



Survival Mediterranean Style: Lifestyle Changes to Improve the Health of the US Fire Service

Maria Korre^{1,2}, Mercedes Sotos-Prieto^{1,3,4} and Stefanos N. Kales^{1,2*}

¹ Environmental & Occupational Medicine & Epidemiology Program, Department of Environmental Health, Harvard T.H. Chan School of Public Health, Boston, MA, United States, ² Cambridge Health Alliance, Harvard Medical School, Cambridge, MA, United States, ³ The Diabetes Institute, Ohio University, Athens, OH, United States, ⁴ Department of Food Sciences and Nutrition, School of Applied Health Sciences and Wellness, Ohio University, Athens, OH, United States

OPEN ACCESS

Edited by:

Alessandra Lafranconi,
Università degli studi di Milano
Bicocca, Italy

Reviewed by:

Christopher Alan Birt,
University of Liverpool,
United Kingdom
Katerina Stylianou,
University of Michigan, United States
Giuseppe Grosso,
NNEdPro Global Centre for Nutrition
and Health, United Kingdom

*Correspondence:

Stefanos N. Kales
skales@hsph.harvard.edu

Specialty section:

This article was submitted
to Public Health Policy,
a section of the journal
Frontiers in Public Health

Received: 10 August 2017

Accepted: 22 November 2017

Published: 18 December 2017

Citation:

Korre M, Sotos-Prieto M and
Kales SN (2017) Survival
Mediterranean Style: Lifestyle
Changes to Improve the Health
of the US Fire Service.
Front. Public Health 5:331.
doi: 10.3389/fpubh.2017.00331

Cardiovascular disease (CVD) causes almost half of all on-duty deaths in US firefighters and is an important and costly cause of morbidity. In addition, cancer is a growing health concern in this population. Obesity and obesity-associated, cardiometabolic risk clustering are major, modifiable risk factors for fire service CVD and cancer risk. The Mediterranean diet (MedDiet) is proven effective in primary and secondary CVD prevention. It is also associated with a decreased risk of cancer and other chronic diseases. Moreover, it can be adapted into successful workplace interventions. Emerging data from our group regarding the US Fire Service show that greater compliance with the MedDiet is associated with improved CVD risk profiles and less weight gain among career firefighters. Moreover, the fact that career firefighters take a considerable number of meals communally on the job also represents an excellent opportunity for a workplace Mediterranean Diet Nutritional Intervention (MDNI). The devastating effects of obesity, CVD, and cancer on the US fire service are recognized, but currently few effective preventive programs exist. The consistently positive health benefits from following a MedDiet and promising preliminary data in the fire service justify translational research to determine the most effective means of delivering MDNIs to US firefighters. Therefore, a high priority should be assigned to efforts, which can help further disseminate and implement our program of novel behavior change strategies, “Survival Mediterranean Style,” throughout the US fire service and eventually to other occupations.

Keywords: Mediterranean diet, lifestyle, firefighters, workplace health, obesity, cardiovascular health, cancer

INTRODUCTION

Today, as a result of the worldwide epidemics of obesity and diabetes, we are witnessing a strong and renewed interest in the traditional Mediterranean diet (MedDiet). A nutritional approach that derives its appeal not only from its many proven health benefits but also from its delicious meals combining diverse flavors, colors, and aromas fresh from the land and sea.

The MedDiet has consistently been associated with decreased all-cause mortality, less chronic disease, and better quality of life (1–6). Robust evidence in the general population consistently demonstrates the benefits of MedDiet on cardiovascular risk factors including obesity, hypertension, diabetes, and metabolic syndrome (4, 7–13). Therefore, it also decreases the risk for cardiovascular disease (CVD) morbidity and mortality (2, 8, 14–18).

Variants of the MedDiet have been consumed in more than 15 countries surrounding the Mediterranean Sea (19). The MedDiet includes high consumption of extra-virgin olive oil, fruits, vegetables, nuts, and legumes, unrefined whole grain and fish; a moderate intake of yogurt and fermented dairy, eggs, and poultry; moderate wine consumption with meals and low intake of processed and red meats and sweets (5, 14).

After a successful proof of concept, MedDiet has been shown to be applicable in non-Mediterranean countries as well, with supportive evidence for carrying on its cardioprotective role (20). From Australia to Japan, Chile and Iran as well as North-European countries, following the key principles of MedDiet has given great opportunities to various food types of local cuisines that can serve as great substitutes of food items that can be more easily found only in the Mediterranean region, thus enhancing its adherence on a global scale (20). Although a challenge, the applicability and transferability of the MedDiet in non-Mediterranean countries is desirable and supported by the current scientific evidence on its health benefits in non-Mediterranean countries. Some approaches such as the alternative MedDiet (16), and the recognition of this dietary pattern in the latest 2015 Dietary Guidelines for Americans are clear examples.

Emerging data from firefighters in the US, a population with significant health concerns, also support beneficial effects and potential for greater adoption of this eating pattern, despite living in a non-Mediterranean country. While less than 2% of firefighters currently follow the MedDiet, over 60% want to learn more about it and over 70% would be interested in an online nutritional platform (21). Controlled trials can quantify these benefits and determine the cost-effectiveness of implementation (22).

