FACTORS ASSOCIATED WITH COMPONENTS OF ARTERIAL PRESSURE AMONG OLDER INDIVIDUALS (THE MULTINATIONAL MEDIS STUDY): THE ROLE OF THE MEDITERRANEAN DIET AND ALCOHOL CONSUMPTION

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ABSTRACT

Aim of this work was to evaluate factors associated with arterial blood pressure in a sample of older Mediterranean people without known cardiovascular disease. During 2005-2011, 2,813 older (aged 65-100 years) individuals from 22 Mediterranean islands and the rural Mani region (Peloponnesus) were voluntarily enrolled. Standard procedures were used to determine arterial blood pressure, as well as pulse pressure, and for the evaluation of dietary habits (including tea and alcoholic beverages consumption), lifestyle, anthropometric and clinical characteristics of the participants. Participants who reported low alcohol drinking (i.e., 0-1 glasses/day) were less likely to have hypertension [OR=0.34 (95%CI): 0.14 to 0.83] as compared with those reported high (i.e., 5+ glasses/day). Adherence to the Mediterranean diet was inversely associated with mean arterial pressure [b-coefficient (95% CI): -0.18 (-0.33 to -0.03)]. Alcohol drinking remains an important modifiable risk factor for hypertension. Adherence to the Mediterranean diet was associated with decreased arterial peripheral resistance. **Key words**: hypertension; Mean Arterial Pressure; Pulse Pressure; elders; alcohol; Mediterranean diet. *J Clin Hypert (Greebnwich) 2014;*

INTRODUCTION

According to the World Health Organization, arterial hypertension constitutes an important modifiable risk factor related to 4.5% of the worldwide disease burden and associated with approximately 40% reduction of the stroke risk and 15% reduction of the myocardial infarction risk, when treated and controlled[1]. Due to improved longevity rates in developed countries, hypertension constitutes a major public health problem, especially in older adults, affecting half of those aged 60 to 69 years old and around three quarters of those aged more than 70 years old[2].

Recently it has been reported that the use of components of blood pressure measurement [i.e., mean arterial pressure (MAP) and pulse pressure (PP)] different from the traditional ones [systolic blood pressure (SBP) and diastolic blood pressure (DBP)] provides a broader image in the prediction of cardiovascular (CVD) risk[3]. MAP is a measure of cardiac output and peripheral resistance[3,4], whereas PP reflects the stiffness of the large arteries which increases with advancing age (>50 years old), because of opposing trends in SBP and DBP[5-7]. It has been reported that the ageing process plays a major role in shifting the relation of blood pressure components to CVD risk[8].

In parallel, anthropometric parameters and dietary patterns constitute, among genetic, socio-demographic and other factors, important determinants of arterial blood pressure. Among dietary patterns, the Mediterranean diet has been regarded as a healthy one, exhibiting favorable associations with various CVD risk factors[9,10]. As a component of the Mediterranean diet, alcohol restriction has been shown to be an effective lifestyle intervention for both systolic and diastolic blood pressure reduction[11]. Specifically, the dose-response relationship of alcohol and blood pressure has been found to be either linear or J-shaped[12,13], while the dose-response relationship of alcohol and coronary heart disease is J-shaped only[14].

Regarding blood pressure, Mediterranean diet has been shown to have a neutral association with the incidence of hypertension and an inverse relationship with both systolic and diastolic arterial pressure in follow-up studies[15]; in addition, cross-sectional studies in Greece have reproduced an inverse association between adherence to the Mediterranean diet and hypertensive status in Mediterranean populations[9,16]. To date, a series of studies have investigated the role of Mediterranean diet in blood pressure taking into account the traditional measurements (SBP, DBP and hypertension). However, to the best of our knowledge, no one has investigated the role of the Mediterranean diet and other dietary components in blood pressure hydraulic loads (PP and MAP) in older Mediterranean adults.

