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"Dietary preferences & nutrition information needs of United States Volunteer firefighters"

Project in collaboration with Harvard T.H Chan School of Public Health

ELENI DELIGIANNI²

Student ID: 230467854888

Supervisors: Prof Stefanos Kales¹, Dr Maria Korre¹

¹*Department of Environmental Health, Harvard T.H. Chan School of Public Health,
Boston, MA, United States*

²*Department of Epidemiology and Medical Statistics, Medical School, University of
Athens, Greece*

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ABSTRACT

Among US firefighters, cardiovascular disease (CVD) is the leading cause of on-duty death and lifetime mortality, with 45% of on duty fatalities occurring from sudden cardiac death. Evidence demonstrates a growing obesity problem in the fire service which is associated with CVD risk. Poor diet contributes to this burden but effective strategies to encourage healthy eating in the fire service are not established. This study aimed to investigate US volunteer firefighters' dietary preferences and to assess their nutritional knowledge and additional nutrition information needs. An online survey was conducted using the SurveyMonkey platform in collaboration with the National Volunteer Fire Council, which represents US volunteer firefighters. Invitations for the survey were sent via email by the National Volunteer Fire Council to its members and data were collected from January-March 2015. The statistical analysis was carried out using SPSS software. Among the 554 US volunteer firefighter respondents, the majority were obese with mean BMI $31 \text{ kg/m}^2 (\pm 6.6)$. Most of the firefighters (73%) stated that they do not follow a specific dietary plan and nearly over the half of respondents (56%) felt that they do not receive sufficient information from the fire service. The obese respondents reported more limited nutritional knowledge ($p=.002$) and greater dissatisfaction with the healthiness of their diet ($p<.001$) compared to the participants with normal body weight. Over 75% of the respondents showed willingness to learn more about healthy eating and 75% expressed interest for a free online learning platform about healthy eating strategies. When presented with descriptive text regarding various popular diets, Mediterranean diet was rated as the most favourable compared to Paleo, Atkins, Therapeutic Lifestyle Changes, and the Esselstyn Engine 2 diets. Improved nutrition education could support positive lifestyle changes and weight control among volunteer firefighters. Among popular dietary choices Mediterranean diet was rated the most appealing to the US volunteer firefighters, and it could be used in online platforms for nutritional education interventions.

Keywords: **firefighters, obesity, mediterranean diet, occupational health, nutritional intervention, education, cardiovascular disease**

Abbreviation - Glossary

BMI: Body Mass Index

CVD: Cardiovascular Disease

NVFC: National Volunteer Fire Council

TLC: Therapeutic Lifestyle Changes Diet

NFPA: National Fire Protection Association

MS: Musculoskeletal

LDL: Low Density Lipoprotein

LVH: Left Ventricular Hypertrophy

CHD: Coronary Heart Disease

SCD: Sudden Cardiac Death

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1. INTRODUCTION

1.1 Epidemiology of obesity in the United States of America

Over recent decades an increase in overweight and obesity prevalence has been observed globally. Obesity prevalence has been persistently high among adult and youth populations in the United States of America. According to reports from the Centers for Disease, Control and Prevention the prevalence of obesity was 39.8% and affected approximately 93.3 million of US adults in 2015–2016.¹ Obesity has affected some population groups more than others. For instance, the overall prevalence of obesity was higher among non-Hispanic black and Hispanic adults than among non-Hispanic white and non-Hispanic Asian adults^{1,2} (Appendix 2; Appendix 3). In 2015–2016 the prevalence of obesity in youth was 18.5%. Similarly, with adults the prevalence of obesity among non-Hispanic black and Hispanic youth was higher than among both non-Hispanic white and non-Hispanic Asian youth¹ (Appendix 4).

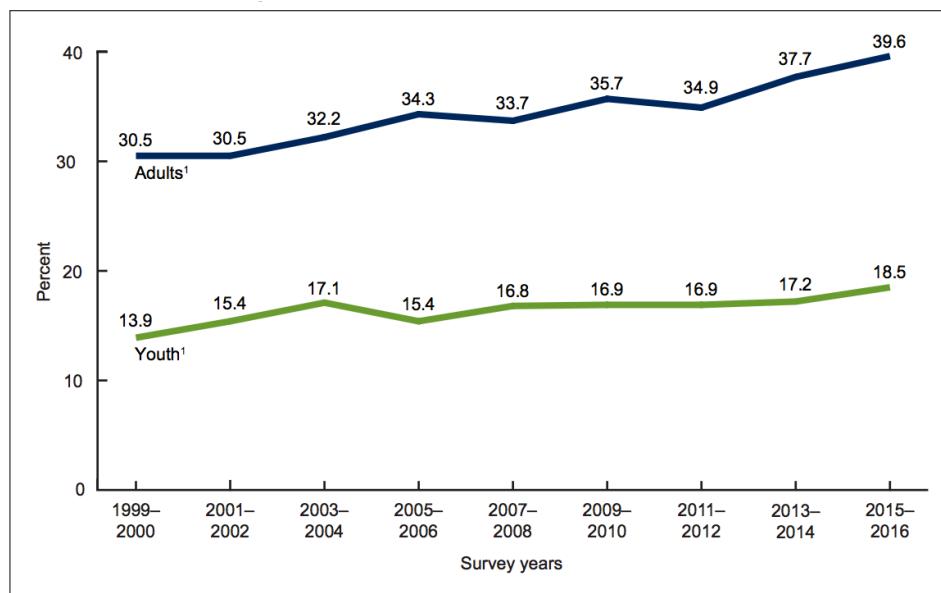


Figure 2: Trends in obesity prevalence among adults (aged 20 and over) and youth (aged 2–19 years) in the United States of America, from 1999–2000 to 2015–2016.¹

In the US population has been noticed a significantly increasing trend in obesity during the eighteen years from 1999–2000 to 2015–2016¹ (Figure 2). According to the Office of Disease, Prevention and Health Promotion the prevalence of obesity in the United States of America is higher than the Healthy People 2020 goals (obesity prevalence supposed to be 30.5% for adults and 14.5% for youth).³

1.2 Obesity and relevant health complications in the US firefighters

According to NFPA (National Fire Protection Association) approximately 1,160,450 firefighters were recorded in the United States in 2015, with 30% of them identified as career firefighters, while 70% were volunteer firefighters.⁴ The occupation of firefighters is challenging, physically demanding, stressful and poses many risks. Exposure to extreme heat and physical exertion during fire suppression may lead to myocardial ischemia and heat-related injuries among firefighters.^{5,6,7} Cardiovascular complications, including sudden cardiac death (SCD), are statistically associated with strenuous duties and emergencies, particularly fire suppression.^{8,9} Firefighters experience the highest proportionate mortality due to heart disease in the line of duty in comparison to other occupations.¹⁰ From retirements of Massachusetts firefighters, the highest percentage (77%) was due to coronary heart disease and 23% were due to other cardiovascular conditions.¹¹

