A Mediterranean Lifestyle Is Associated With Lower Hypertension Prevalence and Better Aerobic Capacity Among New England Firefighter Recruits

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Objective: Examine the association between healthy Mediterranean lifestyle practices and cardiovascular disease (CVD) risk factors among New England firefighter recruits. **Methods:** A MEDI-Lifestyle score was used to measure adherence to a Mediterranean lifestyle (not smoking, increased physical activity, high adherence to Mediterranean diet, non-obese body mass index, decreased screen time, adequate nightly sleep, and napping) among the recruits. MEDI-Lifestyle scores were cross-sectionally analyzed with blood pressure, aerobic capacity, and other CVD risk factors. **Results:** Among 92 recruits, high adherence to MEDI-Lifestyle was significantly associated with a decreased risk of prevalent hypertension (odds ratio [OR] = 0.14 [0.03–0.71]) and a greater probability of high aerobic capacity (OR = 5.80 [1.05–32.05]) as compared with low adherence in age- and sex-adjusted analyses. **Conclusions:** Increased adherence to MEDI-Lifestyle is associated with a better CVD risk profile in firefighter recruits.

Keywords: aerobic capacity, cardiovascular disease, fire academy, healthy lifestyle, hypertension

While firefighter sudden cardiac death (SCD) and cardiovascular disease (CVD)-related disability may be precipitated by strenuous work duties, such events occur almost exclusively among firefighters with traditional CVD risk factors.[1–4] Pioneering studies have shown prevalent lifestyle CVD risk factors among firefighters, including long sedentary periods, poor dietary habits, and smoking, as well as prevalent health problems such as obesity, hypertension, and diabetes.[1] Given that firefighters' heart weights and thus, cardiomegaly risk are driven by obesity[5] and that cardiac enlargement/cardiomegaly plays a major role in on-duty SCD,[1,6] it is crucial to prevent/mitigate both obesity and hypertension in the fire service.

Research has also clearly documented firefighters' increased risk of cancer,[7] and obesity,[8] as well as growing concerns regarding firefighters' behavioral health (PTSD, depression and suicide).[9] All of these conditions: CVD, obesity, hypertension, cancer, and mental illness are multifactorial and have occupational components. Yet, their risks can be mitigated considerably by implementing healthy lifestyle measures.[10,11]

Recognizing the importance of lifestyle interventions, various teams have attempted preventive intervention strategies in firefighters. These include weight management programs[12] and other dietary interventions.[13,14] The landmark "Phlame study" investigated the combined effect of various healthy lifestyle strategies through either team-centered or individualized interventions and demonstrated benefits in the promotion of healthy behaviors among firefighters.[15] Nutritional interventions among firefighters have also shown beneficial effects on firefighters' cardio-metabolic markers, physical fitness, and occupational performance.[13,14] A recent qualitative study showed that fire recruits would be interesting in knowing more about the Mediterranean diet and would be interested in a Medi-lifestyle intervention.[16]

Adherence to a Mediterranean lifestyle is known to promote better health, quality of life, and longevity, while decreasing the risks of a wide variety of chronic illnesses.[17] Robust evidence is based on research investigations performed over the last 70 years in a variety of settings and in many countries including the United States, as well as specific working populations, such as US firefighters.[18,19] Specifically, increased adherence to a Mediterranean diet decreases the risk of cancer, heart and other CVD, obesity, diabetes, depression, as well as other chronic diseases.[20–23] While these benefits are recognized, studies addressing the association between Mediterranean diet and health outcomes among firefighters are scarce but promising.[18,19]

The objective of this study was to examine the relationship between adherence to a seven-item global Mediterranean lifestyle score and two important chronic disease risk factors, arterial hypertension (HTN), and low aerobic capacity, among a population of New England fire recruits.

METHODS

Study Design

The parent project ("Fire Recruit Health Study") for the present cross-sectional study started in early 2019 at two New England Fire Academies which train career firefighters. The aim of the "Fire Recruit Health Study" is to describe the food and fitness

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Funding: Rappaport Institute for Greater Boston, John F. Kennedy School of Government, at Harvard University.

