477 community older people were screened for eligibility. Ninety-five subjects were ineligible and 105 subjects did not consent to participate. The main reason for refusal was related to concerns over the time burden for answering questionnaires. Fourteen eligible and consented subjects were screened out because the quota for their frailty

category had been reached. A final group of 263 participants completed data collection; of these 85 were frail (32.3%), 120 pre-frail (45.6%), and 58 were frail (22.1%),

Descriptive data

As shown in the Table 1, the participants' mean age was 77.1±7.5. The mean MoCA score was 21.8±4.9, mean GDS-15 score was 2.4±2.8, and mean MNA-SF was 12.5±1.6. Majority of the participants were female (83.7%), educated at primary level (52.1%), married (56.7%), financially sufficient (46.8%), non-smoker (90.5%), non-drinker (89.7%), having one chronic disease (62.2%), and normal BMI (39.2%).

Frailer people tend to be older ($p<.001$), female ($p=.01$), less educated (<.001), nutritionally poorer ($p<.001$), having more chronic illnesses ($p<.001$), and higher body mass ($p=.010$). The mean MDS score was 30.5±4.9, mean LSA score was 79.1±21.6, and mean RNLI score was 80.8±15.2. Missing data for all variables was less than 2%.

Outcome data

For the frailty status of the participants, as shown in Table 2, the mean FFI score was 1.37±1.3 and majority of participants were pre-frail (45.6%). The most commonly seen frailty component is weakness (53.2%).

Main results

In the multiple ordinal regression with FFI as the dependent variable adjusted for all potential confounders, as shown in Table 3, Mediterranean diet, life-space, and social participation were all significantly associated with frailty. Mediterranean diet adherence only at the 3rd tertile when compared with the lowest tertile was associated with significantly reduced risk of frailty. Life-space and social participation at both 2nd and 3rd tertiles when compared with

the 1st tertile were significantly associated with reduced frailty risk. There was no difference on the significance of the factors associated with frailty between the unadjusted model (Model 1, R^2=0.352), model adjusted for age, gender and education (Model 2, R^2=0.391) or model adjusted additionally for nutrition, body mass, and comorbidity (Model 3, R^2=0.521).

In the binary regression with the FFI phenotypic components as the dependent variables, as shown in Table 4, lifestyle and social factors have preferential associations with different frailty phenotypic components. Mediterranean diet was only significantly associated with weakness and slowness. Social participation was associated with slowness and low activity. Life-space was associated with slowness only.

Discussion

To our knowledge, this is the first study showing that a Mediterranean diet is associated with reduced frailty risk in the Chinese population, whose dietary pattern is traditionally unlike Mediterranean diet. This study gives new information suggesting that the Mediterranean diet can exert its protective effect through elimination of consuming detrimental food in the Mediterranean diet, though not necessarily through increased consumption of beneficial food. Also, adherence to the Mediterranean diet must be high to exert its protective effect. Our results also showed that social participation and life-space are also negatively associated with frailty. Furthermore, protective factors are preferentially associated with particular frailty phenotypical components. Exhaustion and weight loss were not associated with any factors. Slowness was associated with all three factors. Weakness was associated only with Mediterranean diet and low activity was only associated with social participation. These findings extend our understanding on frailty and provide insights about future intervention development..

Underlying mechanisms explicating why the Mediterranean diet is associated with lower frailty risk are not fully known. A recent systematic review reported that sarcopenia, a biological substrate of frailty[39], is associated with elevated inflammatory markers (e.g., C-reactive protein) [40]. It is well-known that the Mediterranean diet attenuates inflammation [41], and oxidative stress [42]. Therefore, the Mediterranean diet's protective role against frailty may exert itself through attenuation of oxidative stress and chronic inflammation leading to better muscle function. This present study aligns with previous findings that Mediterranean diet was preferentially associated with two frailty phenotypic components which are closely related to muscle function: walking speed and muscle strength. Our results offer new evidence to support the notion that Mediterranean diet may reduce frailty risk by optimizing muscle function.

Obesity is associated with increased oxidative stress [43]. Oxidative stress may damage muscle at the mitochondrial level [44]. A recent study showed that sarcopenic obesity associated with higher risk of frailty than obesity alone [45]. A recent systematic review showed that Mediterranean diet can effectively reduce obesity [46]. Our study found that people with higher body mass and concurrently lower adherence to Mediterranean diet are associated with higher risk of frailty. Therefore, Mediterranean diet may exert its protective effect at the physiological level through improving people's allometry (i.e., increasing muscle and reducing fat).

