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DEFINING VITALITY: ASSOCIATIONS OF THREE OPERATIONAL DEFINITIONS OF VITALITY WITH DISABILITY IN INSTRUMENTAL ACTIVITIES OF DAILY LIVING AND FRAILTY AMONG ELDERLY OVER A 3-YEAR FOLLOW-UP (MAPT STUDY)

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Abstract: *Objectives:* This study aimed to examine the associations of three operational definitions of vitality with variation in instrumental activities of daily living (IADL) and frailty over a 3-year follow-up among non-demented, community-dwelling elderly. *Design:* Observational study. *Setting and participants:* 1,679 elderly >70y (64.7% female) participants of the Multidomain Alzheimer Preventive Trial (MAPT). *Measurements:* Vitality was defined as a psychological concept using three items from the Geriatric Depression Scale; as a physical construct using the highest quartile for hand grip strength; and as global physiological reservoir using a combination of good physical and cognitive functions. Variables were assessed at baseline, 6, 12, 24 and 36 months of follow-up. *Results:* Prevalence of high vitality at baseline was 57.1%, 28.5% and 21.6% for psychological, physical, and physiological reservoir, respectively. People with high vitality presented higher IADL scores compared to people with low vitality for all definitions. Analysis from the mixed-effect model found no differences between vitality groups for IADL performance across all definitions. IADL scores improved among subjects with high vitality over time, independent on the definition; while no significant variation was observed among those with low vitality. Participants with low vitality presented 2.0 to 6.1 higher odds of having more frailty components over time ($p<0.0001$). *Conclusion:* High vitality defined as a concept related to psychological, physical, or physiological reservoir constructs were positively associated with better IADL performance and with reduced likelihood of frailty worsening over time.

Key words: Vitality, elderly, activities of daily living, frailty, cognition.

Abbreviations: ADCS ADL-PI: Alzheimer's Disease Cooperative Study Activities of Daily Living-Prevention Instrument; ADL: activities of daily living; ANOVA: analysis of variance; BMI: body mass index; CDR: Clinical Dementia Rating; GDS: Geriatric Depression Scale; IADL: Instrumental Activities of Daily Living; MAPT: Multidomain Alzheimer Preventive Trial; MMSE: Mini-Mental State Examination; SAS: Statistical Analysis Software; SPPB: Short Physical Performance Battery; WHO: World Health Organization.

Introduction

The construct of intrinsic capacity has been recently defined by the World Health Organization (WHO) as the composite of all physical and mental capacities of an individual, comprising five domains: locomotion, vitality, cognition, psychological and sensory (1). Healthy aging depends on an individual's intrinsic capacity. Investigating how its domains associate with health impairment may potentially contribute to modify the way clinical practice is currently conducted, shifting focus from disease to function paradigms, in order to help improving quality of life and longevity among older people. Age-related typically observed health impairments include reduced performance in instrumental activities of daily living (IADL) (2) and frailty development, favoring loss of independence (3, 4).

Vitality is a concept often related with self-estimation of liveliness and feeling full of energy, usually considered part of subjective psychological constructs (5–7). However, vitality also emerges from a physical performance construct of vigor and strength (8–10). Due to this hybrid concept that involves both psychological and physical domains, measuring vitality is challenging. To the best of our knowledge, no consensual operational definition of vitality has been proposed in literature so far. Analyses including vitality are usually limited to part of quality of life information (11–13), or to physical functioning as hand grip strength (9, 10) (which is considered a vital sign and a robust predictor of mortality) (14, 15), blood pressure, lung function and heart pulse (9). Such gap provides perspectives on how exploring distinct definitions of vitality and its role in reducing vulnerability to adverse health events may be promising in helping to prevent health decline, especially among the increasing number of community-dwelling elderly people.

This study aimed to examine the associations of three different operational definitions of vitality (one psychological, one physical, and one representing a global physiological reservoir) with IADL performance and with frailty levels over

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a 3-year follow-up among non-demented, community-dwelling elderly with memory complaints. In addition, a concept of very high vitality combining both psychological and physical domains was also investigated. We hypothesized that high vitality (as evaluated by any of the definitions) would be associated with better performance of IADL and lower levels of frailty over time.