This paper will provide the rationale and need for Mediterranean Diet Nutrition Interventions (MDNI) in the US fire service. First, we will summarize data on CVD in firefighters and demonstrate that a major proportion of CVD morbidity and in particular, mortality is attributable to obesity and cardiometabolic risk clustering. We will then discuss nutritional challenges and opportunities in the fire service; the role of healthy diet in CVD prevention; in particular, the proven benefits of MedDiet; as well as the success of workplace interventions to change eating and lifestyle behavior. Moreover, we examine data revealing the role of obesity in increasing the risk of many cancers, while MedDiet reduces the risks of obesity, cancer, and other chronic diseases. Finally, we will use preliminary data from the fire service to support that an MDNI should improve key dietary habits, decrease weight gain, and improve firefighters' CVD risk factor profile.

CVD IN THE US FIRE SERVICE

Cardiovascular disease is the predominant cause of on-duty death and lifetime mortality in the US fire service. Sudden cardiac death (SCD) causes about 45% of on-duty fatalities. Strokes, aneurysms, and other CVD pathologies result in another 5% of on-duty deaths (23–26). There are an estimated 17–25 non-fatal, line-of-duty CVD events in the US fire service for every fatal on-duty CVD event (25). Thus, CVD is also a major cause of morbidity and disability (25, 27, 28). As in the general population, these

CVD events are largely due to coronary heart disease (CHD) (23–25, 27). Finally, CHD accounts for 30% of all deaths and, thus, is the leading cause of lifetime mortality among US firefighters (29). Thus, interventions which prevent CVD are clearly the top priority for US fire service research. In this regard, the effect of MedDiet in CVD prevention is roughly equivalent to statin medications (e.g., Lipitor, Crestor) (30), while having added benefits on weight control, preventing diabetes, and decreasing the risk of cancer (31, 32).

Obesity and cardiometabolic risk clustering are well-established CVD risk factors in the general population, and as well obesity strongly promotes risk factor clustering as mediated by negative effects on blood pressure, metabolism, sleep-disordered breathing, and cardiac enlargement (28). In the fire service, obesity has documented adverse effects on: fitness, metabolic syndrome, left ventricular hypertrophy/cardiomegaly, incident CHD; on-duty CHD events, including SCD; injury risks/workers' compensation costs; job-related disability and CVD retirements (24, 25, 27, 33–36).

The obesity problem in the US fire service has been increasing. Steadily within the worldwide obesity epidemic, about 40% of firefighters are now obese (25). A recent population-based investigation of both career and volunteer firefighters proved that the high obesity prevalence was due to excess adiposity rather than the misclassification of increased muscle mass (37). In fact, obesity was more prevalent when assessed by body fat measures compared to body mass index (BMI).

Even in a study of young fire recruits (mean age 26 years), 44% were overweight and 33% were obese. The obese subjects, compared to normal weight subjects, had an almost sevenfold greater risk of hypertensive blood pressure readings (38). Another recent investigation of young firefighters found 67% to be overweight or obese. Again, high BMI was associated with higher central blood pressure and increased arterial stiffness (39).

While the effects of excess weight on CVD are usually thought of as manifesting in middle-aged and older firefighters, we have recently linked obesity, hypertension, and other modifiable risks to fire service deaths in young firefighters. Among firefighters ≤ 45 years of age, at least two-thirds of on-duty SCD was related to preventable factors such as obesity and CHD (36). Moreover, we found surprising preliminary evidence of excess obesity among on-duty trauma deaths (burns, asphyxiation, and blunt trauma) compared with occupationally active control firefighters (36). These data suggest effective dietary intervention within an overall wellness strategy could reduce both CVD- and non-CVD-related morbidity and mortality.

EXISTING DIETARY CHALLENGES AND OPPORTUNITIES

The high prevalence of obesity and CVD risk clustering in the fire service is multifactorial. First, shift work has been associated with weight gain, increased blood pressure, and worsening insulin resistance (25, 28). Moreover, shift work and unscheduled emergency calls, lead to irregular meal times, which increase the likelihood of choosing fast foods and other takeout foods. Thus, career firefighters are more likely to consume meals higher in

sugars and saturated fats (40–42). These factors likely contribute to certain traditions around over-eating and less healthy choices common in fire service culture.

According to one of our recent studies, the two dietary factors that differed the most between obese and non-obese firefighters were obese firefighters' higher consumption of sugary drinks and fast-food (41). These findings are consistent with those from the general population. Sweetened beverages are the largest contributors to added-sugar consumption in the US (43–45). In addition, investigations have associated increased fast-food consumption with obesity (46–48) and cardiometabolic risk (49).

Nonetheless, there are also good opportunities for intervention in the fire service and successes have been achieved with workplace approaches. Promoting Healthy Lifestyles: Alternative Models' Effects was a prospective randomized controlled study of firefighter wellness, examining individual (one-on-one motivational counseling), and team health promotion approaches. Both interventions had beneficial effects on LDL cholesterol and exercise habits, compared with the control group (50). Moreover, after 1 year, both intervention groups demonstrated better weight control; more fruit/vegetable consumption and perceived greater well-being compared to controls (51). Even 4 years after the 12-month interventions, physical activity and nutrition remained improved compared with baseline (52).