Given the alarming increase in the hypertension rates of older adults, the complexity of arterial blood pressure and the lack of MAP and PP data among Mediterranean populations, the aim of the present work was to

evaluate the role of various factors in different components of arterial blood pressure, in a random sample of older adults living in the Mediterranean basin and participating in the multinational MEDIS (MEDiterranean ISlands) study[10].

METHODS

The MEDIS Study sample

During the period 2005-2011, a population-based, multi-stage convenience sampling method was used to voluntarily enroll elders from 22 Mediterranean islands: Republic of Cyprus (n=300), Malta (n=250), Sardinia (n=60) and Sicily (n=50), Balearic Islands (Mallorca and Menorca, n=111), the Greek islands of Mitilini (n=142), Samothraki (n=100), Cephalonia (n=115), Crete (n=131), Corfu (n=149), Limnos (n=150), Ikaria (n=76), Syros (n=151), Naxos (n=145), Zakynthos (n=103), Salamina (n=147), Kassos (n=52), Rhodes and Karpathos (n=149), Tinos (n=129) and Evoia (n=150), as well as from the rural region of Mani (n=153) (a southern Greek peninsula). According to the study protocol, individuals were not eligible for inclusion if they resided in assisted-living centers, had a clinical history of CVD or cancer, or had lived away from the island for a considerable period of time during their lives (i.e., >5 years); these exclusion criteria were applied because the study aimed to assess lifestyle habits that were not subject to modifications due to existing chronic health conditions or by environmental factors, other than living milieu. A group of health scientists (i.e., physicians, dietitians and nurses) with experience in field investigation collected all the required information using a quantitative questionnaire and standard procedures.

Bioethics

The study followed the ethical considerations provided by the World Medical Association (52nd WMA General Assembly, Edinburgh, Scotland, October 2000). The Institutional Ethics Board of Harokopio University approved the study design (16/19-12-2006). Participants were informed about the aims and procedures of the study and gave their consent prior to being interviewed.

Evaluation of clinical characteristics

All the measurements taken in the different study centres were standardized. Weight and height were measured using standard procedures to attain body mass index (BMI) scores (kg/m^2). A standard procedure was also used for the measurement of waist circumference. Overweight was defined as BMI between 25 and 29.9 Kg/m^2, while obesity was defined as BMI > 29.9 Kg/m^2. Diabetes mellitus (type 2) was determined by fasting plasma glucose tests and was analyzed in accordance with the American Diabetes Association diagnostic criteria (glycated haemoglobin A1C$\geq$6.5 or fasting blood glucose levels greater than 125 mg/dL or 2-h plasma glucose > 200 mg/dL during an oral glucose tolerance test (OGTT) or a random plasma glucose > 200 mg/dL, or by a prior diagnosis of diabetes).

Blood pressure was measured by trained physicians or nurses and having participant in a sitting position and calm; an average of the three measurements was calculated. Participants who had systolic/diastolic blood pressure levels $\geq$140/90 mmHg or used antihypertensive medications were classified as hypertensive. Moreover, mean arterial pressure (MAP) and the pulse pressure (PP) were calculated. Specifically MAP was calculated using the equation: MAP= [(2*diastolic pressure) + systolic pressure]/3. The PP was calculated with the formula: PP= Systolic pressure – Diastolic pressure[4,17]. Fasting blood lipid levels (HDL-, LDL-cholesterol and triglycerides) were also recorded and hypercholesterolemia was defined as total serum cholesterol levels >200 mg/dL or the use of lipid-lowering agents according to the NCEP ATPIII guidelines[18].