Methods

This prospective observational study was a secondary analysis with participants from the 3-year Multidomain Alzheimer Preventive Trial (MAPT) (trial registration NCT00672685), a study created to investigate the efficacy of omega-3 polyunsaturated fatty acid supplementation, lifestyle interventions (physical activity, nutritional advices and cognitive training) or their combination on cognitive function (16, 17).

Study population

MAPT participants were non-demented (with a Mini-Mental State Examination – MMSE score ≥ 24), community-dwelling men and women aged ≥ 70 years with spontaneous memory complaints, limitation in executing at least one IADL, or slow gait speed (<0.8 m/s measured by a 4-meter usual walking test). Participants were recruited from May 2008 to February 2011 by 13 health centers participating in the study. Data collection for the 3-year follow-up ended in April 2014.

MAPT study protocol was approved by the Advisory Committee for the Protection of Persons participating in Biomedical Research of the Toulouse University Hospital and was authorized by the French Health Authority. The protocol is registered on a public-access clinical trial database (www.clinicaltrials.gov). All participants signed an informed consent.

Vitality operational definitions

Vitality was defined by three distinct criteria:

– Vitality representing a mental state of willingness ("vitality A") was determined by a score based on three items from the 15-item Geriatric Depression Scale (GDS) (18) ("Are you basically satisfied with your life?"; "Do you feel that your life is empty?"; "Do you feel full of energy?"), for which high vitality was defined as score = 0.

– Vitality corresponding to a physiological reservoir ("vitality B") was determined by good physical performance (scoring >10 points in the Short Physical Performance Battery – SPPB, out of a total of 12) (19) and cognitive function (scoring >28 points in the Mini-Mental State Examination – MMSE, out of a total of 30, and scoring 0 in the Clinical Dementia Rating – CDR) (20,21).

– The forth quartile for hand grip strength (measured in kg by a handheld dynamometer) was considered the third definition of vitality ("vitality C"). As there is a marked gender difference in hand grip strength across the adult lifespan (with men having higher grip strength) (22, 23), quartiles were characterized separately according to sex. Assessments were performed by trained neuropsychologists, physicians and nurses.

All measures were performed at baseline, 6, 12, 24 and 36 months of follow-up. Additionally, a concept of very high vitality was tested, combining vitality A (psychological domain) and vitality C (physical domain), in which people classified with high vitality by both criteria were considered people with very high vitality.

Outcomes

Activities of daily living

Abilities in performing IADL were evaluated by two different questionnaires. The Alzheimer's Disease Cooperative Study Activities of Daily Living-Prevention Instrument (ADCS ADL-PI) – which consists of 15 IADL tasks covering a wide range of activities usually performed by elderly people (as transportation, shopping, cooking, using the telephone and cleaning) – was assessed at baseline, 12, 24 and 36 months of follow-up. Individuals self-reported how well they were able to perform each item, and answers ranged from "as usual / no difficulty" (3 points) to "unable to do" (0 points), totaling a maximum ADL-PI score of 45 points (24). The Instrumental Activities of Daily Living Scale (25) was measured at baseline and 36 months of follow-up. This questionnaire covers eight IADL tasks, similarly as ADCS ADL-PI, with a maximum scoring of 8 points.

Frailty

Frailty prevalence was evaluated as a dichotomous variable, in which an individual was classified as frail if presenting ≥3 components out of five according to criteria proposed by Fried et al. (26): unintentional weight loss (self-reported unintentional weight loss ≥10 pounds in previous year); self-reported exhaustion (based on two items from the GDS); weakness (measured by hand grip strength); slow walking speed (based on 4-meter walking test); and low physical activity (answering "hardly ever" or "never" for very energetic physical activity and for moderately energetic physical activity). Additionally, frailty components were considered as an ordinal variable. Information was collected at baseline, 6, 12, 24 and 36 months.

Confounders

Sociodemographic information included age, sex and education (no diploma or primary school certificate, secondary education, high school diploma, university level). Height and weight measurements were assessed according to standard procedures (27). Weight was determined to the nearest 0.1 kg using a beam balance scale. Height was determined with a fixed wall scale stadiometer to the nearest 0.1 cm. The body mass index was defined as weight (kg) / height (m) x height (m). MAPT participants randomization into four different