There is also evidence that less intense wellness strategies have positive effects on fire service health. Poston et al. compared 10 fire departments that had implemented key Wellness Fitness Initiative (WFI) components (53) and compared them to 10 otherwise similar departments that had not implemented WFI approaches. Firefighters in the WFI departments had significantly lower BMI, body fat, waist circumference, and were over 40% less likely to be obese (53).

MedDiet AND CVD AND CANCER REDUCTION

Numerous studies have demonstrated the effectiveness of MedDiet in reducing all-cause mortality (54–56), CVD morbidity and mortality, and cancer mortality (1–6, 57). These benefits likely derive from effects on intermediate states such as inflammation, hypertension, obesity, metabolic syndrome, and diabetes mellitus (4, 7–10). Given these clear benefits, the latest US government nutritional guidelines recognize and recommend the MedDiet as a healthy option for Americans (58). Most nutrition experts recognize that there are many healthy eating patterns found across the globe, including Asian and vegetarian options, but there is a consensus that the “Mediterranean diet reigns supreme” considering all the evidence and pros and cons of each (59).

Consistent evidence of benefits from MedDiet has inspired MDNI. In the classic Lyon Heart study, subjects with a history of myocardial infarction were randomized to an MDNI or control diet (59). The MDNI mimicked a traditional Cretan diet with less red meat, but more fruit, vegetables, fish, and margarine. The randomized controlled trial (RCT) was stopped early because of excessive morbidity/mortality in the control arm, while the MDNI lowered the risk of recurrent heart disease by 50–70% during follow-up (60).

Mediterranean Diet Nutrition Intervention trials for primary prevention have also provided very promising results. Metabolic syndrome, a precursor of heart disease, affects over 25% of career firefighters (61). A 2-year randomized trial of MDNI reversed metabolic syndrome in 2/3 of the intervention group, whereas metabolic syndrome persisted in more than 80% of the controls (62). The most notable MDNI trial to date is PREDIMED in Spain (17). Beginning in 2003, PREDIMED ultimately randomized over 7,000 participants at high CVD risk, but without known CVD, to one of three interventions: an MDNI supplemented with extra-virgin olive oil; an MDNI supplemented with mixed nuts or a low-fat diet. The most recent data from PREDIMED provide the highest quality scientific evidence thus far of MedDiet benefits. After an average of 4.8 years of follow-up, subjects given the MDNI with extra-virgin olive oil had a 40% reduction in the incidence rate of new-onset diabetes (63), and a 30% decrease in major CVD events compared to control subjects prescribed a low-fat diet (14). In addition, PREDIMED has already documented other benefits, including decreased risk of breast cancer (64) and cognitive decline (65).

It is important to note that MedDiet is associated with significantly decreased cancer risks (6, 66, 67). First, although there are diverse workplace exposure and other causes of cancer, obesity is a major and modifiable risk factor for many types of cancer (34). Second, obesity is highly prevalent among US firefighters (25, 37) and third, MedDiet can reduce body weight and help maintain lower body weights. Finally, following a MedDiet produces large and significant decreases in cancer risks (1, 68–70). According to the most recent study, cancer is the second leading cause of lifetime mortality among US firefighters and accounts for over 25% of deaths (29). Therefore, long-term Mediterranean dietary changes in the fire service should positively impact firefighters' cancer burden.

MedDiet AND WORKPLACE BEHAVIORAL CHANGE

As we recently summarized in published reviews of MedDiet and the workplace, experience with worksite MDNIs is limited, but the evidence is quite positive (66, 67). Shai et al. have completed the only RCT at an Israeli nuclear facility, where over 300 obese participants were randomly assigned to: a low-fat, restricted-calorie diet; a Mediterranean, restricted-calorie diet; or a low-carbohydrate diet without calorie restriction (71). The 2-year intervention included a spousal education program and changes in the workplace cafeteria (72). After 6 years, the total weight loss was greatest and most significant for the Mediterranean group (3.1 kg), whereas the other two groups gained back most of their weight (73). Moreover, the Mediterranean group had the greatest persistent reductions in triglyceride and cholesterol levels from baseline.

In a Chilean factory, a 1-year, uncontrolled MedDiet intervention using education and changing the employer's cafeteria significantly improved MedDiet scores, waist circumference, HDL, blood pressure, and metabolic syndrome prevalence among the participants (2).

Carey et al. performed an uncontrolled pilot study of a 12-week low-glycemic nutritional program including some MedDiet principles in 10 men from one platoon of the Buffalo, NY Fire Department (74). At baseline, 70% had metabolic syndrome and an average of 3.2 metabolic syndrome risk factors. Upon completion of the pilot, the prevalence of metabolic syndrome and risk factors had decreased significantly: 30% and 1.9 metabolic syndrome risk factors, respectively.

PRELIMINARY DATA

Modified MedDiet Score and Cardiovascular Risk in Midwestern Firefighters

We previously investigated the dietary habits of 780 Midwestern firefighters using a modified Mediterranean diet score (mMDS) derived from a comprehensive lifestyle questionnaire. Greater adherence to MedDiet as measured by the mMDS was significantly associated with improvements in body fat, metabolic syndrome, LDL- and HDL-cholesterol, weight gain, and aerobic fitness (41). Firefighters with greatest adherence to MedDiet showed a 35% decreased risk of metabolic syndrome and 43% lower risk of weight gain compared to the bottom quartile of mMDS. Associations for improved HDL, total cholesterol/HDL, and body fat remained significant even after adjustments for age, BMI, and physical activity levels (36).