Evaluation of dietary habits, socio-demographic and other lifestyle characteristics

Dietary habits were assessed through a semi-quantitative, validated and reproducible food-frequency questionnaire[19]. Frequency of consumption of various food groups and beverages (i.e., meat and products, fish and seafood, milk and other dairy, fruits, vegetables, greens and salads, legumes, cereals, coffee and tea and soft-drinks) on daily, weekly or monthly basis, was assessed. Since non-caffeinated coffee and tea was poorly consumed by the participants (<1%) they were not included in the analyses. Furthermore, consumption of various alcoholic beverages (i.e., wine, beer, whiskey, vodka, and the traditional ouzo, tsipouro and retsina) was measured in terms of wineglasses per day, adjusted for ethanol intake (e.g., one 100 ml glass of wine was considered to have 12% ethanol) and classified into never/rare (i.e., no alcohol drinking), 0-1 glasses/day, 2 glasses/day, 3-4 glasses/day and 5 or more glasses/day. To evaluate the level of adherence to the Mediterranean diet, the MedDietScore (theoretical range 0-55) was used[20]. Higher values for this diet score indicate greater adherence to the Mediterranean diet.

Basic socio-demographic characteristics such as age, gender, years of education, urban residence, financial status, and lifestyle characteristics, such as living alone, smoking habits and physical activity status, were also recorded. Regarding financial status, participants were asked to report their financial status considering their mean income during the previous three years according a four-point scale (low, inadequate to cover daily expenses= 1, medium, trying hard to cover daily expenses = 2, good, adequate to cover daily expenses = 3, high, very adequate to cover daily expenses = 4); this scale was decided upon because of the variety of the populations studied, as well as the common difficulty of accessing exact financial data. The participants that were in the upper category were classified as participants with high financial status while all the others were classified as low and medium financial status (high vs. low-medium financial status). Current smokers were defined as smokers at the time of the interview. Ever smokers were defined those that reported smoking during life course. Physical activity was evaluated in MET-minutes per week, using the shortened, translated and validated Greek version of

the self-reported International Physical Activity Questionnaire (IPAQ)[21]. Minimally active - or "health enhancing physical activity (HEPA) active"- were classified those who reported at least 3 MET-minutes per week and considered for the purposes of this work as physically active.

Further details about the MEDIS study protocol may be found elsewhere[10,22].

Data analysis

Prevalence of hypertension was calculated as the rate of cases divided by the study sample. Normally distributed continuous variables were presented as mean ± SD and categorical variables as frequencies. Comparisons of continuous variables between groups were performed using the independent samples t-test (for normal distribution) and the Mann-Whitney U-test (for skewed distribution). Multiple logistic regression analysis was estimated in order to evaluate the association between the presence of hypertension (dependent outcome) and participant characteristics (i.e., age, sex, urban residence, living education and financial status, current smoking habits, bio-clinical factors) (independent variables). Hosmer-Lemeshow criterion was used to evaluate model's goodness-of-fit. Moreover multiple linear regression analysis was performed in order to evaluate the association between the level of MAP and PP (dependent outcomes) and participant characteristics (i.e., age, sex, urban residence, living alone education and financial status, smoking habits, bio-clinical factors) (independent variables). Colinearity was tested using the Variance Inflation Factor criterion (VIF; values >4 suggested colinearity between independent variables and one of them was excluded from the model). The assumption of homoscedasticity was tested by plotting the scatter plot of standardised residuals over the predicted score values. Results from linear regression models are presented as b-coefficients and their 95% Confidence Intervals. All reported *p*-values were based on two-sided tests. SPSS software (version 20) was used for all calculations (IBM Statistics, Greece).

RESULTS

Of the total sample of 2,813 participants, 1,674 (61%) had hypertension (57% in males and 66% in females, p<0.001). However when the seven geographical areas of the participants were taken into account (West Mediterranean, Ionian, Aegean, Saronikos islands, Crete island, Mani, and Cyprus Republic), the inhabitants of Crete had the highest prevalence of hypertension (i.e., 84%) while the participants living in the West Mediterranean islands (Malta, Sardinia, Sicily, Balearic islands) had the lowest (i.e., 46%) (p<0.001). In ***Table 1*** factors associated with the prevalence of hypertension among older Mediterranean natives, are presented. Compared with normotensive, the hypertensive subjects were less physically active (p=0.06), less educated, fewer smokers (p<0.001), had lower financial status (p=0.02), reported lower alcohol drinking (p=0.05), and higher tea drinking (p=0.007), they were more likely living alone (p=0.007), and they had higher prevalence of obesity, diabetes, hypercholesterolemia, higher levels of BMI (p<0.001) and higher levels of MAP, PP (p<0.001).