Many career and volunteer firefighters though have been suffering from health complications surprisingly not related solely to the extreme conditions and injuries during fire service. The latest years significantly high combined prevalence of overweight and obesity have been documented among US firefighters (79.5% in career and 78.4% in volunteer firefighters respectively)¹² as well as prevalence of low fitness despite the strenuous nature of emergency duty of their profession.⁸ The prevalence of overweight and obesity among US firefighters has exceeded that of the US general population.¹² High prevalence of obesity only has also been recorded in the US firefighters cohort with 33.5% in career and a much higher 43.2% in volunteer firefighters.¹² It is well known that obesity constitutes a serious risk factor for cardiovascular disease and cancer. CVD is the most common cause of on-duty death and lifetime mortality among firefighters with 45% of on duty fatalities occurring from sudden cardiac death (SCD).^{12,13,14} Elevated blood pressure that results to

prehypertension/hypertension and is linked to obesity, is an important risk factor for cardiovascular morbidity and mortality as most of the SCD cases also have cardiac enlargement. From previous research three quarters of emergency professionals such as firefighters and policemen were identified as suffering from prehypertension/hypertension and uncontrolled elevated blood pressure was strongly linked to cardiovascular disease occurrence.¹⁵ The majority of incident CVD events has occurred in respondents who have been initially prehypertensive or mildly hypertensive and have not been under an appropriate course of treatment.^{8,15} Prehypertension/hypertension are significant risk factors for CVD.¹⁶ Left ventricular (LV) mass is another strong predictor of CVD events; increased LV mass has been common among US firefighters and plays an important role in firefighter sudden cardiac death.¹⁷ BMI was found to be an important driver of LV mass increase (left ventricular hypertrophy; enlarged heart/cardiomegaly) among firefighters, therefore, the reduction of obesity levels would improve CVD risk profiles and would lead to decrease of on-duty CVD and SCD events in the fire service.^{17,18} Emergency workers that have high BMIs also tend to have higher cholesterol levels, higher blood pressure and a lower exercise tolerance. In overall, excess weight has been highly associated with elevated cardiovascular risk among emergency working groups.¹² Underlying cardiovascular heart disease, smoking, hypertension and enlarged heart are strong predictors of fatality in male firefighters experiencing on-duty CHD events.^{18,19} The CHD risk factors like dietary habits and physical activity are modifiable factors and can be improved by changes in firefighters' lifestyle and interventions in their working environment. Although other risk factors such as age and gender cannot be changed since they are non-modifiable risk factors.¹⁷

Obesity in firefighters can also pose other risks apart from cardiovascular complications. According to evidence there is an increased risk of musculoskeletal (MS) injury in firefighters with greater BMI. Specifically obese firefighters seemed to be five times more likely to experience MS injury than those with normal weight.²⁰ Excess adiposity and dietary habits are also related to the risk of appearance of chronic diseases such as many types of cancer.²¹ Cancer constitutes the second-leading cause of death among US firefighters (27% of all-cause lifetime mortality),²² and an increased risk for several types of cancer has been reported among US firefighters as compared to the general population.²³ Body composition and dietary

habits can play an important role in cancer risk and prevention. Firefighters could benefit from maintaining a healthier body weight, with decreased adiposity levels and increased muscle mass because many types of firefighting associated cancers' occurrence (meningioma, colorectal and kidney cancers, Non-Hodgkin lymphoma) has been strongly linked with chronic obesity-associated inflammation.²⁴ Healthier eating and dietary patterns that contain foods high in anti-inflammatory bioactive compounds such as polyphenols and n-3 fatty acids have been associated with a decreased risk for certain cancers.²⁴

Additionally, firefighters usually perform shift work, which is associated with adverse metabolic changes, hypertension and cardiovascular disease due to sleep deprivation.²⁵ Therefore it is crucial for firefighters to attempt to maintain good dietary patterns, a high level of physical fitness and also good sleep hygiene.⁷

1.3 Health promotion interventions in firefighter cohorts

A few studies have shown the impact of worksite interventions among professional groups that work irregular hours 'around the clock' and these interventions seem to be effective and leading to a community-level behaviour change of workers regarding their dietary preferences and levels of physical activity.²⁶ Workplace dietary modification interventions alone and in combination with nutrition education have been shown to result in healthier eating habits among participants with an increase of fruit and vegetable intakes but also important reductions in body weight.²⁷

Despite evidence that firefighters have been suffering from a high prevalence of obesity, cardiovascular related morbidity and mortality, and other relevant chronic health complications such as diabetes and cancer,²¹ there has only been a limited number of health promotion programs applied to this occupational group. Health promotion educational programs and nutritional interventions in the workplace may positively affect firefighters' eating habits and lead to an overall improvement of their health status. According to research, volunteer firefighters have expressed a need for appropriate nutritional interventions in their workplaces to improvement their food environment including better access to quick, healthy, and affordable snacks.²⁸

In fire departments with workplace wellness programs, the firefighters were healthier with significantly lower BMI, body fat, waist circumference, and they were less likely to be obese compared to firefighters in other departments without similar health promotion programs.²⁸ Reductions in injury occurrence and an overall better physical state were noted among Probationary Firefighter Fitness (PFF-Fit) programme participants compared with controls.²⁹ A notable intervention study was “PHLAME” where a randomized trial was performed in order to assess two different ways of healthy lifestyle promotion (individual counselling versus team-based). Both the team-centered and individual-oriented interventions efficiently promoted healthy behaviors regarding nutrition, physical activity and healthy bodyweight maintenance.^{30,31} Another firefighter workplace intervention, specifically a short-duration low-glycemic fitness program, showed that anthropometric measures were successfully improved, and there was also a reduction in the prevalence of metabolic syndrome.³²

There is a need for development and implementation of more well – designed health promotion programs in order to assess their effectiveness in the working environment of firefighters. Especially sudden cardiac death in young firefighters has strongly been related to lifestyle factors and could be prevented by a reduction in obesity rates, smoking bans and improved screening strategies but also through health promotion wellness programs in the fire service.³³ Targeted occupational medical screening strategies for coronary heart disease and increased heart size (cardiomegaly) but also hypertension and blood pressure control can be crucial in order to restrict firefighters prompt to cardiovascular complications from strenuous duties¹⁸ and reduce duty-related cardiac deaths.³⁴ There is evidence from previous research that a great percentage of hypertensives have not been adequately controlled from primary health care professionals.¹⁶ Health care professionals’ role and advice is significant especially for weight management that could prevent many of health complications and premature deaths in the fire service.^{19,35} Finally increased levels of fitness are associated with an improved metabolic profile in male firefighters³⁶ and the intense exercise tests could be a very useful clinical assessment tool for evaluating functional capacity and cardiovascular disease risk of active occupational groups.³⁷