National Surveys of International Association of Fire Fighters (IAFF) Members

Dietary change is more likely to happen if the change strategy is acceptable to the target population and addresses perceived knowledge gaps. Therefore, in collaboration with the IAFF (21), we have conducted national surveys of firefighters. We found that 71% of IAFF members do not currently follow any particular dietary plan, and less than 2% report that they currently follow the MedDiet. However, over 70% want to learn more about the MedDiet; and they most frequently rated the MedDiet description as their favorite and gave it better rankings ($p < 0.001$) compared to the Paleo, Atkins, and other popular diets. Diverse and colorful flavors; the ability to enjoy lean meats in moderation; healthy fats and proteins from olive oil, nuts, fish, and the temperate wine consumption in moderation make the MedDiet an attractive and enjoyable option. Most important, the MedDiet does not require completely giving up any specific food and is, therefore, accessible and acceptable for adoption and long-term adherence among diverse groups, including the fire service. The weight status and the opinions expressed by career firefighters results strongly support the need for and a positive reception to potential MDNIs.

DISCUSSION

We know that more than one of every three firefighters in the US is obese and SCD is the number one line of duty killer-far ahead of burns and dangerous gases in fire smoke. We are also aware that fire department environments may promote and reinforce

poor eating habits and thus, may inadequately increase CVD and obesity risks. Obviously, given the positive effects of MedDiet on CVD, obesity control, and cancer, it is more important than ever to more widely disseminate and implement MedDiet in the US fire service to improve firefighter health and longevity. We step–step provided the evidence necessary to promote behavioral change strategies in the fire service and modify the existing food culture, with the ultimate purpose to be getting more firefighters and their families to adopt the principles of the MedDiet to decrease their risks of chronic disease.

All our research stated above has provided the evidence needed and put the rationale and the basis; and with an unprecedented success, the US Department of Homeland Security awarded our team in 2015 with a \$ 1.5-million, 3-year, competitive research grant entitled “Feeding America’s Bravest: MedDiet-Based Interventions to Change Firefighters’ Eating Habits and Improve Cardiovascular Risk Profiles” to conduct Mediterranean Diet Nutritional Interventions in selected US firefighters. Namely, our trials consist of two parallel designs. First, regarding the career firefighters, we have developed multi-pronged, MDNI behavior change strategies including: diet/lifestyle education; discounted access to key MedDiet foods; electronic education platforms and reminders. MDNI components have been refined *via* surveys, literature review, and local/national firefighter input including labor/management and fire service focus groups, and as a result of the above refinements, our team has developed original firefighter-specific MedDiet pyramid, food shopping guides and recipes many of which were designed and created based on firehouse favorites. Second, we have developed an online, open trial as a demonstration project to help change volunteer firefighters’ health habits and improve cardiovascular risk profiles using a MedDiet intervention strategy. The online tools include firefighter-centered guidelines for eating and exercise, firefighter-favorite recipes, food shopping tips, guides for eating out and on the go, running healthy meetings and a series of short instructional videos, among other resources.

Nutrition and medical experts agree that following a Mediterranean-style diet improves health. However, the health system has had very limited effectiveness in changing Americans’ eating and other lifestyle behaviors, while limited evidence suggests that workplace-based nutrition interventions can be beneficial. Building on our prior work with firefighters and the above rationale, our funded projects seek to establish the effectiveness of behavioral change strategies in the fire service to modify the existing food culture. Our goal is to motivate firefighters and their families to adopt key features of the MedDiet at work and home through education, participation, and incentives.

Overall, our team aims to create comprehensive, accessible, and sustainable programs around the time-honored and scientifically proven principles of the Traditional MedDiet that after a successful proof of concept, can be disseminated to nationally to the rest of the US fire service, as well as other workplaces and schools in the future. Already, we are working with two other outstanding employers who are preparing to adopt and incorporate healthy dietary workplace initiatives: overall, our team aims to create a comprehensible, approachable, and sustainable program around the time-honored and scientifically proven principles of the Traditional MedDiet that after a successful proof of concept,

can be disseminated to the rest of the fire service and other workplaces and schools in the future: law enforcement officers at the Broward County Sheriff's Office (Florida) and the automobile manufacturer, SEAT, in Spain (75).

CONCLUSION

The ultimate purpose of this work is to get more firefighters and their families to adopt the principles of the MedDiet to decrease their risks of chronic disease.