Table 1
Baseline characterization of participants according to vitality status

		Vitality A[1]		Vitality B[2]		Vitality C[3]	
	Total	High vitality	Low vitality	High vitality	Low vitality	High vitality	Low vitality
	n = 1679	n = 957	n = 720	n = 356	n = 1290	n = 463	n = 1164
	mean (SD)*	mean (SD)*	mean (SD)*	mean (SD)*	mean (SD)*	mean (SD)*	mean (SD)*
Female sex	1087 (64.7%)	591 (61.8%)	494 (68.6%)†	235 (66.0%)	834 (64.7%)	309 (66.7%)	739 (63.5%)
Age (years)	75.3 (4.4)	75.0 (4.3)	75.8 (4.5)†	74.0 (3.6)	75.7 (4.6)†	73.8 (3.6)	75.9 (4.6)†
Education (n = 1643)							
No diploma or primary school certificate	371 (22.6%)	200 (21.4%)	170 (24.1%)	43 (12.3%)	322 (25.5%)†	96 (21.2%)	263 (23.1%)
Secondary education	553 (33.7%)	309 (33.0%)	243 (34.5%)	109 (31.2%)	434 (34.4%)	157 (34.7%)	378 (33.1%)
High school diploma	242 (14.7%)	146 (15.6%)	96 (13.6%)	60 (17.2%)	179 (14.2%)	65 (14.4%)	168 (14.7%)
University level	477 (29.0%)	282 (30.1%)	195 (27.7%)	137 (39.3%)	327 (25.9%)	135 (29.8%)	332 (29.1%)
Weight (kg) (n = 1672)	68.4 (13.0)	68.6 (12.8)	68.1 (13.2)	68.0 (12.3)	68.5 (13.2)	70.7 (13.5)	67.6 (12.7)†
Height (m) (n = 1678)	1.62 (0.08)	1.62 (0.09)	1.61 (0.09)†	1.62 (0.08)	1.62 (0.09)	1.64 (0.09)	1.61 (0.09)†
Body mass index (kg/m^2) (n = 1672)	26.1 (4.1)	26.0 (3.9)	26.3 (4.3)	25.8 (3.9)	26.2 (4.1)	26.2 (4.2)	26.1 (4.0)
Hand grip strength (kg) (n = 1627)	27.5 (9.3)	28.4 (9.6)	26.3 (8.7)†	28.8 (9.4)	27.1 (9.1)†	34.7 (8.9)	24.6 (7.8)†
GDS score (n = 1670)	3.3 (2.6)	1.8 (1.4)	5.2 (2.6)†	2.7 (2.3)	3.4 (2.7)†	2.8 (2.4)	3.5 (2.7)†
MMSE score	28.1 (1.6)	28.1 (1.5)	28.0 (1.7)†	29.4 (0.5)	27.7 (1.6)†	28.3 (1.5)	28.0 (1.6)†
Activities of daily living							
ADCS ADL-PI score (n = 1665)	39.7 (4.8)	40.4 (4.4)	38.7 (5.2)†	41.0 (3.9)	39.3 (5.0)†	40.5 (4.2)	39.4 (5.0)†
IADL score (n = 1247)	7.96 (0.25)	7.97 (0.16)	7.94 (0.33)†	7.99 (0.08)	7.95 (0.28)†	7.97 (0.21)	7.95 (0.27)
Frailty (n = 1588)							
Not frail (0 to 2 components)	1537 (96.8%)	889 (98.2%)	646 (94.9%)†	338 (99.7%)	1185 (96.1%)†	454 (99.8%)	1083 (95.6%)†
Frail (≥ 3 components)	51 (3.2%)	16 (1.8%)	35 (5.1%)	1 (0.3%)	48 (3.9%)	1 (0.2%)	50 (4.4%)

ADCS ADL-PI: Alzheimer's Disease Cooperative Study Activities of Daily Living-Prevention Instrument; IADL: Instrumental Activities of Daily Living; [1] based on Geriatric Depression Scale (GDS); [2] based on Short Physical Performance Battery (SPPB), Mini-Mental State Examination (MMSE) and Clinical Dementia Rating (CDR); [3] based on hand grip strength; *except where indicated other; † p< 0.05.

groups consisted of: omega-3 supplementation; multidomain intervention composed of cognitive training, physical activity counseling and nutrition counseling with placebo; multidomain intervention with omega-3 supplementation; and placebo alone (16).