Table 1. Socio-demographic, clinical and lifestyle characteristics in relation to hypertension status of the multinational MEDIS study participants.

	Normal	**Hypertensive**	***p***
N	*1058*	*1674*	
Male sex (%)	55%	46%	<0.001
Age (years)	73.3±7.6	74.5±7.1	<0.001
Older adults (>80 yrs) (%)	39%	28%	0.12
Living in urban areas (%)	58%	62%	0.08
Education status (in school years)	7.0±4.1	6.6±3.8	<0.001
High financial status[1] (%)	22%	17%	0.02
Living alone (%)	22%	27%	0.007
Diabetes (%)	14%	27%	<0.001
Hypercholesterolemia (%)	35%	57%	<0.001
Obesity (%)	25%	38%	<0.001
Body Mass Index (kg/m^2)	27.7±10.0	29.0±4.8	<0.001
Systolic blood pressure (SBP) (mm Hg)	127±14	140±17	<0.001
Diastolic blood pressure (DBP) (mm Hg)	76±9	79±11	<0.001
Mean arterial pressure (mm Hg)	93±10	99±11	<0.001
Pulse pressure (mm Hg)	51±13	60±16	<0.001
Current smoking (%)	19%	13%	<0.001
Physically active[2] (%)	61%	42%	0.06
MedDietScore (0-55)	32.6±5.3	32.7±5.0	0.68
Alcohol drinking (% daily drinking, >1 glass)	50%	46%	0.05
Coffee drinking (% daily drinking, >1 cup)	82%	82%	0.92
Tea drinking (% daily drinking, >1 cup)	36%	41%	0.007

p-values were derived using t-test for the continuous variables or the chi-square test for the categorical variables. [1] financial status was defined using the mean income during the previous three years, *high* was considered very adequate to cover daily expenses according to participants' reports. [2] were defined those who had engagement in physical activities with at least 3 MET-minutes per week expenditure.

After adjusting for age, gender, urban residence, physical activity, living alone, education and financial status, smoking habits, adherence to the Mediterranean diet, alcohol, tea and coffee consumption, it was

revealed that diabetic, obese and hypercholesterolemic older adults were at a greater likelihood of having hypertension (***Table 2***). Greater adherence to the Mediterranean diet was beneficially associated with the presence of hypertension (p<0.08). Moreover, it was found that alcohol drinking (i.e., 0-1 glasses per day) [OR=0.34 (95% CI): 0.14 to 0.83] was associated with less likelihood of being hypertensive, compared with the high alcohol consumption (i.e., 5+ glasses per day).

Table 2. Factors associated with the presence of hypertension among older individuals living in the Mediterranean basin (the multinational MEDIS study).

	Odds Ratio	**95% CI**
Age (per 1 year)	1.06*	1.03 to 1.09
Sex (Male vs. Female)	0.73	0.46 to 1.15
Urban vs. Rural area of residence	1.39	0.97 to 1.99
Education (per 1 year)	1.02	0.97 to 1.07
Living alone (Yes vs. No)	1.49	0.95 to 2.32
High financial status (Yes vs. No)	1.36	0.87 to 2.13
Diabetes (Yes vs. No)	2.02*	1.25 to 3.26
Hypercholesterolemia (Yes vs. No)	1.85*	1. 30 to 2.62
Obesity (Yes vs. No)	2.16*	1.44 to 3.25
Smoking current (Yes vs. No)	0.74	0.49 to 1.12
Physical activity (Yes vs. No)	1.18	0.82 to 1.72
MedDietScore (per 1/55 unit)	0.96	0.92 to 1.00
Daily coffee drinking (Yes vs. No)	1.42	0.85 to 2.37
Daily tea drinking (Yes vs. No)	1.11	0.77 to 1.59
Alcohol drinking		
5+ glasses of wine/day		Ref category
0-1 glasses of wine/day	0.34*	0.14 to 0.84
2 glasses of wine/day	0.41	0.16 to 1.03
3-4 glasses of wine/day	0.51	0.19 to 1.22