The authors declare no conflict of interest.

Clinical significance: A high adherence to a healthy Mediterranean lifestyle is associated with lower risk of prevalent hypertension and higher aerobic capacity among young firefighter recruits.

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DOI: 10.1097/JOM.0000000000001868

environment in New England fire training academies along with the baseline health/fitness of fire recruits, as well as the health changes which occur across the course of these 15 to 16 weeks training programs. In addition, the study seeks to look at subsequent health changes after joining a career fire department as a probationary firefighter. This effort will help identify opportunities and challenges to improve recruits' health behaviors in future lifestyle intervention phases of the project.

The parent study was approved by the Institutional Review Board of Harvard T.H. Chan School of Public Health (IRB18–1902), and written informed consent was signed by all participants prior to their inclusion in the research.

Study Population

Fire recruits from two New England fire academies 2019 classes were recruited as long as they were 18 years of age or older and were currently were active as recruits at the time of consent.

Adherence to the Mediterranean Lifestyle: MEDI-Lifestyle Score

During the first week of the academy, consented recruits completed an on-line, baseline questionnaire (Qualtrics platform) using their cell phone or a tablet, which included information on general and behavioral health, physical activity, sleep behaviors, cigarette smoking, and dietary information. Physical activity was assessed using a validated and standardized self-reported physical activity questionnaire.[24] Dietary data were collected via the English version of the PREDIMED questionnaire,[25] a validated 14-item questionnaire of Mediterranean diet adherence, which consists of 12 questions about food consumption and two questions about food intake habits. Height was measured to the nearest 0.6 cm (0.25 in.) in standing position with a stadiometer (seca). Body weight was measured to the nearest 0.11 kg (0.25 pound) with bare feet and underwear on a Bioelectrical Impedance Analysis scale (Tanita or InBody), which then automatically calculated body mass index (BMI) as the weight in kilograms divided by the square of height in meters and estimated body fat percentage.[26]

Baseline adherence to Mediterranean lifestyle was assessed using the MEDI-Lifestyle score described in Table 1. The MEDI-Lifestyle score consists of seven dichotomously assessed items present in a Mediterranean healthy lifestyle (including: weight control [non-obese BMI], not smoking, Mediterranean diet, physical activity, limited tv-watching, adequate sleeping, and napping). A value of 0 or 1 was assigned to each of the seven Medi-Lifestyle components. Participants were assigned a value of 1 for each of the following: no smoking in the last 6 months, moderate-high physical activity (more than 16 METs-h/wk), high adherence to Mediterranean diet pattern (PREDIMED more than or equal to nine points),[17] BMI less than or equal to 30 kg/m^2, time watching television (less than 2 h/d), adequate sleeping (between 7 and 8 h/d) and taking naps throughout the day (siesta or after lunch short nap); otherwise participants were assigned a value of 0. The total MEDI-Lifestyle score ranged therefore, from 0 to 7 (with 7 reflecting the highest adherence to a Mediterranean healthy lifestyle and 0 the lowest).

TABLE 1. Healthy Lifestyle Score: MEDI-Lifestyle Score

	Score	*N* (%)
No obesity		
BMI (<30 kg/m^2)	1	72 (78.26)
BMI (≥30 kg/m^2)	0	20 (21.74)
Smoking		
No smoking (in the last 6 months)	1	84 (91.3)
Smoker (current and former within 6 months)	0	8 (8.7)
Mediterranean diet pattern (PREDIMED score)		
High adherence (≥9)	1	24 (26.18)
Low adherence (<9)	0	68 (73.91)
Physical activity, MET-h/wk		
Physically active (≥16 MET-h/wk)	1	38 (41.3)
Not physically active (<16 MET-h/wk)	0	54 (58.7)
Time spent watching television		
Low television watching (<2 h/d)	1	45 (48.91)
High television watching (≥2 h/d)	0	47 (51.09)
Adequate sleep		
Sleeping average 7–8 h/d	1	26 (28.26)
Sleeping average less 7 or more than 8 h/d	0	66 (71.74)
Napping		
Take afternoon naps	1	62 (67.39)
No afternoon naps	0	30 (32.61)