Statistical analysis

Descriptive statistics was provided as means and standard deviation (SD) or absolute numbers and percentages. The normality of the distribution of each variable was assessed with the Kolmogorov-Smirnov test, and logarithmic transformation was used when needed. Student's T-test or analysis of variance (ANOVA) and Chi-square test were used as appropriate. Linear mixed effects models (with a random effect at the subject level) were performed to explore the variation in ADCS ADL-PI score (dependent variable) according to vitality status (high vitality and low vitality) over the 3-year follow-up for each vitality definition separately. Fixed effects were: vitality status, time (categorical variable), interaction between vitality status and time, and all the potential confounders (sex, age, education, body mass index, MAPT intervention groups and the interaction between time and these variables). Ordinal logistic regressions using a similar approach were performed to investigate frailty worsening according to vitality status over the 3-year follow-up. All analyses were performed using the Statistical Analysis Software (SAS) version 9.4 (Cary, NC, USA), at a significance level of 5% ($\alpha = 0.05$).

Results

Characterization of the sample

Participants' characteristics at baseline according to each vitality definition are shown in Table 1. From the total sample (n = 1,679), 57.1% (n = 957) presented high vitality based on three questions from the GDS questionnaire, while only 21.6% (n = 356) met the "vitality B" criteria (based on SPPB, MMSE and CDR). For the classification based on hand grip strength (vitality C), 28.5% (n = 463) presented high vitality. At baseline, only 5.5% (n = 92) of participants were classified with high vitality according to all three criteria, and 26.0% (n = 437) were classified as low vitality by the three definitions. Participants with high vitality according to all criteria were

younger, presented higher hand grip strength, MMSE score and ADCS ADL-PI score (all $p < 0.05$), compared to the group with low vitality.

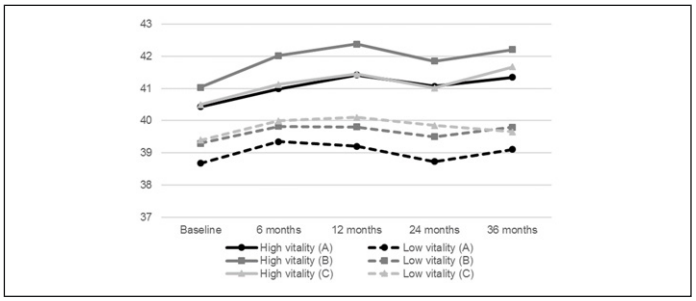
At baseline, 17.4% (n = 283) individuals met the high vitality criteria according to both GDS items (vitality A) and hand grip strength (vitality C), thus being considered with very high vitality. Compared to people that did not meet any of these criteria for high vitality, participants with very high vitality were younger (73.5 years, SD = 3.4 vs. 76.2, SD = 4.6; $p < 0.0001$), taller (1.65 m, SD = 0.09 vs. 1.60, SD = 0.09; $p < 0.0001$), presented higher body weight (70.7 kg, SD = 13.4 vs. 67.3, SD = 13.0; $p = 0.0004$), hand grip strength (35.5 kg, SD = 9.0 vs. 23.9, SD = 7.3; $p < 0.0001$), MMSE score (28.4, SD = 1.5 vs. 27.9, SD = 1.7; $p < 0.0001$), ADCS ADL-PI score (40.8, SD = 4.1 vs. 38.2, SD = 5.4; $p < 0.0001$) and IADL score (7.98, SD = 0.14 vs. 7.92, SD = 0.38; $p = 0.0039$), and lower GDS score (1.7, SD = 1.4 vs. 5.4, SD = 2.6; $p < 0.0001$) (Supplementary Table 1).

Variation in ADCS ADL-PI score according to vitality status

Changes in ADCS ADL-PI total score from baseline to the end of follow-up according to vitality status are shown in Figure 1. People with high vitality presented higher ADCS ADL-PI scores compared to people with low vitality at baseline, and at all other moments ($p < 0.05$) (Figure 1).