*p-values <0.05. Results are presented as Odds Ratios and their corresponding 95% confidence intervals (CI). Reference categories are "No", otherwise stated (e.g., alcohol drinking).

In order to assess a wider spectrum of arterial blood pressure indices, the relation of MAP and PP with a variety of factors was evaluated (***Table 3***).

Table 3. Results from regression models that evaluated factors associated with pulse pressure (PP) and mean arterial pressure (MAP) among older individuals living in Mediterranean basin (the multinational MEDIS study).

Model for pulse pressure	**b coefficient**	**95% CI**
Age (per 1 year)	0.003	-0.14 to +0.14
Sex (Male vs. Female)	-0.53	-2.76 to +1.70
Living in urban area (vs. Rural)	0.06	-1.90 to +2.02
Education status (per 1 year)	-0.38*	-0.69 to -0.07
Living alone (Yes vs. No)	2.19*	+0.05 to +4.33
High financial status (Yes vs. No)	3.00*	+0.41 to +5.60
Diabetes (Yes vs. No)	3.21*	+1.01 to +5.41
Hypercholesterolemia (Yes vs. No)	-1.37	-3.30 to +0.55
Obesity (Yes vs. No)	3.18*	+1.21 to +5.15
Smoking current (Yes vs. No)	-1.04	-3.87 to +1.79
Physical activity (Yes vs. No)	-2.26*	-4.25 to -0.28
MedDietScore (per 1/55 unit)	-0.09	-0.33 to +0.15
Daily coffee drinking (Yes vs. No)	0.85	-1.68 to +3.39
Daily tea drinking (Yes vs. No)	1.05	-0.82 to +2.94
Daily alcohol drinking (Yes vs. No)	1.34	-0.73 to +3.41
Model for mean arterial pressure	**b coefficient**	**95% CI**
Age (per 1 year)	0.04	-0.05 to +0.13
Sex (Male vs. Female)	-0.36	-1.85 to +1.13
Living in urban area (vs. Rural)	-0.18	-1.49 to +1.25
Education status (per 1 year)	-0.10	-0.31 to +0.10
Living alone (Yes vs. No)	1.14	-0.28 to +2.57
High financial status (Yes vs. No)	1.86*	+0.07 to +3.64
Diabetes (Yes vs. No)	0.85	-0.61 to +2.32
Hypercholesterolemia (Yes vs. No)	0.47	-0.81 to +1.75
Obesity (Yes vs. No)	1.51*	+0.20 to +2.82
Smoking current (Yes vs. No)	0.31	-1.58 to +2.20
Physical activity (Yes vs. No)	0.89	-0.43 to +2.21
MedDietScore (per 1/55 unit)	-0.18*	-0.33 to -0.16
Daily coffee drinking (Yes vs. No)	-0.17	-1.86 to +1.52
Daily tea drinking (Yes vs. No)	0.88	-0.37 to +2.14
Daily alcohol drinking (Yes vs. No)	-1.17	-2.55 to +0.21

*p-values <0.05. Results are presented as b-coefficients and their corresponding 95% confidence intervals (CI). Otherwise stated (e.g., alcohol drinking), the reference categories are the "No" group.

