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ORIGINAL ARTICLE

Mediterranean lifestyle patterns are associated with cognition in older adults

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Abstract

Introduction: In recent years, research interest has shifted to the study of overall lifestyle, rather than individual lifestyle factors, in relation to health outcomes. The aim of this study was to investigate the association of different lifestyle patterns, close to the concept of the Mediterranean lifestyle, using both a priori and a posteriori methods, with cognition of older adults, free of dementia.

Methods: A total of 1726 participants ≥65 years old (59% women) from the HELIAD study were included in the present cross-sectional analysis. Diet, physical activity, sleep, social life, and daily functioning were assessed using standard, validated questionnaires. A comprehensive neurological and neuropsychological assessment was conducted, evaluating all cognitive domains: memory, executive functions, visual–spatial perception, language, and attention-processing speed, as well as global cognitive functioning.

Results: Two lifestyle indices were constructed on the basis of the Mediterranean lifestyle, whereas principal component analysis was used to generate lifestyle patterns. The results showed that the two indices and the Mediterranean diet and activities pattern as well as the Mediterranean diet and social contacts pattern were positively associated with almost all major cognitive domains as well as global cognitive functioning. Specifically, every unit increase in one of the lifestyle indices, consisting of adherence to the Mediterranean diet, sleep quality, physical activity, and daily functioning, was associated with 9.8%, 7.1%, 6.8%, 7.2%, and 8.5% increased odds of better memory, executive function, visual–spatial perception, language, and global cognitive functioning, respectively.

Conclusions: Our results showed that a healthy lifestyle, close to the concept of the Mediterranean lifestyle, independently of the approach used to define it, was positively associated with cognitive function in older adults. Thus, health experts should also consider overall lifestyle when screening for cognitive deficits in this vulnerable age group.

KEYWORDS
dementia, elderly, Mediterranean diet

1 | INTRODUCTION

Mediterranean diet is a dietary pattern, initially described by Ancel Keys in the Seven Countries study, in the early 1970s.[1] Nowadays, it is used to describe the traditional dietary habits of people living around the Mediterranean basin and it consists of plenty plant foods: fruits, vegetables, bread, and other forms of cereals, legumes, nuts, and seeds, with olive oil being the main source of fat. It also includes moderate amount of dairy products, principally in the form of cheese and yogurt, small to moderate amounts of fish and poultry, small amounts of red meat, and wine, which is consumed in moderation and typically with meals.[2] Cumulative evidence supports the protective effect of the Mediterranean diet on longevity as well as the development and progression of many chronic diseases, that is, cancer, cardiovascular diseases, dementia, and type 2 diabetes.[3–5]

Apart from the consumption of specific foods and the diet per se, several lifestyle factors had been underlined as important components of the Mediterranean way of living, namely, the participation in a wide range of leisure time activities, including physical ones, social interaction, and adequate sleep.[5,6] Accordingly, there are hypotheses that the beneficial role of the Mediterranean diet may be attributed to the clustering of lifestyle parameters. Thus, there have been several research methodological approaches to investigate overall lifestyle patterns and their relationship to health outcomes. Specifically, a lifestyle characterized by high adherence to the Mediterranean diet, low body weight, moderate alcohol intake, low television exposure, no binge drinking, daytime napping, and high frequency of social interaction was associated with a 78% reduction in the risk of primary cardiovascular diseases after 10 years.[7] A previous analysis by our research team indicated that higher values of a lifestyle index, comprising adherence to the Mediterranean diet, physical activity, sleep quality, and functionality, were associated with 65% reduced odds for mild cognitive impairment and 43% reduced odds for poor global cognitive performance.[8]

Interestingly, each study has adopted a different approach for the evaluation of a lifestyle. Irrespective of the approach used, what remains unknown is which factors should be included in a lifestyle pattern that has beneficial effects on health. In the present analysis, we focused on cognitive health in older adults: we investigated various lifestyle patterns, based on the Mediterranean lifestyle, using both a priori, that is, hypothesis-driven, and a posteriori, that is, exploratory approaches, and we examined their potential associations with performance in several cognitive domains in older people.

