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TITLE Eating habits of professional firefighters: comparison with national guidelines and impact of a healthy eating promotion program

Abstract

Objective: Firefighters' eating habits may be an additional risk factor for metabolic diseases. We assessed eating habits of firefighters, compared them to national guidelines, and evaluated the impact of a prevention program.
Methods: Twenty-eight professional firefighters from a Swiss airport benefited from a healthy-eating program. Food intake, eating behavior, and anthropometric data were collected at baseline and 1-year follow-up using an electronic food record, questionnaires, and bio-impedance.
Results: Participants had unbalanced diets with low-quality food choices associated with low intakes of fibers and micronutrients compared with national guidelines. Intervention did not impact eating habits or anthropometrics data at the group level, but changes were measured in sub-groups. Main reported barriers for healthy eating were lack of motivation, prioritization, or time.
Conclusions: Intensive and culturally tailored prevention interventions targeting nutritional behaviors are needed at the individual, group, and organizational levels.

Keywords

Nutrition, Firefighters, Prevention, Healthy eating promotion program

Introduction

Despite the high physical demands of firefighting, the prevalence of sedentary lifestyles, obesity, hyperlipidemia, and hypertension are relatively high among firefighters.[1] These factors lead to an increased risk of cardiovascular disease (CVD), which is the primary cause of on-duty death among firefighters,[2] representing 39% to 50% of on-duty fatalities in US firefighters.[2-4] In addition, CVD represents a major cause of morbidity and disability with an estimated 17-25 nonfatal on-duty CVD for every fatal event in this population.[5]

On top of classic cardiovascular disease risk factors such as age, smoking, hypertension, obesity, dyslipidemia, diabetes, or preestablished coronary heart disease, firefighters face specific chronic stressors and acute cardiovascular (CV) strains. Chronic stressors include inadequate physical activity, poor dietary habits, circadian disruption due to shiftwork, sleep deprivations, psychological stress, smoke exposure leading to hypoxia and free radical formation, and excess noise.[2] Acute CV strains of firefighting include a sympathetic nervous system activation leading to an increased heart rate, a high physical workload including dynamic aerobic and static physical exertion, heavy personal-protection devices, exposure to heat, and dehydration leading to decreased plasma volume and hemoconcentration. Together, these factors may trigger sudden cardiac events through several biologically plausible pathways: increased stress leading to a rupture of vulnerable plaque, hypercoagulability, or a lack of oxygen for responding to the increased myocardial oxygen demand.[2]

Obesity prevalence in firefighters also reaches concerning levels. They rank third in obesity prevalence among 41 male occupations in the United States, and this prevalence tends to increase.[6,7] Obesity is a risk factor for CVD and for injuries.[8] In a longitudinal study, baseline weight status was a significant predictor of musculoskeletal injuries, with obese firefighters being 5.2 times more likely (95% CI = 1.1-23.4) to experience a musculoskeletal injury compared to their normal-weight colleagues over the course of a 9-month period (professional firefighters).[9]

Occupational and behavioral causes of obesity are strongly interrelated in firefighters, especially regarding eating habits, beyond individual food choice.[10] The unpredictability of the job is a major factor influencing food and meal choices. However, a qualitative study[11] identified 4 other factors influencing food and meal choices: 1) physiological (fatigue, physical health, hunger, and craving), 2) psychosocial (lifestyle choices, experience, and shift work colleagues), 3) physical environment (availability and access, station location, convenience, and ambulance environment), and 4) organizational environment (night vs day vs afternoon shift, workload, and meal break structure). Another study based on focus groups identified 5 main determinants of obesity among firefighters: 1) fire station eating culture, 2) night calls and sleep interruption, 3) supervisor leadership and physical fitness, 4) sedentary work, and 5) age and generational influences.[10]

As lifestyle factors are important modifiable predictors of sudden cardiac deaths in firefighters [4] or work ability,[12] a limited number of health promotion interventions have been developed and evaluated among firefighters. The largest intervention implemented is the "Promoting Healthy Lifestyle: Alternative Models' Effects" (PHLAME), a 12-month prospective randomized-controlled trial comparing individual one-on-one motivational counseling or a team-based, peer-led, healthy-promotion approach to a control condition. The study showed that both interventions had beneficial effects on LDL cholesterol and exercise habits compared to controls. The group intervention also demonstrated better weight control, more fruit and vegetables intake, and perceived well-being compared to controls.[13,14] Even 4 years after the end of the intervention, physical activity and nutrition remained improved compared with baseline.[15] Other 1-group, short-term nutritional interventions

showed positive results. In a 12-week, low-glycemic nutritional and fitness program (twelve 2-hour sessions), the number of firefighters diagnosed with metabolic syndrome decreased from 7 to 3 out of 10 at the end of the program. However, these results were only partially maintained 6 months after the end of the program.[16] Goheer and colleagues reported that the majority of the 90 participants declared changes in the food environment at their stations and in their homes following a 6-month intervention based on monthly education sessions (nutritional presentations and cooking demonstrations).[17]