After adjusting for various confounders, the education status [b-coefficient (95% CI): -0.38 (-0.69 to -0.07)] and the physical activity [b-coefficient (95% CI): -2.26 (-4.25 to -0.28)] were inversely associated with PP, while, obesity [b-coefficient (95% CI): 3.18 (+1.21 to +5.15)], diabetes [b-coefficient (95% CI): 3.21 (+1.01 to +5.41)], living alone [b-coefficient (95% CI): 2.19 (+0.05 to +4.33)] and high financial status [b-coefficient [b-coefficient (95% CI): 3.00 (+0.41 to +5.60)] were positively associated with PP. Moreover, adherence to the Mediterranean diet [b-coefficient (95% CI): -0.18 (-0.33 to -0.16)] was inversely associated with the levels of MAP, while a positive association was observed with obesity [b- coefficient (95% CI): 1.51 (+0.20 to +2.82)], and high financial status [b-coefficient (95% CI): 1.86 (+0.07 to +3.64)].

DISCUSSION

The present work revealed high levels of morbidity (ie., obesity, hypercholesterolemia, diabetes, etc.) and high levels of MAP and PP among the older Mediterranean hypertensive islanders. According to recent evidence on the use of MAP (indicator of arterial resistance) and PP (indicator of arterial stiffness), these two major cardiac hydraulic load components offer a wider image of CVD risk[3]. Following this approach multi-adjusted analysis revealed that, greater adherence to the Mediterranean diet was associated with lower MAP levels and tended to be inversely associated with the presence of hypertension. Furthermore, low and medium alcohol consumption is a part of the traditional holistic Mediterranean diet[20]. Data analysis revealed that alcohol restriction compared with high alcohol consumption, was inversely associated with the presence of hypertension, irrespective of the age, gender, urban residence, smoking habits, education and financial level, physical activity, obesity, diabetes, hypercholesterolemia, adherence to the Mediterranean diet, tea and coffee drinking. The aforementioned relationships among MAP, PP and different socio-demographic and bio-clinical factors, especially among older adults of the Mediterranean basin, have rarely been studied.

Older hypertensive subjects in the Mediterranean basin were more likely to be obese, diabetic, hypercholesterolemic and less physically active in the analyzed multinational dataset of the MEDIS study. All the aforementioned clinical and lifestyle factors are well-known determinants of abnormal arterial blood pressure[9]. Possible mechanisms of the aforementioned clinical factors (such as obesity, diabetes, etc.) among the hypertensive subjects, might be attributable to the patho-biological pathway of insulin resistance, sympathetic nervous system activation, systemic inflammatory molecules or leptin levels[23,24].

Multi-adjusted analysis revealed an inverse association between adherence to the Mediterranean diet and the presence of hypertension among older adults. Strong, inverse associations between Mediterranean diet and hypertension in the Mediterranean basin have already been reported from other investigators studying middle aged populations[9,25]. The Mediterranean diet is highly protective throughout its variation of dietary components. High amounts of vegetable, fruits, olive oil, and especially virgin olive oil, tree nuts and walnuts are mainly responsible for the apparent protection against hypertension conveyed by the Mediterranean diet[25,26,27]. Moreover intake of fermented alcohol beverages is an important component of the Mediterranean diet, which is beneficially related to hypertension and abnormal blood pressure levels[20,28].

Additionally, an inverse association between alcohol drinking per glasses/day and the likelihood of being hypertensive was found. In previous preliminary results of the MEDIS study (only for the Greek islands), a J-shaped association was observed between alcohol consumption and arterial blood pressure levels[29]. According to a recent meta-analysis of 12 cohort studies[12], a linear dose-response relationship was revealed in males (RR 1.57 at 50 g alcohol per day), whereas for females, a significant protective effect was reported for consumption at or below about 5 g/day, after which a similar linear dose-response relationship was observed. However until now, dietary interventions to lower systolic and diastolic blood pressure have been analysed mainly in adults and to a lesser extent in the older adults[16,30].