2 | MATERIALS AND METHODS

2.1 | Sample and procedures

The present sample is from the HELIAD (Hellenic Longitudinal Investigation of Aging and Diet) study, which is a population-based, multidisciplinary, collaborative study. The sample consisted of community-dwelling older people (≥65 years old) from two areas in Greece: a well-populated suburb of Athens (Marousi) and an urban area in central Greece, the city of Larissa (including its rural surroundings). Potential participants were selected through random sampling from municipality registries. In Figure 1, a flowchart describes the selection of the participants and the final sample size. In the present study, only participants with complete information on all lifestyle components were included ($N = 1726$, age: 72.8 ± 5.8 years, 59% women). All study assessments took place in day care centers for older people, the participants' homes, or municipal public health clinics and they were conducted by certified neurologists, neuropsychologists, and dieticians from January 2011 to October 2015. Written informed consent was provided by all participants and the study protocol was approved by the Ethics Committees of the University of Thessaly and the National and Kapodistrian University of Athens. Exhaustive information regarding medical and family history, lifestyle, diet, physical activity, and demographics was collected. Also, all participants received a neurological and neuropsychological evaluation through structured questionnaires, psychometric tests, and clinical evaluation. Details about study procedures and assessments have been previously published.[9] Table S1 presents a STROBE checklist[10] for the present study regarding the items that should be included in reports of observational studies.

2.2 | Dietary assessment

Dietary intake was assessed using a validated semiquantitative food frequency questionnaire (FFQ),[11] administered by registered dieticians. It consists of 69 questions on the consumption of foods or combination of foods, including dairy products, cereals, fruits, vegetables, meat, fish, legumes, added fats, alcoholic beverages, stimulants, and sweets, during the previous month. Using a 6-point scale ("never/rarely," "one to three times/month," "one to two times/week," "three to six times/week," "one time/day," and "more than two times/day"), participants were asked to indicate the absolute frequency of consuming a certain amount of food, expressed in grams, milliliters, or in other common measures, such as slice, tablespoon, or cup, depending on the food. Adherence to the Mediterranean dietary pattern was evaluated using the MedDietScore, an 11-item composite score calculated for each participant from the FFQ-based food consumption.[12] The scoring is based on the weekly consumption of 11 food groups (nonrefined cereals, fruits, vegetables, legumes, potatoes, fish, meat and meat products, poultry, full fat dairy, olive oil use, and alcohol) and a score of 0–5 is given for each of these food groups. Specifically, for the consumption of food groups presumed to be healthful components of the Mediterranean diet, that is, those with a recommended intake of three servings per week or more, such as nonrefined cereals, fruits, vegetables, legumes, fish, potatoes, and olive oil use, a score of 0 was assigned when the participants reported no consumption and scores 1–5 for rare to daily consumption. For the unhealthy food components of the pattern, scoring was assigned on a reverse scale, that is, from 5 when someone reported no consumption to 0 for daily consumption. For alcohol intake, it was assumed that small amounts of consumption were characteristic of the Mediterranean