Outcomes

Hypertension (HTN): Blood pressure was assessed at baseline, 7 to 8 weeks, and 15 to 16 weeks. At each assessment, blood pressure was measured in a sitting position after at least 5 minutes resting in a seated position using an automated and calibrated sphygmomanometer (Omron, Kyoto, Japan) following the guidelines from the Report of the Working Group of the American College of Cardiology and American Heart Association on Clinical Practice Guidelines.[26] At each visit, an average of three readings (each taken at 1-minute intervals) was recorded. These averaged blood pressure readings were taken on more than or equal to two occasions and then averaged again over the more than or equal to two different visits to define each recruit's blood pressure level as per the guidelines. Under the current criteria and for this study, the cut off for Stage 1 hypertension was an average systolic blood pressure more than or equal to 130 mm Hg or average diastolic blood pressure more than or equal to 80 mm Hg.[26]

Aerobic capacity: Our team estimated the maximum oxygen absorption (VO_2 max) from each recruit's timed 1.5 mile run during the baseline academy fitness assessment using the Jack Daniels formula.(VO_2 max = VO_2/percent max, where percent max = $0.8 + 0.1894393 \times \exp(-0.012778 \times \text{time}) + 0.2989558 \times$ - $+ 0.2989558 \times \exp(-0.1932605 \times \text{time})VO_2 = -4.60$ - $-4.60 + 0.182258 \times \text{velocity} + 0.000104 \times \text{velocity}^2$ where time is the race time, and velocity is race velocity in m/min)[27]

The cut off for high versus low capacity was then established according to the median VO_2 max obtained for the recruit population.

Other Covariates

The baseline questionnaire also included socio-demographic variables (eg, age, sex, educational level, marital status) as well as behavioral health information (The Beck depression inventory, the Patient health questionnaire, and the Posttraumatic Stress Disorder Checklist [PCL-5]).[10,28,29] The latter were used to collect trauma and depression symptoms. Academy training staff supervised and documented baseline push-up capacity (number performed in 1 min/single trial) and pull-up capacity (number in single trial).

Statistical Analysis

Adherence to Mediterranean lifestyle was categorized based on the MEDI-Lifestyle score as low (0 to 2 pts.), medium (3 to 4 pts.), or high (5 to 7 pts.). The lowest category was used as the reference group for the analysis. Descriptive statistics were used to describe socio-demographic, anthropometric, mental health, and lifestyle characteristics of participants. Results are presented as stratified by the MEDI-Lifestyle adherence groups. To obtain descriptive statistics results, we used Pearson chi-squared tests for the binary and categorical variables, and one-way analysis of variance tests for the continuous variables.