1.4 Mediterranean diet's beneficial role in health promotion

Unhealthy lifestyle and dietary habits have been linked to the development of a variety of health complications such as elevated blood pressure, cardiovascular diseases, diabetes, chronic inflammations, cancer and other disorders. On the other hand, the Mediterranean Diet has been associated with providing great benefits on human health. Specifically, following a Mediterranean diet has been linked to an overall better quality of life and a reduced risk of inflammation-associated chronic illnesses, such as obesity, diabetes mellitus, cardiovascular disease, cancer and cognitive decline among others.³⁸ The main protective effects of the Mediterranean diet appear to be most attributable to olive oil, fruits, vegetables, and legumes.³⁹ High consumption of the main components of Mediterranean diet has been associated with reduced incidence/prevalence of metabolic syndrome, diabetes mellitus type 2 but also decrease in cardiovascular related morbidity and mortality.^{40,41,42,43} It has been emphasised Mediterranean diet's protective role against CVDs since the Mediterranean dietary pattern can favorably affect many CVD risk factors. In previous clinical studies where Mediterranean diet was used as an intervention it was observed a reduction in participants' total cholesterol, low-density lipoprotein (LDL) cholesterol and blood pressure that are important cardiovascular risk factors but there was also an improvement of atherogenic dyslipidemia.⁴⁴ According to ATTICA study even subjects with previously unhealthy lifestyle behaviors may benefit from adherence to a Mediterranean diet leading to CVD risk reduction.^{45,46} There has also been evidence that Mediterranean diet can have important neuroprotective properties and play an anti-inflammatory role in aging.⁴⁷ Use of Mediterranean diet as an anti-inflammatory dietary pattern could be crucial for the prevention and management of diseases related to chronic inflammation such as visceral obesity, metabolic syndrome and type 2 diabetes mellitus.⁴² It is worth mentioning that the adoption of Mediterranean dietary plan has been associated with lower risk of metabolic syndrome occurrence⁴⁸ therefore Mediterranean diet could have an important role in primary prevention of metabolic syndrome.⁴⁹

There is robust evidence in literature for the importance of adherence to Mediterranean diet in many health aspects. From clinical studies in participants that followed a Mediterranean diet it was observed an overall improvement in health status

such as lower cardiovascular risk⁴³; significant reduction in overall cancer mortality⁵⁰; a reduction in incidence of neurodegenerative diseases such as Alzheimer's and Parkinson's disease^{51,52,53}; a reduced risk for gestational diabetes mellitus^{54,55}; lower risk of coronary heart disease and stroke incidence⁵⁶; decrease in BMI, abdominal circumference and maintenance of lower body weights^{57,58} and reduction of risks of central obesity and hyperglycemia.⁵⁹ The Prevención con Dieta Mediterránea (PREDIMED) study demonstrated the beneficial effects of a Mediterranean diet intervention supplemented with extra-virgin olive oil in the primary prevention of breast cancer where lower incidence of cancer cases were recorded in the cohorts following a Mediterranean diet pattern.⁶⁰ Similarly the PREDIMED – NAVARA trial indicated the importance of Mediterranean diet in the improvement of cognition.⁶¹ From meta-analyses studies and systematic reviews there is also important evidence supporting the beneficial role of Mediterranean diet in CVD prevention in populations (including individuals with diabetes)⁶² and significant reduction in stroke and coronary heart disease (CHD) incidence and mortality as well as reduction in myocardial infarction incidence.³⁹

1.5 Aim of the study

The primary aim of this study was to assess US volunteer firefighters' nutrition knowledge background, as well as to investigate their additional nutrition information needs. A secondary aim of the study was to determine the dietary preferences of the firefighters and favorability between well-known dietetic plans in order to suggest better nutritional interventions in the future.

2. METHODOLOGY

2.1 Ethical approval

The study was approved by the Institutional Review Board (IRB) of the Cambridge Health Alliance, a teaching affiliate of the Harvard Medical School. The IRB review was submitted by Stefanos N. Kales and Justin Yang and received approval in January 2014. Participation in this study was on a voluntary basis and no identifiable information of the participants was recorded. Informed consent was assumed by

individuals agreeing to proceed with the survey. Participants could withdraw from the survey at any time.

2.2 Survey Design

The survey was developed using the SurveyMonkey online platform (www.surveymonkey.com), a Web survey development service with wide use internationally. This platform was used as it provides analytical tools and is easy to use. An online survey was considered to be the most appropriate method in order to elicit a wide range of views of individuals in a short time and to collect useful information about firefighters' eating habits, dietary preferences and additional nutrition information needs. The survey was conducted in collaboration with the National Volunteer Fire Council (NVFC) which represents US volunteer firefighters in all fifty US states. The questionnaire was developed by modifying surveys that were performed by the Harvard research team in previous firefighter studies^{63,64}. Additional questions were added to the online survey in order to investigate the dietary preferences of the firefighters, but also to assess their satisfaction with their nutrition knowledge background and their additional nutrition information needs.

The online survey was comprised from thirty five questions and it was structured into four main parts. The first part of the survey had questions focused on the firefighters' nutrition knowledge background and their additional nutrition information needs. The second part asked about firefighters' dietary preferences and whether the firefighters were following a specific diet plan from the diets mentioned in the *US News and World Report's* "Best diets rankings" (2014) website⁶⁵. The firefighters were requested to rank (from 1 as the most favourable to 5 as the least favourable) five famous diet plans from the *US News and World Report's* according to their preferences. These five diets {Atkins diet, Engine 2 (Eselstyn) diet, Mediterranean diet, Paleo diet and Therapeutic Lifestyle Changes (TLC) diet} were chosen due to their popularity in general population and firefighters cohort or due to health evidence according to recent research^{46,65}. The diets (Table 1) were presented in the online questionnaire without labelling them by name, but using only short text descriptions. The list of the five diets was presented in random order to each respondent to ensure that the firefighters were not influenced by the order of the diets appearance when they had to assign them their own relative

preference rankings. The survey software included a randomization function for the feature mentioned above (diets random listing) and it this was important for the avoidance of bias regarding the dietary plans preference rankings. The third part of the survey was asking about firefighters' daily eating habits at the fire station and off work but also their perception and satisfaction regarding the quality of their nutrition. For the fourth part of the questionnaire the firefighters were asked to report their demographic characteristics and anthropometric measurements (height, weight) for the calculation of their body mass index.

Table 1: Dietary plans and their description

Dietary Plans	Description of the dietary practices for the online survey
Atkins Diet	The “bulk up diet”, eliminating sugars and starches like potatoes, white bread, and rice, but consuming heavily proteins and fats like chicken, red meat, and eggs.
Esselstyn (“Engine 2) Diet	A low-fat, plant-based diet focusing on immediately or gradually slashing all animal products, processed foods, and vegetable oils.
Mediterranean Diet	Emphasizes fruits/vegetable, whole grains, beans, nuts, legumes, and olive oil; eating fish and seafood at least a couple of times a week; enjoying poultry, eggs, cheese, and yogurt in moderation; saving sweets and red meat for special occasions. Moderate red wine consumption is also encouraged in this diet.
Paleo Diet	Focuses on whole natural foods including meat, fish, poultry, fruits, and vegetable; avoid eating processed foods and artificial ingredients such as refined sugar, dairy, legumes, and grains.
Therapeutic Lifestyle Changes Diet (TLC)	Cuts back sharply on saturated fat (fatty meat, whole-milk dairy, and fried foods); increased consumption of fruits/vegetables, whole grains, low-fat or non-fat dairy, fish, and skin-off poultry.