REFERENCES

- Mitrou PN, Kipnis V, Thiebaut AC, Reedy J, Subar AF, Wirfalt E, et al. Mediterranean dietary pattern and prediction of all-cause mortality in a US population: results from the NIH-AARP Diet and Health Study. *Arch Intern Med* (2007) 167(22):2461–8. doi:10.1001/archinte.167.22.2461
- Leighton F, Polic G, Strobel P, Perez D, Martinez C, Vasquez L, et al. Health impact of Mediterranean diets in food at work. *Public Health Nutr* (2009) 12(9A):1635–43. doi:10.1017/S1368980009990486
- Trichopoulou A, Bamia C, Trichopoulos D. Anatomy of health effects of Mediterranean diet: Greek EPIC prospective cohort study. *BMJ* (2009) 338: b2337. doi:10.1136/bmj.b2337
- Trichopoulou A, Kouris-Blazos A, Wahlqvist ML, Gnardellis C, Lagiou P, Polychronopoulos E, et al. Diet and overall survival in elderly people. *BMJ* (1995) 311(7018):1457–60. doi:10.1136/bmj.311.7018.1457
- Trichopoulou A, Orfanos P, Norat T, Bueno-de-Mesquita B, Ocke MC, Peeters PH, et al. Modified Mediterranean diet and survival: EPIC-elderly prospective cohort study. *BMJ* (2005) 330(7498):991. doi:10.1136/bmj.330.7503.1329-b
- Knoops KT, de Groot LC, Kromhout D, Perrin AE, Moreiras-Varela O, Menotti A, et al. Mediterranean diet, lifestyle factors, and 10-year mortality in elderly European men and women: the HALE project. *JAMA* (2004) 292(12):1433–9. doi:10.1001/jama.292.12.1433
- Babio N, Bullo M, Salas-Salvado J. Mediterranean diet and metabolic syndrome: the evidence. *Public Health Nutr* (2009) 12(9A):1607–17. doi:10.1017/S1368980009990449
- Vincent-Baudry S, Defoort C, Gerber M, Bernard MC, Verger P, Helal O, et al. The Medi-RIVAGE study: reduction of cardiovascular disease risk factors after a 3-mo intervention with a Mediterranean-type diet or a low-fat diet. *Am J Clin Nutr* (2005) 82(5):964–71.
- Panagiotakos DB, Pitsavos CH, Chrysohoou C, Skoumas J, Papadimitriou L, Stefanadis C, et al. Status and management of hypertension in Greece: role of the adoption of a Mediterranean diet: the Attica study. *J Hypertens* (2003) 21(8):1483–9. doi:10.1097/00004872-200308000-00011
- Kafatos A, Diacatou A, Voukiklaris G, Nikolakakis N, Vlachonikolis J, Kounali D, et al. Heart disease risk-factor status and dietary changes in the Cretan population over the past 30 y: the Seven Countries Study. *Am J Clin Nutr* (1997) 65(6):1882–6.
- Garcia-Fernandez E, Rico-Cabanas L, Rosgaard N, Estruch R, Bach-Faig A. Mediterranean diet and cardiometabolic syndrome: a review. *Nutrients* (2014) 6(9): 3474–500. doi:10.3390/nu6093474
- Babio N, Toledo E, Estruch R, Ros E, Martinez-Gonzalez MA, Castaner O, et al. Mediterranean diets and metabolic syndrome status in the PREDIMED randomized trial. *CMAJ* (2014) 186(17):E649–57. doi:10.1503/cmaj.140764
- Godos J, Zappala G, Bernardini S, Giambini I, Bes-Rastrollo M, Martinez-Gonzalez M. Adherence to the Mediterranean diet is inversely associated with metabolic syndrome occurrence: a meta-analysis of observational studies. *Int J Food Sci Nutr* (2017) 68(2):138–48. doi:10.1080/09637486.2016.1221900
- Estruch R, Ros E, Salas-Salvado J, Covas MI, Corella D, Aros F, et al. Primary prevention of cardiovascular disease with a Mediterranean diet. *N Engl J Med* (2013) 368(14):1279–90. doi:10.1056/NEJMoa1200303
- Martinez-Gonzalez MA, Garcia-Lopez M, Bes-Rastrollo M, Toledo E, Martinez-Lapiscina EH, Delgado-Rodriguez M, et al. Mediterranean diet and the incidence of cardiovascular disease: a Spanish cohort. *Nutr Metab Cardiovasc Dis* (2011) 21(4):237–44. doi:10.1016/j.numecd.2009.10.005

AUTHOR CONTRIBUTIONS

All authors contributed equally to designing and drafting the manuscript.

FUNDING

This investigation was supported by the Federal Emergency Management Agency (FEMA) Assistance to Firefighters Grant (AFG) Program's Award EMW-2014-FP-00612 (PI: SK).