Figure 1

Variation in Alzheimer's Disease Cooperative Study Activities of Daily Living – Prevention Instrument (ADCS ADL-PI) total score over a 3-year follow-up according to vitality status among non-demented, community-dwelling elderly. $P < 0.05$ for all high vitality vs. low vitality groups at all moments. Vitality A based on Geriatric Depression Scale (GDS); Vitality B based on Short Physical Performance Battery (SPPB), Mini-Mental State Examination (MMSE) and Clinical Dementia Rating (CDR); Vitality C based on hand grip strength



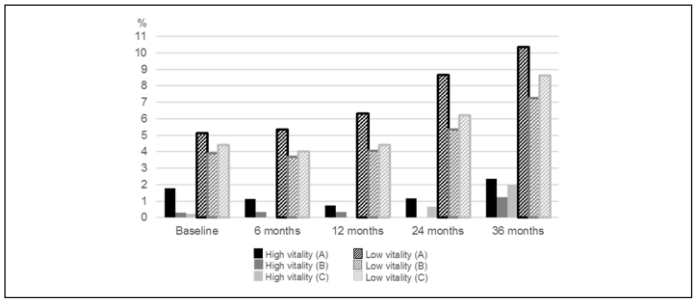
ADCS ADL-PI score increased among subjects with high vitality over the 3-year follow-up, independent on the vitality criteria (from baseline to 36 months, vitality A: 0.42, 95% CI 0.10 to 0.74, $p = 0.01$; vitality B: 0.69, 95% CI 0.18 to 1.20, $p = 0.009$; vitality C: 0.86, 95% CI 0.42 to 1.30, $p = 0.0001$). Meanwhile, no significant variation between baseline and 36 months of follow-up was observed among those with low vitality. In the non-adjusted model, variation on ADCS ADL-PI score between groups (high vitality vs. low vitality) over time were only significant for vitality based on hand grip strength (vitality C) between baseline and 36 months (0.92, 95% CI: 0.39 to 1.46, $p = 0.001$). However, after adjusting for age, sex, education, BMI, MAPT groups and time interactions, this result did not remain significant (Table 2).

Variation in frailty according to vitality status

The prevalence of frailty over the 3-year follow-up among people with high vitality ranged from 0.0% to 2.4%. Meanwhile, prevalence of frailty among participants classified with low vitality ranged from 3.7% to 10.4%. Prevalence of frailty according to vitality status was significantly lower among people with high vitality, compared to their correspondent low vitality group, at all moments and for all three different definitions ($p < 0.05$ for all) (Figure 2).

Figure 2

Variation in frailty prevalence over 3-year follow-up according to vitality status among non-demented, community-dwelling elderly. $P < 0.05$ for all high vitality vs. low vitality groups at all moments. Vitality A based on Geriatric Depression Scale (GDS); Vitality B based on Short Physical Performance Battery (SPPB), Mini-Mental State Examination (MMSE) and Clinical Dementia Rating (CDR); Vitality C based on hand grip strength



Results of ordinal logistic regressions on frailty components variation according to vitality status can be found in Table 3. In the unadjusted analysis, participants with low vitality (according to all three definitions) presented 2.0 to 6.1 higher odds of having more frailty components over the follow-up, compared to participants with high vitality ($p < 0.0001$ for all). Results persisted similar after adjusting for potential confounders.

Discussion

The present study showed that participants with low vitality, compared with those with high vitality, had an increased likelihood of worsening frailty levels over the follow-up, regardless the vitality definition in a sample of non-demented, community-dwelling French elderly. Moreover, independent

Table 2

Mixed-effect linear regression analysis for variation in Activities of Daily Living – Prevention Instrument total score over 3-year follow-up according to vitality status among non-demented, community-dwelling elderly