* These dietary plans were chosen to be presented in our research due to their popularity as dietary practice choices according to the US News and World Report's "Best diets rankings" (2014) website⁶⁵

2.3 Participants and Data Collection

Invitations for the survey were sent via email by the National Volunteer Fire Council to its members and data was collected from January to March 2015. In each email there was an electronic link that directed the respondents to the online questionnaire. In the emails it was also explained the aim of the study and there was information regarding privacy protection to reassure that the members were aware that their participation

was voluntary and anonymous. Survey Monkey's online platform was used for the data collection and storage. The data set was handled securely and anonymity was retained because emails and IP addresses were not recorded. The participants could skip any questions that they did not want to answer and a survey was considered as "complete" when the participant was submitting the survey by pressing the "done" button at the end of the questionnaire.

2.4 Data Analysis

The present study analyses were restricted to those participants who reported accurate age (>18), and height and weight that allowed calculating a physiologically plausible BMI. These incomplete surveys were excluded from the data analysis (n= 252). The complete responses (n=554) were used for the statistical analysis that was carried out using SPSS software. Descriptive statistics were performed to describe the demographic characteristics and basic features of data but also to present in further detail the firefighters' dietary preferences and additional nutrition information needs. The continuous variables in demographic characteristics were presented as mean and standard deviation (SD). The relative ranking order preferences of dietary plans (ranking 1 to 5, with 1 the most favourite and 5 the least favourite choice) were compared using a favorability index. This index was calculated as, favorability that was equal to group probability of high rankings (1st or 2nd) minus group probability of low rankings (4th or 5th).

Chi-square correlation tests comparing categorical variables were used to assess whether changes in demographics and BMI affected nutritional knowledge background or nutritional information needs of the firefighters. The significance level was set to $p < 0.05$. IBM ® SPSS Statistics (version 24) for MacOS Sierra 10.12.3 was used.

3. RESULTS

Overall, 806 US volunteer firefighters, responded to the online survey and 554 firefighters' responses were considered as complete and to meet all inclusion criteria in order to perform the data analysis. In Table 2, the self-reported demographic characteristics of the firefighters are presented. The majority of respondents were men

(493; 90% of the total respondents), and the mean age of the respondents was 49 years (SD 13). About half of the respondents were 50 years old or older, while approximately a quarter of the respondents were between 18 and 39 years old (Appendix 1).

Table 2: Demographic characteristics of US Volunteer firefighters

	Completed responses (N= 554)* (Mean ± SD)
Age (years)	49 ± 13
Gender (%)	males (90%) females (10%)
Years of Volunteer Service	23 ± 13
Weight (kg)	99.8 ± 22.7
Height (metres)	1.79 ± 0.09
Body Mass Index (kg/m²)	31 ± 6.6

* Analyses were restricted to participants that reported valid heights/weights

The average BMI of all the respondents was 31 (SD 6.6) indicating a high level of obesity within the firefighters cohort. According to the BMI reports the likelihood of obesity was higher among the older age groups of firefighters (40 – 49 years, 50+ years old; Appendix 1).

From Table 3, we see that the majority of the US volunteer firefighters reported that they do not practice a specific diet plan (403; 73%). Among the respondents that did not follow a specific diet the majority of them (351; 87%;) were overweight and obese ($BMI > 25$).

From the respondents that expressed interest (412) for the development of an educational online platform regarding healthy eating, more than the half of them (219; 53.2%) were obese ($BMI \geq 30$).

In Table 3, we show dietary patterns that were followed by the firefighters, their needs for additional nutritional information and their willingness for learning regarding healthy eating. The majority of the respondents (73%; Table 3) reported that they do not follow any specific dietetic plan. From the respondents that self- reported following a dietetic

plan, the majority of them were overweight or obese (82%). Among the 18 diets listed on the survey, the low-carbohydrate diet was the most frequently practiced (11%) followed by a low-fat diet (8%) and the paleo diet (5%). Less than 3% volunteer firefighters reported following a commercial diet plan, and only 2% reported following the Mediterranean diet.

Table 3: Dietary practices & additional nutritional information needs

	Completed responses N= 554 (100%)
Do not follow a specific diet plan	73%
Do not receive sufficient nutritional information from the fire service	56%
Willingness to learn more about healthy eating	78%
Interested in the creation of a free online educational platform about healthy eating	75%

Over the half of the respondents (308 ; 56%) reported they lack or have insufficient information regarding healthy eating from the fire service. Over two- thirds of the overweight and obese respondents cohort expressed interest in the creation of a free online educational platform regarding healthy eating.

In Table 4, the firefighters' self-reported perception regarding their nutritional knowledge is stratified by Body Mass Index. The obese respondents were significantly less likely to report their own nutritional knowledge "somewhat or very sufficient" (67%), while 84% of participants with a normal BMI reported that they possessed "somewhat or very sufficient" nutritional knowledge ($P<0.05$).

Table 4: Self-perceived nutritional knowledge stratified by Body Mass Index (N=549)

	All subjects (N= 549)		<25 kg/m ² (N= 74)		25-29 kg/m ² (N= 193)		≥30 kg/m ² (N=282)		
Nutritional knowledge	N	(%)	N	(%)	N	(%)	N	(%)	p value
Very limited	11	(2)	1	(1.4)	2	(1)	8	(2.8)	
Somewhat limited	64	(11.7)	4	(5.4)	14	(7.3)	46	(16.3)	
Neither limited or sufficient	81	(14.8)	7	(9.5)	34	(17.6)	40	(14.2)	
Somewhat sufficient	302	(55)	43	(58)	104	(53.9)	155	(55)	
Very sufficient	91	(16.6)	19	(25.7)	39	(20.2)	33	(11.7)	.002*
Missing values	5								

*statistically significant at p<0.01. Test performed excluding the missing values

In Table 5, the firefighters' self-reported level of dissatisfaction about the healthiness of their diet is presented. The obese respondents were significantly more likely to report dissatisfaction (somewhat or very dissatisfied) about the healthiness of their diet (49%), while only 15% of the respondents with a normal BMI reported that they were "somewhat or very dissatisfied" with the healthiness of their diet ($p<0.001$).

Table 5: Level of dissatisfaction with the healthiness of diet stratified by Body Mass Index (N=547)

	All subjects (N= 547)		<25 kg/m ² (N= 74)		25-29 kg/m ² (N= 192)		≥30 kg/m ² (N=281)		
Satisfaction with healthiness of diet	N	(%)	N	(%)	N	(%)	N	(%)	p value
Very dissatisfied	37	(6.8)	1	(1.4)	5	(2.6)	31	(11)	
Somewhat dissatisfied	167	(30.5)	10	(13.5)	49	(25.5)	108	(38.4)	
Neither dissatisfied or satisfied	133	(24.3)	19	(25.7)	45	(23.4)	69	(24.6)	
Somewhat satisfied	163	(29.8)	26	(35.1)	76	(39.6)	61	(21.7)	
Very satisfied	47	(8.6)	18	(24.3)	17	(8.9)	12	(4.3)	<0.001*
Missing values	7								

\. Test performed excluding the missing values

Regarding firefighters' interest ("somewhat or very interested") in learning more about a diet according to the diet descriptions proposed in our survey; the Mediterranean diet description received the highest level of interest (62%), followed closely by TLC diet (61%). There was also a great percentage of respondents that were interested in the descriptions of the Paleo and Atkins diets, 56% and 48% respectively. The Esselstyn diet description received the lowest level of interest with only 19% of responses.