- Fung TT, Rexrode KM, Mantzoros CS, Manson JE, Willett WC, Hu FB. Mediterranean diet and incidence of and mortality from coronary heart disease and stroke in women. *Circulation* (2009) 119(8):1093–100. doi:10.1161/CIRCULATIONAHA.108.816736
- Estruch R, Martinez-Gonzalez MA, Corella D, Salas-Salvado J, Ruiz-Gutierrez V, Covas MI, et al. Effects of a Mediterranean-style diet on cardiovascular risk factors: a randomized trial. *Ann Intern Med* (2006) 145(1):1–11. doi:10.7326/0003-4819-145-1-200607040-00004
- Grosso G, Marventano S, Yang J, Micek A, Pajak A, Scalfi L, et al. A comprehensive meta-analysis on evidence of Mediterranean diet and cardiovascular disease: are individual components equal? *Crit Rev Food Sci Nutr* (2017) 57(15):3218–32. doi:10.1080/10408398.2015.1107021
- Keys A, Menotti A, Karvonen MJ, Aravanis C, Blackburn H, Buzina R, et al. The diet and 15-year death rate in the seven countries study. *Am J Epidemiol* (1986) 124(6):903–15. doi:10.1093/oxfordjournals.aje.a114480
- Mocciaro G, Ziauddeen N, Godos J, Marranzano M, Chan M-Y, Ray S. Does a Mediterranean-type dietary pattern exert a cardio-protective effect outside the Mediterranean region? A review of current evidence. *Int J Food Sci Nutr* (2017) 24:1–12. doi:10.1080/09637486.2017.1391752
- Yang J, Farioli A, Korre M, Kales SN. Dietary preferences and nutritional information needs among career firefighters in the United States. *Glob Adv Health Med* (2015) 4(4):16–23. doi:10.7453/gahmj.2015.050
- Sotos-Prieto M, Cash SB, Christophi C, Folta S, Moffatt S, Muegge C, et al. Rationale and design of feeding America's bravest: Mediterranean diet-based intervention to change firefighters' eating habits and improve cardiovascular risk profiles. *Contemp Clin Trials* (2017) 61:101–7. doi:10.1016/j.cct.2017.07.010
- Kales SN, Soteriades ES, Christophi CA, Christiani DC. Emergency duties and deaths from heart disease among firefighters in the United States. *N Engl J Med* (2007) 356(12):1207–15. doi:10.1056/NEJMoa060357
- Smith DL, Barr DA, Kales SN. Extreme sacrifice: sudden cardiac death in the US fire service. *Extrem Physiol Med* (2013) 2(1):6. doi:10.1186/2046-7648-2-6
- Soteriades ES, Smith DL, Tsismenakis AJ, Baur DM, Kales SN. Cardiovascular disease in US firefighters: a systematic review. *Cardiol Rev* (2011) 19(4): 202–15. doi:10.1097/CRD.0b013e318215c105
- Fahy R. *U.S. Firefighter Fatalities Due to Sudden Cardiac Death, 1995-2004*. Quincy, MA: USA National Fire Protection Association (2005).
- Holder JD, Stallings LA, Peebles L, Burress JW, Kales SN. Firefighter heart presumption retirements in Massachusetts 1997-2004. *J Occup Environ Med* (2006) 48(10):1047–53. doi:10.1097/01.jom.0000235909.31632.46
- Kales SN, Tsismenakis AJ, Zhang C, Soteriades ES. Blood pressure in firefighters, police officers, and other emergency responders. *Am J Hypertens* (2009) 22(1):11–20. doi:10.1038/ajh.2008.296
- Daniels RD, Kubale TL, Yiin JH, Dahm MM, Hales TR, Baris D, et al. Mortality and cancer incidence in a pooled cohort of US firefighters from San Francisco, Chicago and Philadelphia (1950-2009). *Occup Environ Med* (2014) 71(6):388–97. doi:10.1136/oemed-2013-101662
- Estruch R. Cardiovascular mortality: how can it be prevented? *Nefrologia* (2014) 34(5):561–9. doi:10.3265/Nefrologia.pre2014.Apr.12481
- Kales SN, Smith DL. Firefighting and the heart: implications for prevention. *Circulation* (2017) 135(14):1296–9. doi:10.1161/CIRCULATIONAHA.117.027018
- Willett WC. The Mediterranean diet: science and practice. *Public Health Nutr* (2006) 9(1A):105–10. doi:10.1079/PHN2005931
- Willett WC. Food for thought. *Harv Public Health* (2013) 3:34–5.