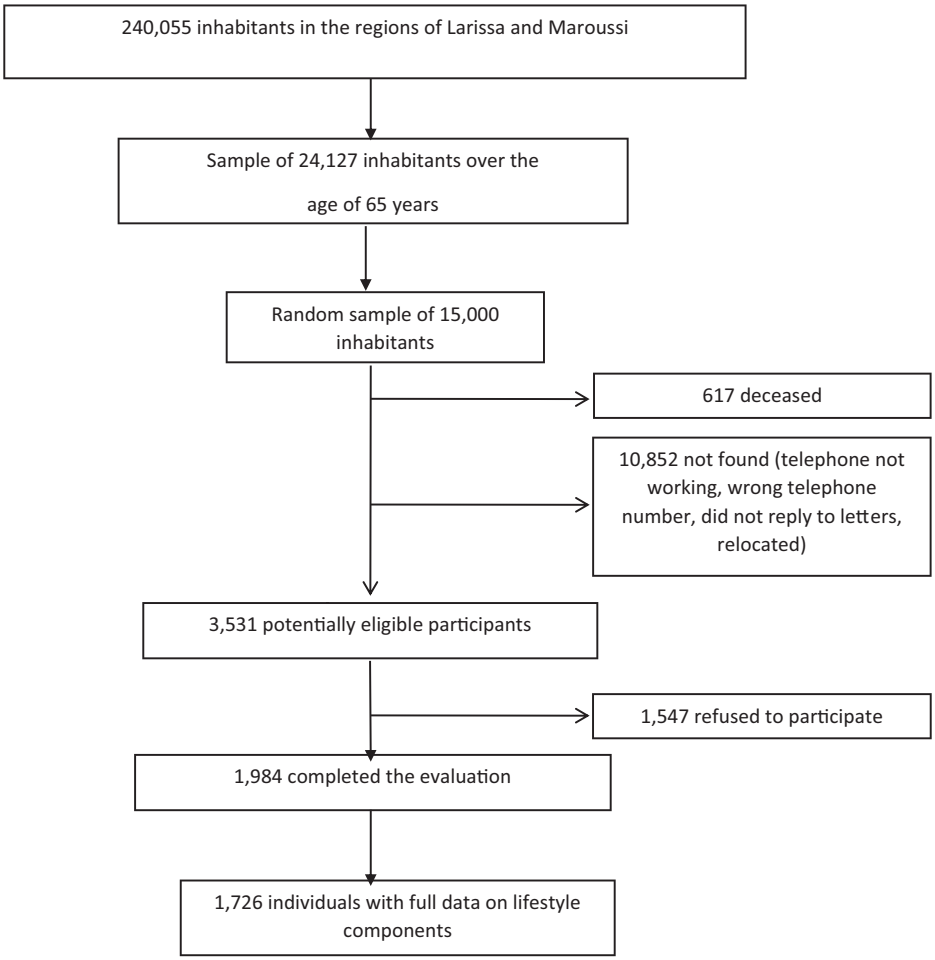

FIGURE 1 A flowchart of the participants' sampling

diet, whereas either high or no consumption was assumed to diverge from this dietary pattern. Thus, a score of 5 was assigned for consumption of less than 300 ml of wine/day but above 0 ml of wine/day, a score of 0 was assigned for no consumption or for consumption of 700 ml/day, and scores of 4–1 were assigned for consumption of 600–700, 500–600, 400–500, and 300–400 ml/day, respectively. All alcoholic beverages were converted into milliliters of wine, assuming that 12 g of ethanol correspond to 100 ml of wine. MedDietScore ranges between 0 and 55, with higher values indicating greater adherence to the Mediterranean diet.

2.3 | Physical activity and leisure time activities assessment

Physical activity assessment was conducted with the validated Athens Physical Activity Questionnaire (APAQ).[13] Participants were asked regarding their participation in physical activities in the last week and through this, time spent in occupational, household, and recreational activities, as well as sedentary and sleep time, was calculated. Based on the specific metabolic equivalent (MET), which corresponds to each of these activities, energy expenditure was calculated based on the participant's body weight in kilograms divided by 60. Thus, total energy expenditure was used as total MET-min/day, MET-min for household activities/day, and MET-min for resting/day.

Regarding the participants' involvement in common leisure time activities, a self-reported questionnaire was used[14]; they were asked to indicate the frequency of engaging in 23 common leisure time activities during the previous month, on a 5-point scale: 0 indicates participation in the activity once a year or less; 1, several times a year; 2, several times a month; 3, several times a week; and 4, every day or almost every day. The activities were divided into four subcategories[15]:

- Social activities: visiting friends or relatives, going out for a movie, theatre, restaurant, or sporting event, going on day or overnight trips, going to day care centers for older people, participating in groups and taking part in activities, offering unpaid community or volunteer work, maintaining paid employment, visiting museums, and attending religious services. The social activities score ranges from 0 to 36, with higher values indicating more frequent participation.
- Intellectual activities: reading newspapers, books, magazines, playing a musical instrument, knitting or spending time on any other hobbies, playing cards or chess, solving crossword puzzles, and taking classes. The intellectual activities score ranges from 0 to 28, with higher values indicating more frequent participation.

- Recreational activities: shopping, gardening, preparing meals, watching television, and listening to the radio. The recreational activities score ranges from 0 to 20, with higher values indicating more frequent participation.
- Physical activities: walking and exercising. The physical activities score ranges from 0 to 8, with higher values indicating more frequent participation.

The number of social contacts with friends or relatives during the previous month was also recorded, and it was expressed as number of social contacts per month.