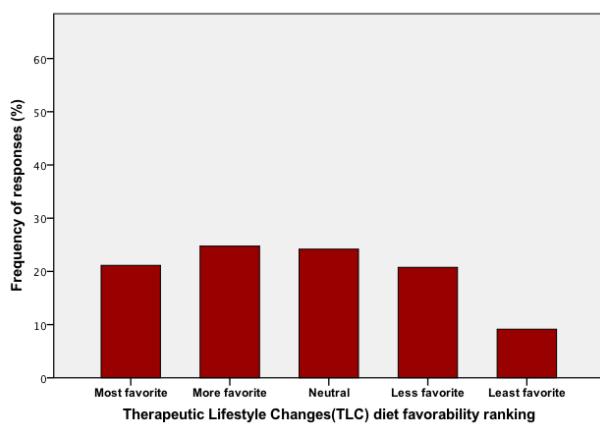
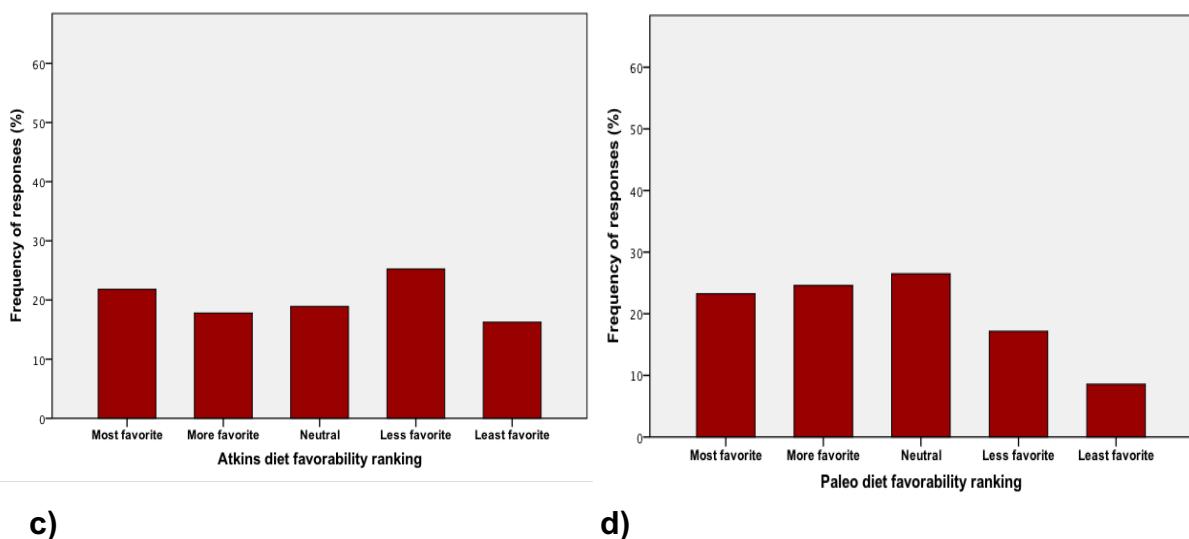
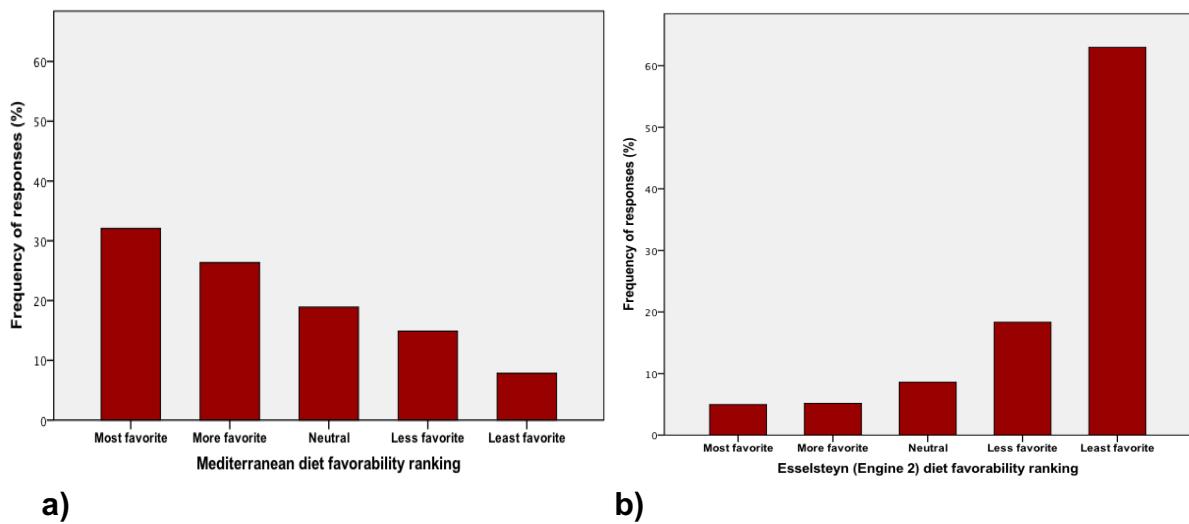


Figure 1: Volunteer firefighters' rank order favorability ratings of the five proposed diet descriptions (well-known dietetic plans) in percentages (N=547). Specifically above presented the rank order favorability ratings for a) the Mediterranean diet, b) Esselstyn diet (Engine 2), c) Atkins diet, d) Paleo diet, e) Therapeutic Lifestyle Changes diet.

*The range in ranking varied from the most favorite to the least favorite dietetic plan.

In the Figure 1 are presented the outcomes of rank order preference ratings for the five diet descriptions that were proposed in our survey. The most favorable distribution of rankings was received for the Mediterranean diet that it was ranked in the first place by almost 33% of volunteer firefighters. On the other side the Esselstyn diet had the least favourable distributions and it was ranked in the last place (fifth) by 63% of respondents.