TABLE 2. Characteristics of Study Population by MEDI-Lifestyle Adherence Group

	Categories of MEDI-Lifestyle Score			
	Low (0–2 pts)	**Medium (3–4 pts)**	**High (5–7 pts)**	***P***
n	10	55	27	
Age	31.9 (8.2)	27.6 (3.9)	29.4 (5.5)	**0.031**
Male *N* (%)	10 (100.0)	53 (96.4)	26 (96.3)	0.828
Education *N* (%)				0.699
No college deg.	1 (10.0)	8 (14.6)	2 (7.4)	
College degree	5 (50.0)	29 (52.7)	12 (44.4)	
Advanced degree	4 (40.0)	18 (32.7)	13 (48.2)	
Marital status *N* (%)				0.486
Never married	6 (60.0)	37 (67.3)	22 (81.5)	
Married	4 (40.0)	15 (27.3)	4 (14.8)	
Divorced	0 (0.00)	3 (5.5)	1 (3.7)	
Never smoked *N* (%)	8 (80.0)	39 (70.9)	17 (70.0)	0.572
Feel like napping *N* (%)				0.200
Rarely or never	9 (90.0)	33 (60.0)	14 (51.6)	
Sometimes	1 (10.0)	20 (36.4)	13 (48.2)	
Most of the time	0 (0.00)	2 (3.6)	0 (0.00)	
Pull-ups	4.9 (3.6)	6.4 (4.5)	10.2 (6.2)	**0.002**
Push-ups	30.8 (9.6)	35.8 (13.7)	44.3 (14.2)	**0.008**
Run time 1.5 miles, min	13.1 (1.9)	12.9 (1.9)	11.5 (1.3)	**0.003**
Body fat (%)	25.0 (4.7)	21.3 (7.3)	17.2 (5.0)	**0.003**
BMI, kg/m^2	31.9 (3.9)	28.0 (3.8)	26.1 (2.7)	**<0.001**
Hours sitting	53.9 (12.0)	51.1 (25.3)	36.8 (19.6)	**0.021**
Hours slept	6.7 (1.5)	6.6 (1.2)	6.6 (1.0)	0.947
Hours worked	45.0 (14.1)	43.2 (9.6)	43.0 (11.1)	0.865
PREDIMED score	5.5 (1.5)	6.4 (2.0)	7.9 (2.0)	**<0.001**
Beck Questionnaire	6.1 (5.2)	4.7 (5.9)	4.4 (7.5)	0.785
PCL Questionnaire	0.9 (1.1)	0.3 (0.9)	0.3 (1.0)	0.217
PHQ score	2.3 (2.4)	1.8 (2.5)	1.1 (2.9)	0.374

$P < 0.05$ was marked bold.
Mean (SD). BMI, Body Mass Index; Beck, Beck Depression Inventory; PCL, Post-Traumatic Stress Disorder (PTSD) Questionnaire; PHQ, Patient Health Questionnaire.

The associations between the MEDI-Lifestyle and HTN and high aerobic capacity were assessed using logistic regression models. Odds ratios (OR) and 95% confidence intervals (CI) were calculated. Models were also created considering the index score as a continuous variable. To control for possible confounding factors, a multivariable model adjusted for age and sex was also calculated.

Secondary analyses were conducted to assess the individual contribution of each specific MEDI-Lifestyle component factor on the probability of prevalent HTN or high aerobic capacity at baseline. Logistic regression models were adjusted for the other components of the MEDI-Lifestyle score. The reference category was the absence of a healthy lifestyle (score 0 for each component factor). Additional analyses were performed by replacing total time watching television by total sitting time as the sedentary behavior component for calculating the MEDI-Lifestyle score.

All P values presented are two-tailed and a $P < 0.05$ was considered statistically significant. Statistical analyses were conducted using Stata SE12.0 (Stata Corporation, College Station, TX).

RESULTS

From 101 eligible recruits, 6 declined consent and 3 were excluded because of essential missing data in the questionnaire; therefore 92 (91.1%) firefighter recruits were included in the analyses. Participants were mostly young men (96.8% male, mean age 25.6 ± 5.1). The prevalence of HTN (stage 1 or higher) was 35.9%. Baseline characteristics of the recruits stratified by MEDI-Lifestyle adherence are described in Table 2. Increased Lifestyle

TABLE 3. OR and 95% CI of Prevalent Hypertension According to the MEDI-Lifestyle Score

	Categories of MEDI-Lifestyle Score				
	Low (0–2 pts)	**Medium (3–4 pts)**	**High (5–7 pts)**	***P* for Trend***	**Per Each 1-Point Increment**
n	10	55	27		92
Hypertension	7	20	6		33
Crude OR (95% CI)	1 ref.	0.24 (0.06–1.05)	0.12 (0.02–0.62)	**0.011**	0.63 (0.42–0.95)
Age and sex adjusted OR (95% CI)	1 ref.	0.30 (0.07–1.34)	0.14 (0.03–0.71)	**0.017**	0.64 (0.43–0.96)

$P < 0.05$ was marked bold.
CI, confidence interval; OR, odds ratio.
*Statistics were derived from the models testing trends across the ordinal categories (low to high).