A recent study conducted in Taiwan Chinese showed that some foods which are classified as beneficial in the Mediterranean diet (e.g., fresh fruit, nuts, and milk) are associated with reduced frailty risk [47]. However, our study showed that the MDS beneficial score is low, while the MDS detrimental score in this population is on the very high side. This finding suggests that in the Chinese population, the Mediterranean diet's protective effect may be exerted through reduced consumption of detrimental food (e.g., meat and poultry), and not necessarily through

increased consumption of beneficial food items (e.g., dairy product, olive oil). As such, this evidence supports the case for developing a culturally adjusted Mediterranean dietary intervention. It may not be necessary to advocate for increased consumption of culturally unfriendly food in ethnic groups whose traditional diets do not include those beneficial foods listed in the Mediterranean diet.

Our study finds that the Mediterranean diet is associated with reduced risk of frailty in Chinese community-dwelling older people; this contradicts results from a previous study conducted in Hong Kong Chinese in 2001-2003 [48]. Furthermore, we found that only those at the 3rd tertile (i.e., those with the highest adherence to Mediterranean diet) had reduced frailty risk. Mediterranean diet adherence should be at a high threshold to produce its protective effect. This observation supports a hypothesis that Mediterranean diet adherence in Chinese population 15 years ago may have been too low to demonstrate its protective effect towards frailty. These ambiguous results may also possibly be explained by different methods of dietary pattern measurement used in different studies.

A previous longitudinal study found that frailty is associated with a faster decline in life-space [16]. Reduced life-space in older people can be a result of reduced mobility and physical capacity [49]. Our findings are consistent with others', but also highlights that life-space is preferentially associated with slowness. Reduced life-space may result from poor age-supportive environment rendering proximity to resources or recreational facilities, social support, transportation, neighborhood security, and user-friendliness of walking environment [50]. Slow-walking frail older people may find it difficult to navigate in a city. Thus, facilitating slow-walking older people to maximize their life-space through environmental design (e.g., priority access to public transport) may possibly reduce frailty.

Previous work examining actual participation social activities (e.g., music group, social club) organized by social groups (e.g., churches, political/trading union) and its association with frailty yielded ambiguous results [20,51]. This study conceptualized social participation as the degree of one's satisfaction with participating in social events in order to fulfill their social needs. Our finding first showed that the perceived satisfaction on social participation is associated with lower frailty. This implies that the perceived satisfaction on social participation may play a more important role than how much a person actually participated in the social events. Therefore, when planning for social activities, older people should be actively involved in deciding upon and selecting activities that are salient to the community. Such strategies that increase ownership over the communal activities and events may increase overall satisfaction.

Given the positive results, there are several limitations. This is a cross-sectional design, so conclusions on causality cannot be made. Although we attempted to employ quota sampling, the number of subjects in each category was uneven. The study did not employ random sampling because of a lack of sampling frame and accessibility. Last, the regression was adjusted to only the known potential confounders.

Conclusion

In conclusion, high adherence to Mediterranean diet, life-space, and social participation were associated with reduced risk of frailty. In term of phenotypes of frailty, slowness was associated with Mediterranean diet adherence, life-space, and social participation. Weakness and low activity was associated with Mediterranean diet adherence and social participation respectively.

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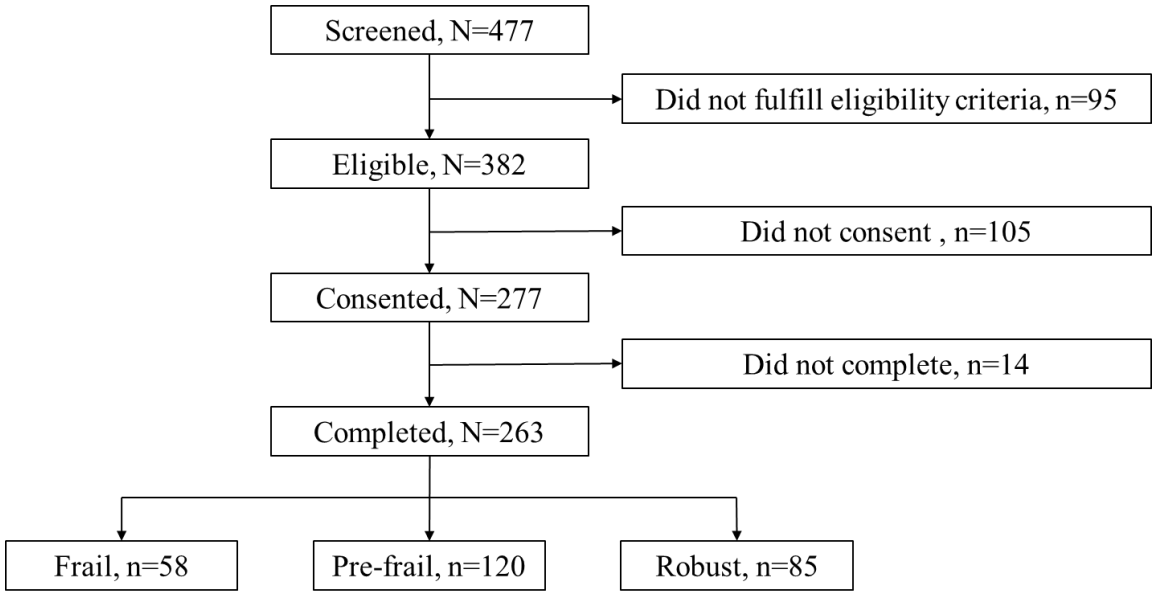
Author Contributions