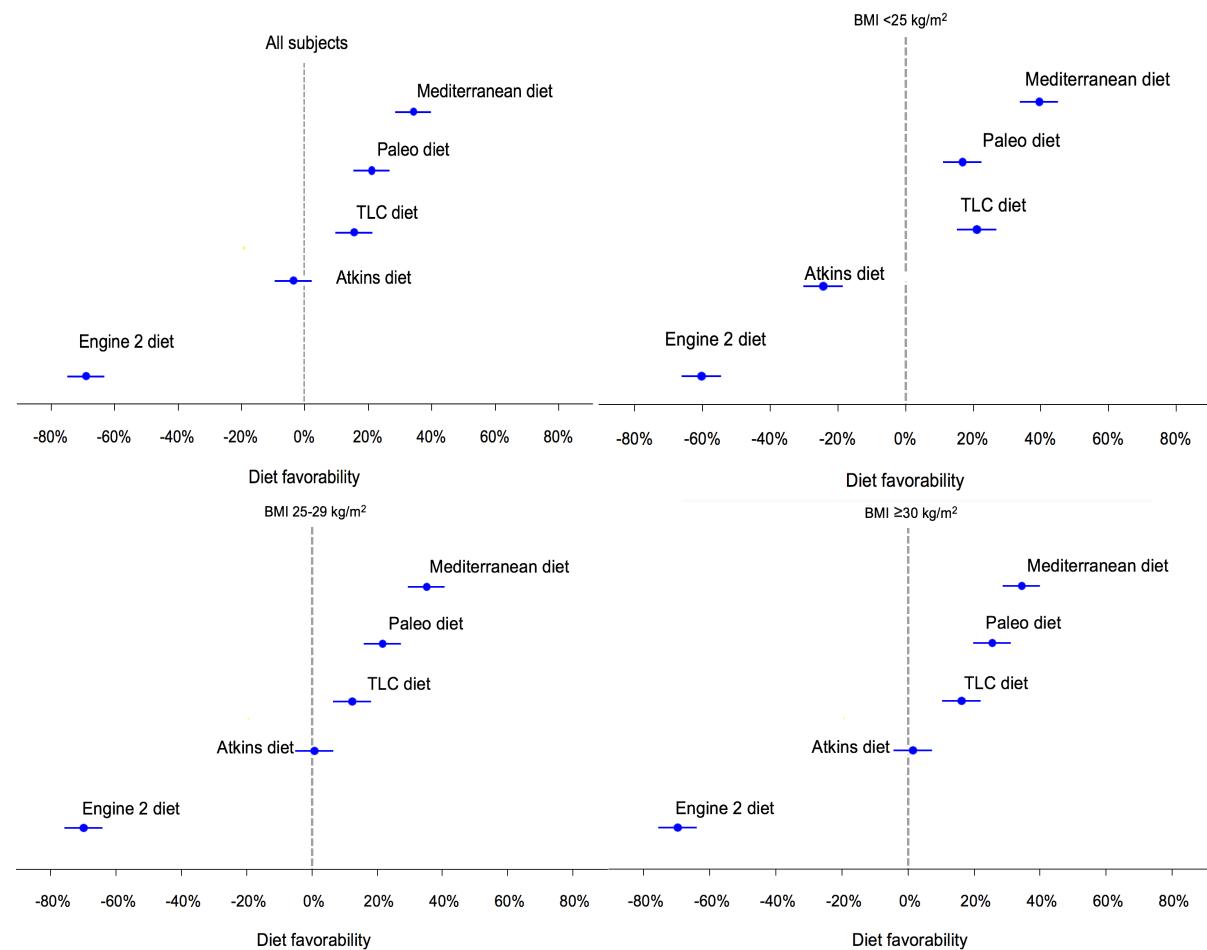


Figure 2: Diet favorability indices for all the respondents as well as stratified by self-reported body mass index.

**(favorability was calculated by group probability of high rankings {1st or 2nd (most/more favorite)} minus group probability of low rankings {4th or 5th (less/least favorite)}).*

In Figure 2, a further comparison was made among the different dietary plan preferences using a favorability index. The Mediterranean diet was most favourable, while the Esselstyn diet was the least favorite.

4. DISCUSSION

Our research is one of few studies focusing on the eating habits and preferences of US Volunteer firefighters. It provides interesting facts regarding their self-perceived nutritional knowledge and their needs for additional nutrition information. It also investigated volunteer firefighters' preferences among a variety of popular diets proposed for health promotion and how these preferences may be correlated with the firefighters' body composition. The information obtained from our study may constitute a fundamental starting point for the development of effective nutrition interventions as part of health promotion programs in the volunteer fire service.

According to the self-reported demographic characteristics from our national sample of volunteer firefighters, the large majority were overweight or obese with an average BMI equal to 31 m/kg². This finding is in agreement with previous studies of firefighter cohorts.^{8,12,14,21,33,34,66} As expected from the average and distribution of volunteer firefighters' body composition measurements, the majority of the respondents (over the two-thirds) were not following a specific dietetic plan similar to findings of a previous study of career firefighters.²¹ In contrast, among respondents with a normal weight, nearly half of them were following a specific eating pattern. This latter finding was also in agreement with the findings of the previous study in career firefighters.²¹ As expected, normal weight professionals tend to have healthier eating habits. Although there have also been cases where more overweight/obese adults followed a specific dietetic pattern in order to lose weight.⁶⁷ It needs to be mentioned that in cases where an overall improved dietetic pattern has been followed for many years

there is an association with a significantly lower risk of mortality or occurrence of life threatening events (cardiovascular complications, cancer).^{68, 69}

Obese and overweight firefighters were also significantly less likely to report sufficient nutritional knowledge compared to respondents with a normal-weight. This finding supports that nutritional knowledge is a factor correlated with lifestyle, eating habits and relevant outcomes in the body weight and composition agreeing with the previous study in career firefighters.²¹ Furthermore the obese volunteer firefighters expressed significantly higher levels of dissatisfaction with the healthiness of their diet compare to normal-weight and overweight respondents showing that there is a need for further nutritional education.

Similar to career firefighters²¹, most volunteer firefighters (over 75%) expressed they wanted to learn more about healthy eating through online educational platforms. Recently, Harvard team has initiated an online platform based on the "Survival Mediterranean Style" project³⁸ providing interesting recipes, videos and nutritional advise based on firefighters' needs in order to help the firefighters to adopt healthier eating habits by following Mediterranean diet principles. This innovative platform may constitute a starting point for further nutritional education actions through interactive methods and easily accessible information that may play a crucial role for lifestyle and eating behaviour changes among firefighters.

Nutritional intervention in the fire service work environment would be of major importance considering that the firefighters consume considerable meals at the fire stations (6 meals per week on average for career firefighters).^{38,64} Health promotion programs with nutritional interventions would be very important especially for the obese and overweight firefighters that have expressed limited nutritional knowledge and dissatisfaction with their eating habits and lifestyle.²¹ It is greatly important to achieve improvement of workplace eating patterns, meal quality and frequency but also promotion of healthier eating habits. It has been shown that employees who are eating lunch at worksite canteen offering healthy options tend to make healthier food choices (closer to nutritional recommendations) compare to employees who are not using the canteen.⁷⁰ Therefore, catering services in the worksite may contribute to the

promotion of healthier eating habits and conformation of better dietary practices in the working professionals.

For the development of a successful nutritional intervention in the workplace it is highly important to identified the ideal dietary pattern to use and promote. Such an eating pattern must be beneficial to health based on robust evidence from clinical research studies, but also needs to be appealing to the working group where it will be applied. Among the five dietary patters that were proposed in our research (Atkins, TLC, Esselstyn, Paleo, Mediterranean), the volunteer firefighters expressed the most favourable opinions and highest interest regarding the Mediterranean diet. This finding was also in agreement with the prior study of career firefighters.²¹ The variety of healthy food choices following a Mediterranean diet and the ability to enjoy diverse flavours such as vegetables, lean meat in moderation, healthy fats and proteins from nuts, fish, olive oil and moderate consumption of wine make this dietary pattern very attractive and enjoyable compare to other well-known dietetic practices. It is also important to note, that the Esselstyn Engine 2 diet (a strictly plant-based diet) was ranked as the least favourite potential eating plan. This is likely due to the requirement that all dairy and meat be removed from the diet as well as other significant restrictions. On the other hand, surprisingly, the Atkins diet was ranked as unfavorable as well by the majority of the firefighters even though it encourages heavy consumption of proteins and fats such as chicken, red meat and eggs. Thus, it is likely that participants recognize that balance and moderation are important for improving health. It is also notable that the Atkins diet was very negatively ranked by the respondents with a normal BMI, although overweight and obese volunteer firefighters seemed to have a more neutral opinion regarding this diet. This may correlate with the other findings of our study relative to overweight/obese participants' self-reported lack of nutritional knowledge.