2.4 | Sleep assessment

Sleep habits were assessed with the questionnaire Sleep Scale from the Medical Outcomes Study.[16] This is a self-report questionnaire consisting of 12 questions, and refers to the 4 weeks prior to the evaluation. Sleep quality was evaluated through the Sleep Index II [42], by summing up the following questions: (1) "How long did it usually take for you to fall asleep?" and "How often do you …"; (2) "Feel that your sleep was not quiet (moving restlessly, feeling tense, speaking, etc., while sleeping)?"; (3) "Get enough sleep to feel rested upon waking in the morning?"; (4) "Awake short of breath or with a headache?"; (5) "Feel drowsy or sleepy during the day?"; (6) "Have trouble falling asleep?"; (7) "Awake during your sleep time and have trouble falling asleep again?"; (8) "Have trouble staying awake during the day?": and (9) "Get the amount of sleep you needed?". The score for each of these questions ranges from 1 to 6, based on the frequency of the sleep problem. The total score for sleep quality, which ranges from 1 to 54, was reversed, so that higher values indicate better sleep quality, in order for the variable to be in accordance with the directionality of the other lifestyle variables. Furthermore, in order to examine sleep duration, participants were asked to report how many hours they slept each night during the past 4 weeks. For the analyses reported herein, self-reported total sleep duration was used in hours and as a continuous variable.

2.5 | Assessment of Activities of Daily Living (IADL)

Assessment of Activities of Daily Living was done using the IADL-extended scale, which evaluates functionality and capabilities relating to maintenance of self and lifestyle.[17] The scale contains nine questions, five of which refer to cognitive leisure time activities (going to classes, participating in community volunteer work, going out to a club or center activities, to the movies, restaurant, sporting event, and visiting friends or relatives in the last month) and four refer to more complex/advanced activities (having difficulties shopping, doing light housework, or getting around the neighborhood and needing help with medication). The answers to these questions were dichotomous (yes/no) and the total scale score ranges from 0 to 9, with higher values indicating a higher functional status regarding the aforementioned activities.

2.6 | Neuropsychological evaluation

Neuropsychological evaluation was conducted by trained neuropsychologists with an extensive battery of neuropsychological tests, lasting approximately 1 h, assessing all major cognitive domains: orientation, memory, language, attention and information processing speed, visual–spatial ability, and executive functions. In detail, orientation was tested using subtests of Mini Mental State Examination[18]; memory was evaluated with the Greek Verbal Learning Test (immediate and delayed recall)[19] and the Medical College of Georgia Complex Figure Test (immediate recall, delayed recall, and recognition)[20]; language was assessed with a semantic and phonological verbal fluency test,[21] subtests of the Greek version of the Boston Diagnostic Aphasia Examination short form, namely, the Boston Naming Test short form, and selected items from the Complex Ideational Material Subtest[22]; attention and information processing speed by subtests of Mini Mental State Examination[18] and the Trail Making Test Part A[23]; visual–spatial ability was tested with the abbreviated form of Benton's Judgment of Line Orientation,[24] the Medical College of Georgia Complex Figure Test (copy condition), and Clock Drawing Test[25]; and executive function with Part B of the Trail Making Test,[23] verbal fluency,[21] anomalous sentence repetition,[22] graphical sequence test, and motor programming.[26]

The raw values of the individual neuropsychological tests were converted into *z*-scores using mean and standard deviation values of the nondemented participants. Subsequently, the neuropsychological tests evaluating the same cognitive domain were grouped and a *z*-score for each cognitive domain was calculated. Finally, from the *z*-scores of the individual cognitive domains, a composite *z*-score was computed, indicating global cognitive functioning.

Based on the neuropsychological evaluation as well as the structured neurological examination, where neurological findings were documented, and after consensus meetings including all study investigators, the diagnosis of dementia was determined where appropriate, according to international criteria.[27,28]

2.7 | Statistical analyses

Statistical analyses were performed using STATA software. Nominally significant α values were defined as $p < 0.05$. Characteristics of the participants were expressed as mean values with standard deviations or as percentages. The correlations between the different lifestyle indices were examined by Pearson's correlation coefficients.