TABLE 4. OR and 95% CI of High Aerobic Capacity According to the MEDI-Lifestyle Score

	Categories of MEDI-Lifestyle Score				
	Low (0–2 pts)	Medium (3–4 pts)	High (5–7 pts)	*P* for Trend*	Per Each 1-Point Increment
n	9	55	27		91
High aerobic capacity	3	23	20		46
Crude OR (95% CI)	1 ref.	1.44 (0.33–6.35)	5.71 (1.12–29.21)	**0.023**	1.96 (1.28–2.98)
Age and sex adjusted OR (95% CI)	1 ref.	1.09 (0.23–5.19)	5.80 (1.05–32.05)	**0.025**	2.07 (1.32–3.24)

$P < 0.05$ was marked bold.
CI, confidence interval; OR, odds ratio.
*Statistics were derived from the models testing trends across the ordinal categories (low to high).

scores were significantly associated with increased levels of physical fitness and decreased body fat.

In age- and sex-adjusted analyses, compared with participants in the lowest MEDI-Lifestyle adherence category (0 to 2 points), participants in the highest adherence category (5 to 7 points) had a lower risk of prevalent HTN (OR = 0.14 [95% CI 0.03 to 0.71]; $P = 0.017$) (Table 3), and an increased probability of better aerobic capacity (OR = 5.80 [95% CI: 1.05–32.05]; $P = 0.025$) (Table 4).

When we analyzed the specific association of each MEDI-Lifestyle component individually, they were all protective of HTN, though none of the results reached statistical significance (Fig. 1). However, for each extra point added to the overall MEDI-Lifestyle score, the risk of prevalent HTN dropped by 36% (OR = 0.64 [95% CI: 0.43 to 0.96]) (Fig. 1).

Regarding the associations of individual MEDI-Lifestyle items with high aerobic capacity, greater physical activity and adequate total sleep had a positive and significant association with increased aerobic condition (Fig. 2). Additionally, for each extra point added to the overall MEDI-Lifestyle score, the odds of high aerobic capacity doubled, (OR = 2.07 [95% CI: 1.32 to 3.24]) (Fig. 2).

In further analyses, conducted by replacing total time watching television with total sitting time on the MEDI-Lifestyle score, the associations remained significant for both HTN and high aerobic capacity (OR = 0.26 [95% CI 0.09 to 0.73] and OR = 3.72 [95% CI: 1.31 to 10.57], respectively).

DISCUSSION

In this cross-sectional study of New England firefighter recruits, increased adherence to a Mediterranean lifestyle at academy entry, as assessed by greater MEDI-Lifestyle scores, was associated with a decreased prevalence of HTN and increased aerobic capacity. The MEDI-Lifestyle score includes a combination of different health indicators and healthy lifestyle habits, including some well-known protective factors against chronic disease, such as: not smoking, moderate physical activity (more than or equal to 16 MET-h/wk), BMI less than 30 kg/m^2, strong adherence to a Mediterranean diet, adequate nightly sleep, napping, and limited sedentary time.[11,17,30–33]