The Mediterranean diet has been ranked as the best diet in overall score according to the US News and World report rankings 2019.⁶⁵ Health benefits by following a Mediterranean diet have been strongly documented in literature by robust research findings and it has also been proved Mediterranean diet's superiority against to other well-known dietetic patterns that have been presented in our research. Mediterranean diet has been showed to be more effective than low-fat dietetic practices since it may

induce clinically relevant long-term changes in cardiovascular risk factors but also inflammatory markers.^{71,72,73,74,75,76,77} It has also been showed The Mediterranean diet's important role in the reversion of metabolic syndrome, the improvement of HDL-cholesterol, but also the control of systolic and diastolic blood pressure has also been demonstrated.⁴⁹ It has also been stated that following a Mediterranean diet can also lead to protection against acute coronary syndromes and stroke occurrence.^{56,78} In overall adherence to Mediterranean diet has been associated with more than 50% lower rate of all causes or cause- specific mortality.⁷⁹

The Mediterranean diet could be a promising strategy to introduce a healthier eating in the working environment. In a Chilean factory, an uncontrolled Mediterranean diet intervention (nutritional education and changes in the meals provided by the cafeteria of the workplace) significantly improved waist circumference, blood pressure levels, HDL and metabolic syndrome prevalence among the participants.⁴⁹ Another previous study showed that greater compliance to a Mediterranean Diet was associated with improved CVD risk profiles and better weight control among career firefighters.³⁸ An interesting clinical trial study, "Feeding America's Bravest," is currently in progress investigating whether there are beneficial changes after Mediterranean diet intervention fire houses compared control fire houses.⁸⁰ Main goal of "Feeding America's Bravest" project is to encourage healthy eating in the fire stations and motivate the firefighters but also their families to adopt a healthier lifestyle and eating habits by following Mediterranean diet principles.⁸⁰

In the workplace, in addition to nutritional interventions, another important lifestyle behaviour is physical activity. It has been reported that less than thirty percent of fire departments have any structured fitness monitoring or improvement programs for the firefighters.³⁶ The introduction of fitness programs along with nutritional interventions in the fire service would be very beneficial for the firefighters. Recent research has showed that fitness programs such high intensity training (HIT) in the working place of firefighters could have positive outcomes in the firefighters cohort. It was showed that HIT participants were half as likely to be classified as obese according to body fat and waist circumference measurements.³⁷ Other findings suggested that higher baseline push-up capacity is associated with a lower future incidence of CVD events.³⁷

Further research investigating the eating habits, dietary knowledge and preferences of the firefighters in correlation with their body composition would be very important. The obesity and overweight classification though could be improved by using further measurements such as waist circumference and body fat percentage along with BMI for greater precision in the determination of firefighters' exact weight status and avoidance of misclassification.⁸¹ The measurements mentioned above regarding body weight and composition assessment have also a great importance for the identification of potential changes after nutritional interventions in case of clinical studies as part of health promotion programs. The body measurements could also be accompanied by blood tests and cardiometabolic biomarker measurements for more optimal and detailed findings such as in "Feeding America's" bravest trial.⁸⁰

It is concluded that health promotion programs in the occupational environment could be very effective in order to achieve important positive changes in the lifestyle, dietary preferences and overall health condition of the firefighters. Interventions related to the prevention of cardiometabolic conditions and other chronic disease are a priority for workplace health promotion programs that may also improve productivity, while decreasing work accidents, disability and mortality.⁵⁷ Structured health promotion programs can be easy and cost-effective solutions focusing on employees' well-being and better quality of life but also reducing the health care costs due to effects of unhealthy lifestyle and bad dietary habits.⁵⁷

Strengths and weaknesses of the study

Our study has several strengths. First of all, it is one of the first studies to focus on US volunteer firefighters' nutrition knowledge background and their additional nutrition information needs. US volunteer firefighters constitute the largest part of the US firefighting service (approximately 70%), therefore, it is very important to investigate further volunteer firefighters' needs. Another strength of our study is the variety of questions regarding the firefighters' nutritional education level and their preferences among different popular dietary choices that could lead to the development of efficient interventional tools for additional nutrition education but also potential hands-on interventions in the working place. From our knowledge so far, this is one of the first

studies that asses US volunteer firefighters' nutrition knowledge background and their additional nutrition information needs on a national level.

There are also several limitations. There were relatively few female responders to our study, although there are a small number of female firefighters in the firefighting service compared to males. Also, since the weight and height were self-reported by the firefighters, there were some implausible values reported, which had to be excluded. Another limitation of our research is the participation and response rate bias since our survey was online and it was completed in voluntary basis. According to the NFPA there are approximately 800,000 volunteer firefighters in the US and thus, our research outcomes represent a very small sample of volunteer firefighters' opinions. Nonetheless, the demographic characteristics of our respondents are consistent with those reported in other studies.^{12,14,21}

5. CONCLUSION

From our study, it is concluded that the majority of US volunteer firefighters are overweight and obese, they do not follow a specific dietary plan and they do not receive sufficient nutritional information from their working environment in the fire service. These firefighters would be interested in an online nutritional educational platform. Improved nutritional education could support positive lifestyle changes and weight control among US volunteer firefighters. Interventions in the fire service would be extremely beneficial in order to manage and tackle the important barrier of obesity epidemic and health related complications in this working group. Among popular dietary choices, Mediterranean diet was rated the most appealing to the US volunteer firefighters. Therefore, Mediterranean diet could be used as an effective tool for intervention in the work place.