	Change in ADCS ADL-PI score from baseline Within-group mean difference* (95% CI); P-value		Group difference in ADCS ADL-PI score between high vitality group and low vitality group over time Between-group mean difference (95% CI); P-value	
	High vitality	Low vitality	Unadjusted	Adjusted**
Vitality A[1]				
6 months	0.59 (0.30, 0.88); < 0.0001	0.61 (0.27, 0.94); 0.001	-0.01 (-0.47, 0.44); 0.951	-0.12 (-0.58, 0.34); 0.614
12 months	0.79 (0.49, 1.09); < 0.0001	0.65 (0.31, 1.00); 0.0002	0.14 (-0.33, 0.61); 0.572	-0.01 (-0.48, 0.46); 0.970
24 months	0.24 (-0.07, 0.55); 0.135	-0.03 (-0.38, 0.33); 0.872	0.27 (-0.22, 0.75); 0.281	0.00 (-0.49, 0.49); 0.991
36 months	0.42 (0.10, 0.74); 0.010	0.05 (-0.30, 0.41); 0.767	0.37 (-0.12, 0.86); 0.141	0.04 (-0.45, 0.54); 0.869
Vitality B[2]				
6 months	0.76 (0.27, 1.25); 0.002	0.55 (0.30, 0.80); < 0.0001	0.21 (-0.35, 0.77); 0.454	0.08 (-0.49, 0.66); 0.773
12 months	0.78 (0.29, 1.27); 0.002	0.68 (0.42, 0.94); < 0.0001	0.10 (-0.46, 0.67); 0.721	0.01 (-0.57, 0.59); 0.982
24 months	0.41 (-0.10, 0.92); 0.113	0.01 (-0.25, 0.27); 0.934	0.40 (-0.18, 0.98); 0.180	0.06 (-0.54, 0.67); 0.836
36 months	0.69 (0.18, 1.20); 0.009	0.11 (-0.16, 0.37); 0.435	0.58 (-0.01, 1.17); 0.054	0.11 (-0.50, 0.71); 0.729
Vitality C[3]				
6 months	0.67 (0.25, 1.09); 0.002	0.59 (0.33, 0.84); < 0.0001	0.09 (-0.41, 0.59); 0.733	-0.07 (-0.59, 0.44); 0.782
12 months	0.81 (0.37, 1.25); 0.0003	0.68 (0.41, 0.95); < 0.0001	0.13 (-0.39, 0.66); 0.626	-0.13 (-0.67, 0.41); 0.635
24 months	0.49 (0.04, 0.94); 0.035	0.15 (-0.14, 0.43); 0.306	0.34 (-0.20, 0.89); 0.219	-0.05 (-0.61, 0.51); 0.864
36 months	0.86 (0.42, 1.30); 0.0001	-0.06 (-0.35, 0.23); 0.676	0.92 (0.39, 1.46); 0.001	0.46 (-0.09, 1.02); 0.100

ADCS ADL-PI: Alzheimer's Disease Cooperative Study Activities of Daily Living-Prevention Instrument; CI: confidence interval; [1] based on Geriatric Depression Scale (GDS); [2] based on Short Physical Performance Battery (SPPB), Mini-Mental State Examination (MMSE) and Clinical Dementia Rating (CDR); [3] based on hand grip strength; * Negative values indicate decrease over time in the ADCS ADL-PI score (impairment in ADL performance); **Model adjusted by age, sex, education, body mass index, MAPT groups and time interactions.

Table 3

Ordinal logistic regression analysis for increase in frailty components over 3-year follow-up according to vitality status among non-demented, community-dwelling elderly

	Unadjusted model		Adjusted model*	
	OR (95% CI)	P-value	OR (95% CI)	P-value
Vitality A[1] (Ref.: high vitality)				
Baseline	2.2 (1.8, 2.7)	< 0.0001	2.1 (1.7, 2.6)	< 0.0001
6 months	2.8 (2.3, 3.5)	< 0.0001	2.7 (2.2, 3.4)	< 0.0001
12 months	3.1 (2.5, 3.8)	< 0.0001	2.9 (2.3, 3.6)	< 0.0001
24 months	3.0 (2.4, 3.7)	< 0.0001	2.7 (2.1,3.4)	< 0.0001
36 months	2.6 (2.1, 3.3)	< 0.0001	2.3 (1.8, 2.9)	< 0.0001
Vitality B[2] (Ref.: high vitality)				
Baseline	2.1 (1.7, 2.6)	< 0.0001	1.8 (1.4, 2.3)	< 0.0001
6 months	2.3 (1.7, 3.0)	< 0.0001	1.9 (1.5, 2.6)	< 0.0001
12 months	2.2 (1.7, 2.9)	< 0.0001	1.8 (1.4, 2.4)	< 0.0001
24 months	2.3 (1.7, 3.1)	< 0.0001	1.7 (1.2, 2.3)	0.0007
36 months	2.0 (1.6, 2.7)	< 0.0001	1.6 (1.2, 2.2)	0.0008
Vitality C[3] (Ref.: high vitality)				
Baseline	3.7 (2.9, 4.7)	< 0.0001	3.3 (2.5, 4.2)	< 0.0001
6 months	4.4 (3.4, 5.8)	< 0.0001	4.1 (3.1, 5.5)	< 0.0001
12 months	3.9 (2.9, 5.1)	< 0.0001	3.9 (2.9, 5.1)	< 0.0001
24 months	3.8 (2.9, 5.0)	< 0.0001	3.4 (2.5, 4.5)	< 0.0001
36 months	6.1 (4.7, 7.9)	< 0.0001	6.6 (5.0, 8.8)	< 0.0001