Regarding the principal component analysis (PCA), generated principal components are noncorrelated variables and their optimal number was chosen based on the Kaiser criterion of unit eigenvalue (greater than one) and the scree plot.[29] A variable was assigned to a particular component, if the corresponding component score was greater—in absolute value—than 0.3. Greater absolute values of component scores represent a greater impact of the corresponding variable on the component's construction. The components are presented after varimax rotation to simplify their structure and their interpretation.

We performed linear regression analyses in order to explore the relationships between the Total Lifestyle Indices as well as the lifestyle patterns (independent variables) and the cognitive domain composite scores as well as overall cognitive functioning composite score (dependent variables), excluding participants with dementia ($N = 60$ participants were diagnosed with dementia). All models were adjusted for sex, years of education, and age as these factors have been previously found to be associated with cognitive health.[30,31]

3 | RESULTS

3.1 | Lifestyle patterns development

Total Lifestyle Indices 1 and 2 were constructed based on healthy lifestyle recommendations, close to the Mediterranean lifestyle, that include adherence to a healthy diet, the Mediterranean diet, sleep, physical activity, functionality, and some aspects of social life. They were computed by taking into account each lifestyle factor in relation to the total distribution of the factor in our sample. For each factor except sleep duration, a score of 0 was given to an individual when the value was in the first quartile of the distribution of each specific factor (<25th percentile) and a value of 1, 2, or 3 when the value was within the second (≥25th percentile and <50th percentile), third (≥50th percentile and <75th percentile), or forth (≥75th percentile) quartile, respectively. For sleep duration, a score of 3 was given when sleep duration was within the recommended range, that is, 7–8 h/night,[29] and a score of 0 when sleep duration was above or below the recommended range. Thus, Total Lifestyle Indices 1 and 2 are the result of the sum of all the sub-scores of the lifestyle factors examined.

Specifically, the variables included in the Total Lifestyle Index 1 were as follows: adherence to the Mediterranean diet, sleep quality, sleep duration, total MET-min/day excluding sleep, frequency of social activities, and number of social contacts/month. Thus, the score for Total Lifestyle Index 1 ranges from 0 to 18, with higher values indicating a more beneficial lifestyle.

Total Lifestyle Index 2 consists of the following lifestyle factors: adherence to the Mediterranean diet, sleep quality, total MET-min/day excluding sleep, and instrumental activities of daily living. The total score for Total Lifestyle Index 2 ranges from 0 to 12, with higher values indicating a more beneficial lifestyle. This index has been previously used by members of our group to explore its association with cognitive health.[9]

The rationale for the use of two different a priori indices was to examine if slight changes in the composition of the indices would result in different outcomes. For example, in Total Lifestyle Index 1 we used the frequency of participation in social activities, as it has been shown to have positive associations with brain health,[32] and in Total Lifestyle Index 2, we used the Instrumental Activities of Daily Living, as the scale includes some social activities, but it also includes questions about difficulties in more complex activities, and it, also, has been proposed that this scale is sensitive to cognitive impairment.[33,34]

In order to investigate lifestyle profiles in our sample, PCA was used. The variables included were similar to those considered for the development of the indices, as described above, that is, adherence to the Mediterranean diet, sleep quality, sleep duration, total MET-min/day, total MET-min at household/day, total MET-min resting/day, number of social contacts/month, frequency of social activities, frequency of intellectual activities, frequency of physical activities, and frequency of recreational activities. Results from the PCA revealed four lifestyle profiles explaining 64% of the variance: the active pattern (characterized by high total MET-min/day, total MET-min at household/day and frequency of recreational activities, and low total MET-min resting/day), the Mediterranean diet and activities pattern (high adherence to the Mediterranean diet and high frequency of intellectual, physical, social, and recreational activities), the poor sleep pattern (low sleep duration and quality), and the Mediterranean diet and social contacts pattern (high adherence to the Mediterranean diet and high social activities and social contacts/month) (Table S2).

Correlations between the two Total Lifestyle Indices and the PCA patterns ranged from −0.634 to 0.816; these values correspond to the correlations between the "poor sleep pattern" and the Total Lifestyle Index 1, and between the Total Lifestyle Index 1 and the Total Lifestyle Index 2, respectively (Table S3).