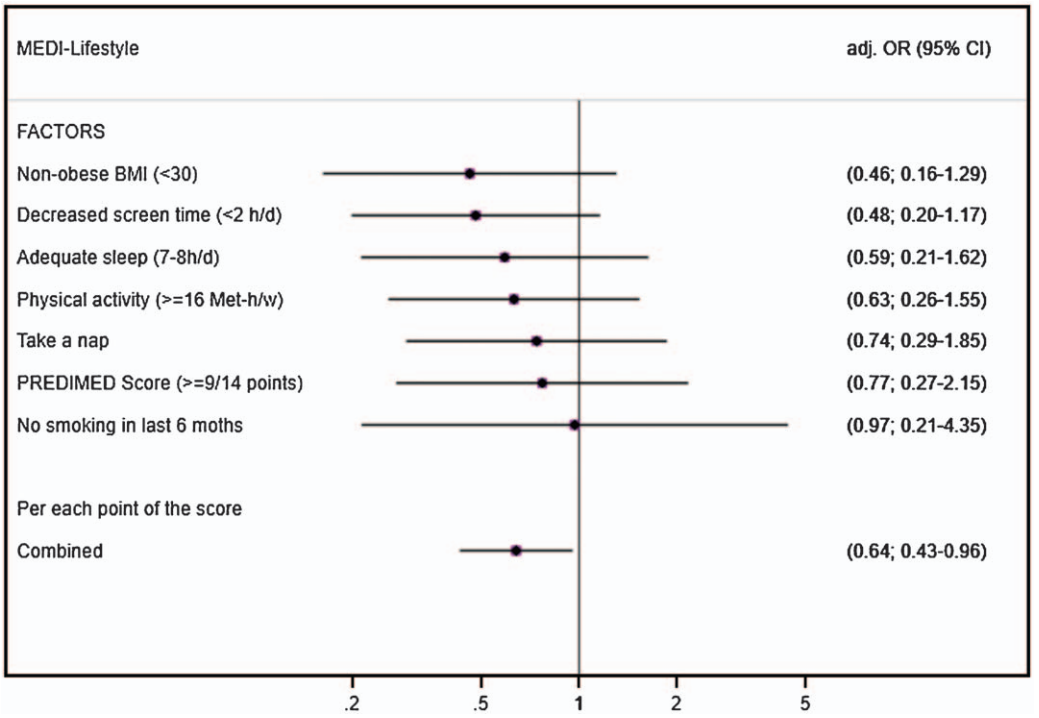

FIGURE 1. Association of each factor of the MEDI-Lifestyle Score with prevalent hypertension. Adj. OR, age and sex adjusted odds ratio; CI, confidence interval.

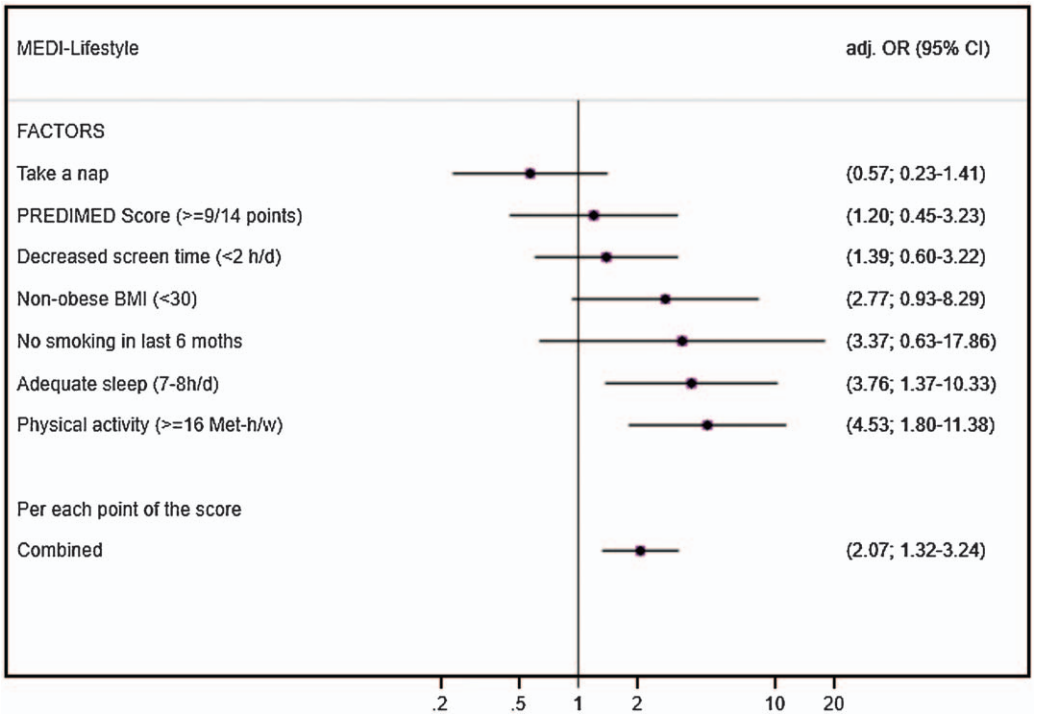

FIGURE 2. Association of each factor of the MEDI-Lifestyle Score with high aerobic capacity. Adj. OR, age and sex adjusted odds ratio; CI, confidence interval.