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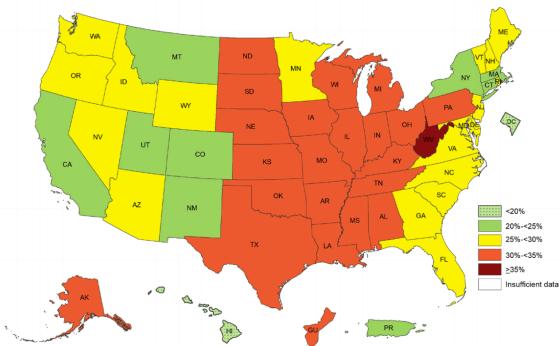
7. APPENDICES

Appendix 1: Self-reported age (age groups categorised) of US volunteer firefighters stratified by BMI (N= 554)

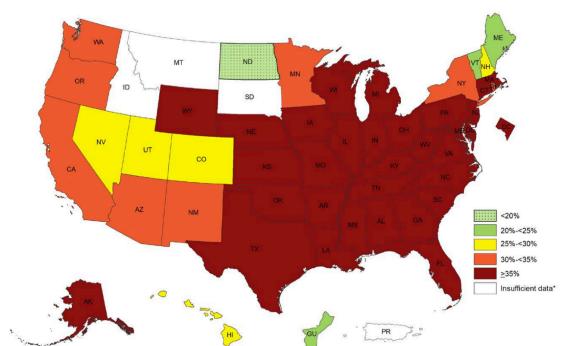
Age (years)	Body mass index			Total
	<25 kg/m ²	25–29 kg/m ²	≥30 kg/m ²	
18–29	8	21	14	43
30–39	15	21	45	81
40–49	16	43	87	146
50+	36	109	139	284
All Subjects	75	194	285	554

*statistically significant at p< 0.05

Appendix 2: Prevalence of self-reported obesity (by state and territory, 2015–2017) among a) Non-Hispanic White Adults, b) Non-Hispanic Black Adults c) Hispanic Adults²



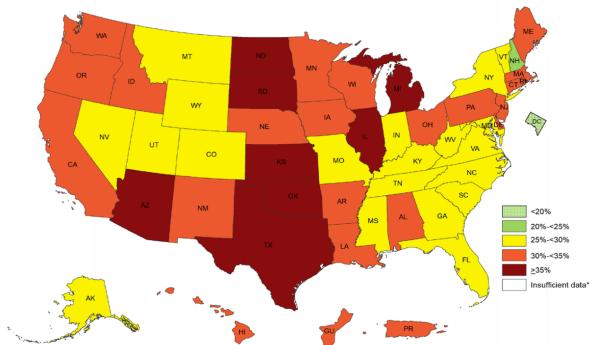
*Sample size <50 or the relative standard error (dividing the standard error by the prevalence) ≥ 30%.



*Sample size <50 or the relative standard error (dividing the standard error by the prevalence) ≥ 30%.

a)

b)

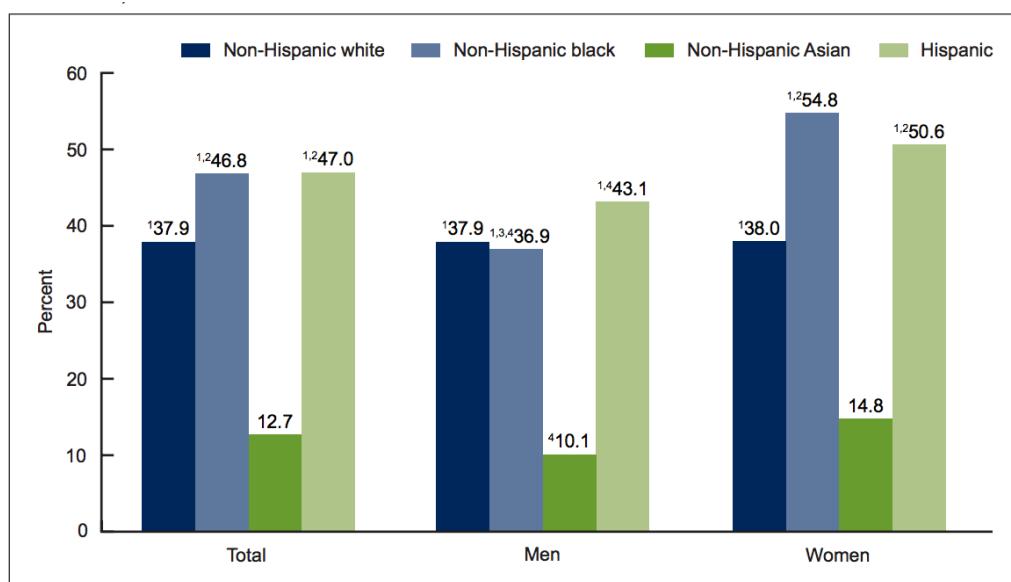


*Sample size <50 or the relative standard error (dividing the standard error by the prevalence) ≥ 30%.

c)

Appendix 3: Age-adjusted prevalence of obesity among adults (aged 20 and over) stratified by sex and race (Hispanic origin, blacks, Asians, etc) in the United States of America in 2015–2016¹

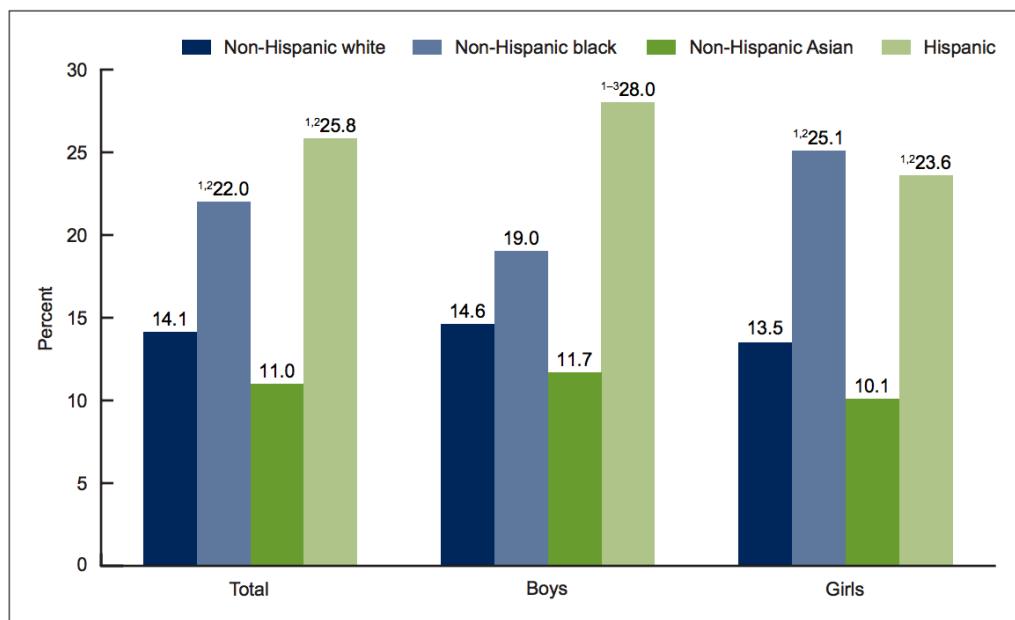
**Obesity in adults was defined as a BMI of greater than or equal to 30.*



Hispanics (47.0%) and non-Hispanic blacks (46.8%) had the highest age-adjusted prevalence of obesity, followed by non-Hispanic whites (37.9%) and non-Hispanic Asians (12.7%).

**Obesity is defined using cut points of body mass index (BMI). BMI does not measure body fat directly, and the relationship between BMI and body fat varies by sex, age, and race and Hispanic origin.*

Appendix 4: Prevalence of obesity among youth aged 2–19 years, by sex and race (Hispanic origin, blacks, Asians): United States, 2015–2016¹



The prevalence of obesity was higher among youth aged 6–11 years (18.4%) and adolescents aged 12–19 years (20.6%) compared with children aged 2–5 years (13.9%).

**Obesity in youth was defined as a BMI of greater than or equal to the age- and sex-specific 95th percentile of the 2000 Centers for Disease Control and Prevention growth charts.*