34. Lauby-Secretan B, Scoccianti C, Loomis D, Grosse Y, Bianchini F, Straif K. Body fatness and cancer – viewpoint of the IARC Working Group. *N Engl J Med* (2016) 375(8):794–8. doi:10.1056/NEJMs1606602
35. Korre M, Porto LG, Farioli A, Yang J, Christiani DC, Christophi CA, et al. Effect of body mass index on left ventricular mass in career male firefighters. *Am J Cardiol* (2016) 118(11):1769–73. doi:10.1016/j.amjcard.2016.08.058
36. Yang J, Teehan D, Farioli A, Baur DM, Smith D, Kales SN. Sudden cardiac death among firefighters \leq45 years of age in the United States. *Am J Cardiol* (2013) 112(12):1962–7. doi:10.1016/j.amjcard.2013.08.029
37. Poston WS, Haddock CK, Jahnke SA, Jitnarin N, Tuley BC, Kales SN. The prevalence of overweight, obesity, and substandard fitness in a population-based firefighter cohort. *J Occup Environ Med* (2011) 53(3):266–73. doi:10.1097/JOM.0b013e31820af362
38. Tsismenakis AJ, Christophi CA, Burrell JW, Kinney AM, Kim M, Kales SN. The obesity epidemic and future emergency responders. *Obesity (Silver Spring)* (2009) 17(8):1648–50. doi:10.1038/oby.2009.63
39. Fahs CA, Smith DL, Horn GP, Agiovlasis S, Rossow LM, Echols G, et al. Impact of excess body weight on arterial structure, function, and blood pressure in firefighters. *Am J Cardiol* (2009) 104(10):1441–5. doi:10.1016/j.amjcard.2009.07.009
40. Lowden A, Moreno C, Holmback U, Lennernas M, Tucker P. Eating and shift work – effects on habits, metabolism and performance. *Scand J Work Environ Health* (2010) 36(2):150–62. doi:10.5271/sjweh.2898
41. Yang J, Farioli A, Korre M, Kales SN. Modified Mediterranean diet score and cardiovascular risk in a North American working population. *PLoS One* (2014) 9(2):e87539. doi:10.1371/journal.pone.0087539
42. Esquirol Y, Bongard V, Mabile L, Jonnier B, Soulat JM, Perret B. Shift work and metabolic syndrome: respective impacts of job strain, physical activity, and dietary rhythms. *Chronobiol Int* (2009) 26(3):544–59. doi:10.1080/07420520902821176
43. Malik VS, Popkin BM, Bray GA, Despres JP, Hu FB. Sugar-sweetened beverages, obesity, type 2 diabetes mellitus, and cardiovascular disease risk. *Circulation* (2010) 121(11):1356–64. doi:10.1161/CIRCULATIONAHA.109.876185
44. Guthrie JF, Morton JF. Food sources of added sweeteners in the diets of Americans. *J Am Diet Assoc* (2000) 100(1):43–51, quiz 49–50. doi:10.1016/S0002-8223(00)00018-3
45. Nielsen SJ, Popkin BM. Changes in beverage intake between 1977 and 2001. *Am J Prev Med* (2004) 27(3):205–10. doi:10.1016/j.amepre.2004.05.005
46. Pereira MA, Kartashov AI, Ebbeling CB, Van Horn L, Slattery ML, Jacobs DR Jr, et al. Fast-food habits, weight gain, and insulin resistance (the CARDIA study): 15-year prospective analysis. *Lancet* (2005) 365(9453):36–42. doi:10.1016/S0140-6736(04)17663-0
47. Duffey KJ, Steffen LM, Van Horn L, Jacobs DR Jr, Popkin BM. Dietary patterns matter: diet beverages and cardiometabolic risks in the longitudinal Coronary Artery Risk Development in Young Adults (CARDIA) Study. *Am J Clin Nutr* (2012) 95(4):909–15. doi:10.3945/ajcn.111.026682
48. Nettleton JA, Polak JF, Tracy R, Burke GL, Jacobs DR Jr. Dietary patterns and incident cardiovascular disease in the Multi-Ethnic Study of Atherosclerosis. *Am J Clin Nutr* (2009) 90(3):647–54. doi:10.3945/ajcn.2009.27597
49. Odegaard AO, Koh WP, Yuan JM, Gross MD, Pereira MA. Western-style fast food intake and cardiometabolic risk in an Eastern country. *Circulation* (2012) 126(2):182–8. doi:10.1161/CIRCULATIONAHA.111.084004
50. Elliot DL, Goldberg L, Duncan TE, Kuehl KS, Moe EL, Breger RK, et al. The PHLAME firefighters' study: feasibility and findings. *Am J Health Behav* (2004) 28(1):13–23. doi:10.5993/AJHB.28.1.2
51. Elliot DL, Goldberg L, Kuehl KS, Moe EL, Breger RK, Pickering MA. The PHLAME (Promoting Healthy Lifestyles: Alternative Models' Effects) firefighter study: outcomes of two models of behavior change. *J Occup Environ Med* (2007) 49(2):204–13. doi:10.1097/JOM.0b013e3180329a8d
52. MacKinnon DP, Elliot DL, Thoemmes F, Kuehl KS, Moe EL, Goldberg L, et al. Long-term effects of a worksite health promotion program for firefighters. *Am J Health Behav* (2010) 34(6):695–706. doi:10.5993/AJHB.34.6.6
53. Poston WS, Haddock CK, Jahnke SA, Jitnarin N, Day RS. An examination of the benefits of health promotion programs for the national fire service. *BMC Public Health* (2013) 13:805. doi:10.1186/1471-2458-13-805
54. Sotos-Prieto M, Bhupathiraju SN, Mattei J, Fung TT, Li Y, Pan A, et al. Association of changes in diet quality with total and cause-specific mortality. *N Engl J Med* (2017) 377(2):143–53. doi:10.1056/NEJMoa1613502
55. Buil-Cosiales P, Zazpe I, Toledo E, Corella D, Salas-Salvado J, Diez-Espino J, et al. Fiber intake and all-cause mortality in the Prevencion con Dieta Mediterranea (PREDIMED) study. *Am J Clin Nutr* (2014) 100(6):1498–507. doi:10.3945/ajcn.114.093757
56. Guasch-Ferre M, Babio N, Martinez-Gonzalez MA, Corella D, Ros E, Martin-Pelaez S, et al. Dietary fat intake and risk of cardiovascular disease and all-cause mortality in a population at high risk of cardiovascular disease. *Am J Clin Nutr* (2015) 102(6):1563–73. doi:10.3945/ajcn.115.116046