OR: odds ratio; CI: confidence interval; [1] based on Geriatric Depression Scale (GDS); [2] based on Short Physical Performance Battery (SPPB), Mini-Mental State Examination (MMSE) and Clinical Dementia Rating (CDR); [3] based on hand grip strength; *Model adjusted by age, sex, education, body mass index, MAPT groups and time interactions.

of the vitality definition, people with high vitality presented higher ADCS ADL-PI scores than subjects with low vitality; within-group analysis found a non-clinically relevant but significant raise in ADCS ADL-PI scores (improved functional status) among people with high vitality, while no variation was observed in the low vitality group over the follow-up. Vitality defined as a physiological reservoir based on good physical performance and cognitive function and vitality based on hand grip strength were considerably less prevalent than psychological vitality.

The long-term associations of vitality with IADL performance or frailty has not been deeply investigated so far and our findings are, thus, pioneer in this field. The inverse relationship between vitality and frailty among elderly people observed in our study agree with previous cross-sectional studies (11, 12). A Brazilian study with community-dwelling elderly women found psychological vitality (measured as part of a questionnaire evaluating quality of life) to be lower among the frail group (12). Similar results were observed among elderly primary health care users (11). For the vitality-IADL associations, our study goes beyond a previous cross-sectional study from Japan (13) that found that psychological vitality was associated with IADL, and longitudinally examines for the first time the associations of different definitions of vitality with IADL performance. It is important to recognize that hand grip strength (even not called as vitality by the original investigators) is a well-known predictor of future personal ADL and IADL disability, as shown by studies evaluating Mexican-American (28, 29), American (30), Mexican (31), Brazilian (32), French (33), Finnish, Italian and Dutch (34) elderly people.

Some additional findings of the present study deserve further discussion. At baseline, only 31.5% of participants received the same classification (high vitality or low vitality) according to the three different criteria. Such discrepancy highlights how defining vitality can be challenging, but the homogeneity of the findings on the relationship between vitality and the outcomes (pointing to the same direction despite of different operational definitions), added to the fact that the additional concept of very high vitality (by combining two different domains of vitality) showed more marked differences on several baseline variables, reinforce the need of considering more than a single domain when evaluating this construct. This is also sustained by studies showing a positive association between psychological vitality and higher hand grip strength (35, 36). Moreover, differently than expected, participants' ADCS ADL-PI score did not decline over the 3-year follow-up among our sample. The mean age of 75 years and the fact that volunteers were non-demented and particularly highly educated (which implies a high level of cognitive reserve) may have contributed to such result, given that IADL are known to decline faster in older ages and to be positively associated with dementia and cognitive decline (37, 38).

Our study has several strengths. Vitality was investigated with three different approaches, broadening the concept to both psychological and physical dimensions. We analyzed a large sample of elderly people. In addition, the long duration of follow-up allowed several assessments: measures used to define vitality and outcomes were collected in five time points over the 3-year follow-up, making it possible to closely follow the variation in ADCS ADL-PI score and frailty components over time. However, some limitations should be mentioned. As typically observed in longitudinal studies, adherence of participants was not complete during the follow-up, which means that the number of people who answered the questionnaires varied over time. This study is a secondary analysis of a randomized controlled trial that might have influenced both our outcomes and vitality definitions; however, analyses were adjusted to MAPT group assignment in an attempt to reduce this potential bias. Physical vitality as measured by hand grip strength outperformed the other vitality definitions for the associations with frailty worsening, however it might be considered that hand grip strength was one of the criteria used to define frailty. Finally, volunteers of our study were particularly highly educated, which reduces the generalizability of our findings.

Conclusions

This study tested the associations of three different concepts of vitality with IADL performance and frailty levels in community-dwelling older adults. All three definitions performed similarly in positively associating with health outcomes, although high vitality defined as a mental state of willingness was the most prevalent (maybe less discriminant), compared to vitality as a physiological reservoir and vitality based on hand grip strength. Further research, particularly longitudinal observational studies, should explore the concept of vitality, in order to strengthen this intrinsic capacity domain as a protective factor over health outcomes, especially among elderly people.

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Conflict of interest: None.

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