3.2 | Associations between lifestyle patterns and cognition

The study population consisted of 1786 participants. The current analysis included only the dementia-free individuals, that is, 1726 participants, with a mean age of 72.8 ± 5.8 years. The mean values for Total Lifestyle Index 1 and 2 were 10.0 ± 3.2 and 6.1 ± 2.4, respectively (Table 1).

Results from linear regression analysis showed that higher values of the Total Lifestyle Index 1 were positively associated with executive functions, visual–spatial functions, and language *z*-scores as well as the overall cognitive functioning composite score, indicating better global cognitive functioning, after adjustment for age, sex, and years of education. Total Lifestyle Index 2 was positively associated with better global cognitive functioning and with higher memory, executive functions, visual–spatial perception, and language. Specifically, every unit increase in the Total Lifestyle Index 2 was associated with 9.8%, 7.1%, 6.8%, 7.2%, and 8.5% higher odds for better memory, executive function, visual–spatial perception, language, and total cognitive functioning, respectively.

With regard to the lifestyle patterns emerged from the PCA, the Mediterranean diet and activities pattern was positively associated with memory, executive function, language, and attention–speed as well as with global cognitive functioning, again after adjustment for age, sex, and years of education (Table 2). What is more, the Mediterranean diet and social contacts pattern was positively connected with memory and executive functions, as well as with global cognitive functioning.

TABLE 1 Demographic characteristics and lifestyle factors of the total study sample, excluding participants with dementia

	All participants ($N = 1726$)
Age (years)	72.8 ± 5.8
Sex (% women)	59
Education (years)	7.7 ± 4.7
Memory	−0.1 ± 0.9
Executive functions	−0.2 ± 0.8
Visual–spatial perception	−0.1 ± 0.9
Language	−0.1 ± 0.8
Attention–speed	−0.2 ± 1.0
Global Cognitive Functioning	−0.1 ± 0.7
MedDietScore (0–55)	33.4 ± 4.5
Total MET-min/day (per 200)	8.9 ± 1.1
Total MET-min/day at household (per 200)	4.7 ± 2.2
Total MET-min resting/day (per 200)	4.0 ± 1.6
Frequency of intellectual activities (0–28)	5.9 ± 4.3
Frequency of physical activities (0–8)	2.2 ± 2.2
Frequency of social activities (0–36)	7.4 ± 4.3
Frequency of recreational activities (0–20)	11.9 ± 3.7
Number of social contacts (the last month)	15.3 ± 18.2
Sleep Quality (1–54)	37.3 ± 7.8
Sleep Duration (h/day)	6.5 ± 1.5
Instrumental Activities of Daily Living (0–9)	4.8 ± 1.2
Total Lifestyle Index 1 (0–18)	10.0 ± 3.2
Total Lifestyle Index 2 (0–12)	6.4 ± 2.4

4 | DISCUSSION

This was a cross-sectional study examining the associations between different lifestyle patterns, based on the Mediterranean lifestyle, using *a priori* and *a posteriori* methods, and cognitive function in older adults. The results showed that a Mediterranean lifestyle was positively associated with almost all major cognitive domains as well as the global cognitive functioning in older adults without dementia, irrespective of the method used. Although previous studies have extensively examined the association of the Mediterranean diet with cognitive health,[35–37] this study expands the previous findings, as we showed that the effect of the Mediterranean lifestyle is positively connected with cognitive health. Thus, along with adherence to the Mediterranean dietary pattern, our results support that clustering of healthy behaviors that constitute a Mediterranean-like living has a protective effect on cognition.

The approach of incorporating different lifestyle factors into a lifestyle index has many benefits to offer in comparison with the study of the individual factors, as the associations between different lifestyle factors and health may be weak and, thus, more difficult to detect. However, there is no consensus regarding which lifestyle factors should be incorporated in the indices and whether they should be

TABLE 2 Results from linear regression analyses that evaluated the association between Total Lifestyle Index 1 and Total Lifestyle Index 2 and the lifestyle profiles emerged from the PCA (independent variable) and *z*-scores of cognitive functions (dependent variables), excluding participants with dementia