57. Sotos-Prieto M, Bhupathiraju SN, Mattei J, Fung TT, Li Y, Pan A, et al. Changes in diet quality scores and risk of cardiovascular disease among US men and women. *Circulation* (2015) 132(23):2212–9. doi:10.1161/CIRCULATIONAHA.115.017158
58. Office of Disease Prevention and Health Promotion. *Scientific Report of the 2015 Dietary Guidelines Advisory Committee* (2015). Available from: <https://health.gov/dietaryguidelines/2015-scientific-report/>
59. Mineo L. *To Age Better, Eat Better*. Harvard Gazette (2017). Available from: <https://news.harvard.edu/gazette/story/2017/05/much-of-life-is-beyond-our-control-but-dining-smartly-can-help-us-live-healthier-longer/>
60. de Lorgeril M, Salen P, Martin JL, Monjaud I, Delaye J, Mamelle N. Mediterranean diet, traditional risk factors, and the rate of cardiovascular complications after myocardial infarction: final report of the Lyon Diet Heart Study. *Circulation* (1999) 99(6):779–85. doi:10.1161/01.CIR.99.6.779
61. Baur DM, Christophi CA, Kales SN. Metabolic syndrome is inversely related to cardiorespiratory fitness in male career firefighters. *J Strength Cond Res* (2012) 26(9):2331–7. doi:10.1519/JSC.0b013e31823e9b19
62. Esposito K, Marfella R, Ciotola M, Di Palo C, Giugliano F, Giugliano G, et al. Effect of a Mediterranean-style diet on endothelial dysfunction and markers of vascular inflammation in the metabolic syndrome: a randomized trial. *JAMA* (2004) 292(12):1440–6. doi:10.1001/jama.292.12.1440
63. Salas-Salvado J, Bullo M, Estruch R, Ros E, Covas MI, Ibarrola-Jurado N, et al. Prevention of diabetes with Mediterranean diets: a subgroup analysis of a randomized trial. *Ann Intern Med* (2014) 160(1):1–10. doi:10.7326/M13-1725
64. Toledo E, Salas-Salvado J, Donat-Vargas C, Buil-Cosiales P, Estruch R, Ros E, et al. Mediterranean diet and invasive breast cancer risk among women at high cardiovascular risk in the PREDIMED trial: a randomized clinical trial. *JAMA Intern Med* (2015) 175(11):1752–60. doi:10.1001/jamainternmed.2015.4838
65. Martinez-Lapiscina EH, Clavero P, Toledo E, Estruch R, Salas-Salvado J, San Julian B, et al. Mediterranean diet improves cognition: the PREDIMED-NAVARRA randomised trial. *J Neurol Neurosurg Psychiatry* (2013) 84(12):1318–25. doi:10.1136/jnnp-2012-304792
66. Korre M, Kalogerakou T, Sotos-Prieto M, Kales SN. What is the Mediterranean diet and how can it be used to promote workplace health? *J Occup Environ Med* (2016) 58(3):e111–3. doi:10.1097/JOM.0000000000000681
67. Korre M, Tsoukas MA, Frantzskou E, Yang J, Kales SN. Mediterranean diet and workplace health promotion. *Curr Cardiovasc Risk Rep* (2014) 8(12):416. doi:10.1007/s12170-014-0416-3
68. Schwingshackl L, Hoffmann G. Adherence to Mediterranean diet and risk of cancer: a systematic review and meta-analysis of observational studies. *Int J Cancer* (2014) 135(8):1884–97. doi:10.1002/ijc.28824
69. Reedy J, Krebs-Smith SM, Miller PE, Liese AD, Kahle LL, Park Y, et al. Higher diet quality is associated with decreased risk of all-cause, cardiovascular disease, and cancer mortality among older adults. *J Nutr* (2014) 144(6):881–9. doi:10.3945/jn.113.189407
70. Grosso G, Buscemi S, Galvano F, Mistretta A, Marventano S, La Vela V, et al. Mediterranean diet and cancer: epidemiological evidence and mechanism of selected aspects. *BMC Surg* (2013) 13(Suppl 2):S14. doi:10.1186/1471-2482-13-S2-S14
71. Shai I, Schwarzfuchs D, Henkin Y, Shahar DR, Witkow S, Greenberg I, et al. Weight loss with a low-carbohydrate, Mediterranean, or low-fat diet. *N Engl J Med* (2008) 359(3):229–41. doi:10.1056/NEJMoa0708681
72. Golan R, Schwarzfuchs D, Stampfer MJ, Shai I; DIRECT Group. Halo effect of a weight-loss trial on spouses: the DIRECT-spouse study. *Public Health Nutr* (2010) 13(4):544–9. doi:10.1017/S1368980009991273
73. Schwarzfuchs D, Golan R, Shai I. Four-year follow-up after two-year dietary interventions. *N Engl J Med* (2012) 367(14):1373–4. doi:10.1056/NEJMc1204792

74. Carey MG, Al-Zaiti SS, Liao LM, Martin HN, Butler RA. A low-glycemic nutritional fitness program to reverse metabolic syndrome in professional firefighters: results of a pilot study. *J Cardiovasc Nurs* (2011) 26(4):298–304. doi:10.1097/JCN.0b013e31820344d7
75. thebuzzbusiness. *Mediterranean Cuisine Comes to the Car Plant*. (2017). Available from: <http://www.thebuzzbusiness.com/mediterranean-cuisine-comes-to-the-car-plant/>

Conflict of Interest Statement: SK reports grants from US Dept. of Homeland Security, non-financial support from Barilla America, non-financial support from California Almond Board, non-financial support from Arianna Trading

Company, non-financial support from Innoliva/Molina de Zafra, during the conduct of the study; personal fees from Medicolegal Consulting, personal fees from Mediterranean Diet Roundtable, outside the submitted work (22). MK and MS-P declare no competing interests.

Copyright © 2017 Korre, Sotos-Prieto and Kales. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.