Previous studies[34,35] in populations of firefighters have analyzed the impact of individual healthy lifestyle habits, but to our knowledge, only the ''Phlame study'' has analyzed the combined effect of various healthy lifestyle factors or habits. The interventional ''Phlame study'' and our cross-sectional study emphasize several similar components in healthy lifestyle, such as healthy dietary patterns and greater physical activity.[15] Ours, however, expanded the classic description of healthy living to also include other healthy habits traditionally followed in Mediterranean populations,[36,37] including sleeping patterns (nocturnal and napping) and lower sitting time. In addition, instead of studying tenured firefighters, we investigated lifestyle effects on fire recruits.

The Mediterranean diet is a nutritional pattern historically consumed by populations living near the Mediterranean Sea, where olives are cultivated, and the climate allows relatively long growing seasons. Thus, this diet is characterized by high consumption plant-based foods: olive oil, fruits, vegetables, legumes, nuts, seeds and whole grains; moderate intake of wine, seafood, dairy, poultry and eggs; and low intake of red meat.[17] The Mediterranean diet pattern is documented to protect against cancer, cardiovascular disease, depression, and other chronic disease risks.[17–22] Moreover, the overall lifestyle pattern common in traditional Mediterranean populations has also been shown to be protective for several diseases.[36,37] Further, it is biologically plausible that combining several healthy lifestyle habits together can produce additionally synergistic health benefits.

Our study shows that the combined impact of high adherence to a healthy Mediterranean lifestyle is strongly associated with decreased HTN prevalence and increased aerobic capacity. The MEDI-lifestyle and similar scores allow simple assessments for both clinical practice and research.[38–41] Our results suggest that fire academy interventions designed to increase healthy lifestyle habits overall could add additional benefits to the physical fitness training traditionally provided in academy settings. Improving blood pressure among firefighters is of particular importance given its relationship to CVD and cardiac hypertrophy, and thus, ultimately to SCD.[1,6]

The present study has some limitations. First, our sample size (92 participants) was relatively small, which limited our statistical power. Nonetheless, we demonstrated statistically significant associations in multivariate analyses. Second, although our results are biological plausible and in accordance with previous studies in different populations, we cannot demonstrate causation as the present analysis was cross-sectional. Finally, the low percentage of women in our population (less than 4%) prevents generalization to female fire recruits.

Our study also enjoyed several strengths. First, over 90% of the eligible recruits participated. Second, the outcomes were assessed objectively and using validated measures. The blood pressure measurements and diagnosis of hypertension were performed by trained personnel and averaged over multiple readings and visits following the recommendations of the American Heart Association.[26] This minimized over-diagnosis based on a single screening or reading.

CONCLUSIONS

In this cross-sectional study of recruits from two New England fire academies, a seven-item MEDI-Lifestyle score was significantly associated with a lower risk of prevalent HTN and better baseline aerobic capacity. Future studies employing strategies for multi-faceted, Medi-Lifestyle interventions are warranted. Given the differences across various academies in different areas and that recruits train in a collective environment, either cluster-randomized or time-controlled (historical control groups) designs would be preferred. Nonetheless, future studies promoting a Mediterranean lifestyle among fire recruits should be conducted to determine if this approach is useful in decreasing the burden of commonly prevalent CVD risk factors among fire recruits.

ACKNOWLEDGMENTS

The authors acknowledge the assistance of Emily Eshelman, MS with Qualtrics surveys; O2x Human Performance for help collecting field data; and the Boston Fire Department and Connecticut State Fire Academy and their respective training staffs. The paper is dedicated to the memory of Captain William DeFord who continues to inspire all of us.

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