Study concept and design: RYCK, DSKC, SKLL, LYWH, CK, YYC, JYWL; Acquisition of data: RYCK, DSKC, SKLL, LYWH, JYWL; Analysis and interpretation of data: RYCK, DSKC, SKLL, LYWH, JYWL; Drafting of the manuscript: RYCK; Critical revision of the manuscript for important intellectual content: RYCK, DSKC, SKLL, LYWH, CK, YYC, JYWL

Conflict of interest

The authors declare that they have no conflict of interest.

Figure 1 Participant flow chart and screening result of frailty status



334 Table 1: Demographic profile of participants

	Mean (SD)/Frequency (%)				p-value
	All	Robust N=85	Pre-frail N=120	Frail N=58	
Age	77.1 (7.5)	73.4 (6.3)	77.6 (7.8)	81.0 (6.3)	<.001***
Nutrition (MNA-SF, range: 0-14)	12.5 (1.6)	13.1 (0.9)	12.6 (1.7)	11.3 (1.5)	<.001***
Gender					.010*
Male	43 (16.3)	18 (21.2)	23 (19.2)	2 (3.4)	
Female	220 (83.7)	67 (78.8)	97 (80.8)	56 (96.6)	
Education					<.001***
Tertiary	14 (5.3)	5 (5.9)	8 (6.7)	1 (1.7)	
Secondary	59 (22.4)	31 (36.5)	22 (18.3)	6 (10.3)	
Primary	137 (52.1)	41 (48.2)	67 (55.8)	29 (50.0)	
Nil	53 (20.0)	8 (9.4)	23 (19.2)	22 (37.9)	
Marital status					.301
Not married	14 (5.3)	2 (2.4)	10 (8.3)	2 (3.4)	
Married	149 (56.7)	58 (68.2)	60 (50.0)	31 (53.4)	
Divorced	3 (1.1)	1 (1.2)	2 (1.7)	0 (0)	
Widow	97 (36.9)	24 (28.2)	48 (40)	25 (43.1)	
Finance sufficiency					.064
Very sufficient	3 (1.1)	5 (5.9)	12 (10.0)	2 (3.4)	
Sufficient	123 (46.8)	40 (47.1)	59 (49.2)	24 (41.4)	
Normal	73 (27.8)	25 (29.4)	32 (26.7)	16 (27.6)	
Insufficient	45 (17.1)	13 (15.3)	16 (13.3)	16 (27.6)	
Very insufficient	19 (7.2)	2 (2.4)	1 (0.8)	0 (0)	
Smoking					.065
Smoker/Ex-smoker	25 (9.5)	9 (10.6)	15 (12.5)	1 (1.7)	
Non-smoker	238 (90.5)	76 (89.4)	105 (87.5)	57 (98.3)	
Alcohol					.155
Drinker/Ex-drinker	27 (10.2)	10 (11.7)	15 (12.5)	2 (3.4)	
Non-drinker	236 (89.7)	75 (88.2)	105 (87.5)	56 (96.6)	
No. of chronic disease					.001*
> 2	73 (27.8)	14 (16.5)	37 (30.8)	22 (37.9)	
2	25 (9.5)	9 (10.6)	4 (3.3)	12 (20.7)	
1	163 (62.2)	60 (70.6)	79 (65.8)	24 (41.4)	
0	2 (0.8)	2 (2.4)	0 (0)	0 (0)	
Body mass index					.010
≥ 25	92 (35.0)	23 (27.1)	44 (36.7)	25 (43.1)	
23.0 – 24.9	56 (21.3)	15 (17.6)	31 (25.8)	10 (17.2)	
18.5 – 22.9	103 (39.2)	45 (52.9)	38 (31.7)	20 (34.5)	
< 18.5	12 (4.6)	2 (2.4)	7 (5.8)	3 (5.2)	