	Lifestyle		Lifestyle		Lifestyle profiles							
	Index 1		Index 2		"active pattern"		"Mediterranean diet and activities pattern"		"poor sleep pattern"		"Mediterranean diet and social contacts pattern"	
Cognitive domains	*Beta*	*p*	*Beta*	*p*	*Beta*	*p*	*Beta*	*p*	*Beta*	*p*	*Beta*	*p*
Memory *z*-score	0.011	0.089	0.098	**<0.001**	−0.031	0.274	0.104	**<0.001**	0.045	0.156	0.104	**0.001**
Executive functions *z*-score	0.014	**0.007**	0.071	**<0.001**	0.038	0.226	0.196	**<0.001**	0.036	0.289	0.091	**0.008**
Visual–spatial functions *z*-score	0.013	**0.033**	0.068	**0.003**	−0.041	0.147	0.052	0.064	−0.032	0.306	0.033	0.298
Language *z*-score	0.013	**0.016**	0.072	**<0.001**	−0.008	0.809	0.201	**<0.001**	0.006	0.871	0.043	0.252
Attention–speed *z*-score	0.009	0.300	0.039	0.084	0.031	0.313	0.144	**<0.001**	0.027	0.416	−0.013	0.706
Composite *z*-score	0.012	**0.011**	0.085	**<0.001**	−0.006	0.855	0.203	**<0.001**	0.030	0.422	0.085	**0.023**

Note: In all models, age, sex, and years of education were entered as confounders. Bold values indicate statistically significant results.

differentiated depending on the studied outcome. To the best of our knowledge, this was the first study to examine the association of cognition and lifestyle using different approaches for pattern development, both hypothesis driven and exploratory. All three patterns showed significant positive relationships with cognitive domains as well as with the global cognitive functioning. Thus, independently of the definition used and the individual lifestyle factors incorporated, a healthy lifestyle, close to the concept of the Mediterranean lifestyle, is positively associated with cognition.

Interestingly, in relation to the *a posteriori-derived* patterns, the lifestyles that were characterized (apart from other lifestyle factors) by the adherence to the Mediterranean diet were positively associated with various cognitive domains as well as with the global cognitive functioning, in contrast to lifestyle patterns that were characterized only by physical activity or sleep. This finding may suggest that diet is an essential parameter in a lifestyle pattern, and this is especially true for a Mediterranean lifestyle, as the whole concept of it started from the Mediterranean diet. Indeed, Mediterranean diet has been extensively associated with cognitive outcomes,[35–37] whereas research regarding the other factors is more limited. However, more studies are needed to further elucidate this issue and to determine whether this is true only for cognitive outcomes or for other health effects, as well.

The results of the present study should be interpreted in the context of its strengths and limitations. Participants were selected through random sampling and thus we ensured that the sample was random and representative. Furthermore, a detailed clinical and neuropsychological evaluation was conducted by dementia experts, allowing for a classification of the participants' cognitive status and enabling us to exclude participants with dementia from the analyses. What is more, all the questionnaires used for the assessment of the lifestyle factors have been previously used in the older population.[38–40] Another important strength is that both *a priori* and approaches were used for the extraction of the patterns. However, the study also has some limitations. Due to the cross-sectional design, causal relationships cannot be determined; we cannot know if the participants with a healthier lifestyle had better cognition or whether those with better cognition also had a more beneficial lifestyle. Also, all the lifestyle behaviors were self-reported by the participants, but this is a common characteristic of observational studies. Finally, we used the equal weighting approach for the construction of the indices, as there is not enough evidence regarding the impact of the individual components on cognitive health.

Our results showed that a healthy lifestyle, based on the principles of the Mediterranean lifestyle, independently of the approach used, was positively connected with cognitive function in dementia-free older adults. Although these findings need to be replicated in other populations, close or not to the Mediterranean diet and lifestyle, we suggest that the effect of overall lifestyle, above and beyond particular lifestyle factors, is important for cognitive health. In any case, health professionals should routinely target lifestyle as a whole for assessment and intervention in older adults, rather than the particular lifestyle factors, especially if cognitive impairment is evident.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Kosmidis and Yannakoulia conceptualized and designed the study. Mamalaki and Poulimeneas analyzed and interpreted the data. Mamalaki drafted the manuscript. Poulimeneas, Kosmidis, and Yannakoulia contributed in critical revision of manuscript for important intellectual content and final approval of version to be published.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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