Increased PP has been shown to promote the development of atherosclerosis[31,32] and may increase the likelihood of plaque rupture throughout the fatiguing effects of pulsatile strain[33]. Moreover an independent association between PP and carotid artery disease[34] and small-vessel disease[35] has been described. PP is recognized as an independent determinant of CVD risk in middle-aged and older individuals[7]. MAP is another indicator of arterial blood pressure and is reporting the arterial blood volume and the arterial and vessels compliance. For this reason is an indicator of multi-organ and tissues perfusion[4]. Abnormal levels of MAP are reported to affect peripheral resistance, which may produce changes in the length and diameter of vessels and changes in the vascular network[4,36]. Despite evidence regarding the beneficial effect of adherence to the Mediterranean diet, of alcohol drinking and the presence of hypertension[9,25], and of high levels of SBP and DBP[16], information about their role in a wider spectrum of arterial blood pressure such as MAP and PP is sparse, and particularly so for the older population. Moreover throughout the multinational MEDIS data analysis, the greater the adherence to the Mediterranean diet, the lower was the levels of MAP. It may be speculated that the reduction of oxidative stress, the anti-inflammatory effect, the beneficial effect on lipid profiles and the improvement in endothelial function[37,38] are the possible mechanisms of the aforementioned favorable association between the Mediterranean diet and MAP[39,40]. Moreover, there was no association between MAP, PP and alcohol drinking; this lack of relationship could be attributed to the physiological hemodynamic nature (i.e., steady flow load and pulsative load) of these indicators that differentiates them from the medical history of hypertension. However clinical investigations have reported the beneficial association between alcohol consumption and improvement in postprandial endothelial function[41,42].

Throughout the data analysis there was reported to be heterogeneity in the determinants related to PP and MAP. However this analysis revealed that obesity was the clinical factor that was consistently related with either the presence of hypertension and with the increase in the levels of PP and MAP. Obesity in older adults is a complex subject[43], firstly due to the probable decline in the added risk for hypertension with increasing age, and secondly due to the paradoxical obesity consequences in hypertensive health of the older adults[23,44]. As recently been outlined by the American Heart Association Professional Education Committee of the Council for High Blood Pressure Research, older age and obesity are two of the most powerful risk factors for the control of hypertension[45], showing that obesity is a risk factor for hypertension in general, but also a risk factor for uncontrolled treated hypertension. Hypertension is quite complex[46,47] and a variety of components other than the classical ones of blood pressure could offer a broader image to increase understanding of the disease, especially among the older[48].

Strengths and limitations

The present study has several strengths. It is one of the few to evaluate the effect of various factors (clinical, socio-demographic and lifestyle), MAP, PP of a large sample of 'healthy', independently-living older people in the Mediterranean basin. Among limitations, the fact that this is a cross-sectional study limits the possibility for aetiological conclusions; in addition, there is always a bias in self-reported questionnaires where drinkers underreport their alcohol consumption and hypertensive persons over-report it. Also, specific drinking patterns were not assessed. Another finding that that may have been altered due to the cross-sectional nature of the study is for smoking habit, which no significant association with blood pressure measurements was observed as expected (probably older participants have modified their smoking habits not only because of age, but also because of known co-morbidities).

Conclusion

Greater adherence to the Mediterranean diet and moderate alcohol drinking seems to constitute a key-point for public health preventive action. In addition, obesity seems to be a common risk factor for hypertension among older people, as well as for increased arterial resistance (MAP) and arterial stiffness (PP). Taking into account that treatment of hypertension constitutes a complex process, especially for older individuals[48], where co-morbidities exist, that includes many lifestyle changes, as well as special medication, promotion of healthy dietary habits close to the Mediterranean type of diet may constitute an effective, non-pharmacologic mean for the management of blood pressure levels as well as weight control.

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Conflict of interest

None of the authors have any conflict of interest related to this project

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