335 *p <.05; **p < .01; ***p <.001

336 MNA-SF, Mini Nutritional Assessment Short Form.

Table 2 Dependent and Independent Variables

	N=263, mean (SD)/frequency (%)
Dependent variable	
Frailty	
Robust	85 (32.3)
Pre-frail	120 (45.6)
Frail	58 (22.1)
Frailty components	
Weight loss	64 (24.3)
Exhaustion	30 (11.4)
Low activity	33 (12.5)
Slow gait	93 (35.4)
Weakness	140 (53.2)
Frailty (FFI, range: 0-5)	1.37 (1.3)
Independent variables	
Mediterranean diet (MDS, range: 0-55)	30.5 (4.9)
MDS-beneficial score (range: 0-35)	12.9 (4.9)
MDS-detrimental score (range: 0-20)	17.6 (2.9)
Life-space (LSA, range: 0-120)	79.1 (21.6)
Social participation (RNLI, range: 0-100)	80.8 (15.2)

FFI, Fried Frailty Index; LSA, Life-space Assessment; MDS, MedDietScore RNLI, Reintegration to Normal Living Index.

Table 3 Multiple Ordinal Regression Model on Frailty

	Model 1 (R^2=0.352)		Model 2 (R^2=0.391)		Model 3 (R^2=0.521)	
N=263	OR	95%CI	OR	95%CI	OR	95%CI
Mediterranean diet, MDS						
Tertile 1	Ref		Ref		Ref	
Tertile 2	0.68	0.39-1.17	0.66	0.38-1.14	0.62	0.35-1.01
Tertile 3	0.25**	0.14-0.45	0.28**	0.15-0.50	0.29**	0.15-0.54
Life-space, LSA						
Tertile 1	Ref		Ref		Ref	
Tertile 2	0.39**	0.23-0.67	0.43*	0.25-0.75	0.38**	0.21-0.66
Tertile 3	0.23**	0.12-0.45	0.29**	0.15-0.58	0.32**	0.16-0.64
Social participation, RNLI						
Tertile 1	Ref		Ref		Ref	
Tertile 2	0.29**	0.17-0.51	0.35**	0.20-0.62	0.45*	0.25-0.81
Tertile 3	0.16**	0.09-0.32	0.23**	0.12-0.45	0.31**	0.15-0.63

*p <.05, **p <.001, Model 1: Unadjusted, Model 2: Adjusted for age, gender, and education, Model 3: Additionally adjusted for nutrition, body mass index, comorbidity

LSA, Life-space Assessment; MDS, MedDietScore RNLI, Reintegration to Normal Living Index.

Table 4 Multiple Binary Logistic Regression Model on Frailty Phenotypic Components

	Weakness		Slowness		Low activity		Exhaustion		Weight loss	
N=263	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI
Mediterranean diet, MDS										
Tertile 1	Ref		Ref		Ref		Ref		Ref	
Tertile 2	0.97	0.50-1.91	0.38*	0.17-0.84	0.44	0.10-0.90	0.46	0.12-1.72	0.88	0.29-2.62
Tertile 3	0.42*	0.21-0.85	0.17**	0.06-0.44	0.86	0.27-2.72	0.78	0.28-2.16	0.69	0.26-1.86
Life-space, LSA										
Tertile 1	Ref		Ref		Ref		Ref		Ref	
Tertile 2	0.73	0.38-1.41	0.50	0.19-1.30	N/A		0.32	0.06-1.78	0.38	0.10-1.47
Tertile 3	0.62	0.29-1.35	0.36*	0.17-0.80	0.38	0.13-1.15	0.38	0.13-1.13	0.46	0.17-1.21
Social participation, RNLI										
Tertile 1	Ref		Ref		Ref		Ref		Ref	
Tertile 2	1.79	0.88-3.62	0.34*	0.13-0.87	0.23	0.04-1.30	0.24	0.05-1.29	0.52	0.15-1.80
Tertile 3	0.87	0.39-1.93	0.25**	0.11-0.56	0.14*	0.04-0.52	0.43	0.15-1.20	0.65	0.24-1.78

*p <.05, all models are adjusted for age, gender, education, nutrition, body mass index, comorbidity

LSA, Life-space Assessment; MDS, MedDietScore RNLI, Reintegration to Normal Living Index.

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