It is well established that, for occupational and behavioral reasons, firefighters face an increased risk of obesity and CVD and that their eating habits are suboptimal. The details of their intake at the food and nutrient level, as well as their eating behaviors, are less understood even though it is essential to base prevention intervention on actual practice to increase acceptability. On top of that, the majority of current studies have been carried out in the US, and, even if the work schedules and living quarters appear comparable, the culture may influence firefighters' eating habits. Therefore, our study aimed to assess the eating habits of a Swiss firefighter population, to compare them to national Swiss dietary guidelines, and to evaluate the impact of an intervention on their nutritional intake, eating behavior, and anthropometric data.

Methods

Study design

In a pre- and postintervention design, we analyzed the food and nutrient intake and the eating behaviors of firefighters before and after a healthy-eating promotion intervention. Baseline measurements, including food record, questionnaires and anthropometric measures, took place in April and May 2016 and follow-up measurements between May and July 2017. Further, we compared the results with national guidelines and evaluated participants' perception of the intervention.

Sample and procedures

Participants (n = 28) were male professional firefighters from the fire service of an international airport comprising a total of 68 firefighters (participation rate 41%). Firefighters work 12-hours shifts (dayshift from 7am to 7pm, nightshift from 7pm to 7am) organized into 2 dayshifts followed by 2 nightshifts, 1 day of recovery, and 3 days off. Compared to other airport employees, firefighters have an autonomous organization and are based in the fire station. Compared to community fire services, our population had more predicable activities and their usual planning, outside emergencies, includes a breakfast and snack break around 8:30am and a lunch cooked on site by 2 firefighters from the team around 12:00pm. For dinner (around 8:30pm), firefighters bring food from home, reheat leftovers from lunch, or buy food in nearby restaurants.

All firefighters participated in an informational meeting about the study and were invited to participate. Measures took place during work hours. All participants signed an informed consent letter, and the Geneva Cantonal Ethics Committee on Research Involving Humans approved this research project.

Intervention

This healthy-eating promotion program took place within a larger health-promotion campaign organized by the airport for their employees. Indeed, the airport had set up a 3-year program focusing each year on a different

topic: prevention of falls and ergonomics in 2015, healthy eating and physical activity promotion in 2016, and stress management and mental health in 2017.

The healthy-eating and physical-activity program included one 1-hour education session in each department, 15-minutes of individual coaching from a dietitian for interested employees, and improved-eating offers and events. As firefighters faced unique challenges and specific team organization within the airport, they benefited from a reinforced healthy-eating promotion program. Their intervention included a 1-hour educational workshop (in June 2016) and a cooking class (in October/November 2016). Each participant received 1 hour of individual coaching from a dietitian (in April/May 2016). Researchers and clinicians implemented the intervention. Table 1 presents the unique program components specifically developed for the firefighters (in grey), as well as the components targeting all airport employees.

Table 1

Measurements and analysis

We performed identical measurements in 2016 and 2017, including an electronic food record, questionnaires, and anthropometrics.

Food, nutrient, and energy intake

Participants used a previously validated electronic food record[18] to log food and beverage intake during 5 consecutive days (1 complete shift), including 2 day shifts, 2 night shifts, and 1 day of recovery. For each food or drink consumed, participants indicated the date, time of the day, type of food or beverage, and portion size. An experienced dietitian reviewed food records with the participants. Nutrient and energy intakes were calculated using data from the Swiss Food Database Composition.[19] Food group servings were calculated according to the Swiss Food Guide Pyramid.[20] We compared participants' intake to the Swiss nutritional dietary guidelines and calculated the number of participants who followed each of the 7 main Swiss Food Guide Pyramid recommendations (non-caloric beverages, fruits and vegetables, dairy products, meat-fish-eggs, vegetable oil, nuts-seeds-olives, and alcohol). To assess eating habits globally, the global score "Plan National Nutrition et Santé Guideline Score" (PNNS-GS) was used to assess the compliance with food intake recommendations.[21] This validated score is based on the French recommendations, which are similar to the Swiss ones.

Eating-behavior questionnaires

We assessed eating behavior using scores from the French-validated Dutch Eating Behavior Questionnaire (DEBQ) [22] and the Intuitive Eating Scale (IES).[23] The DEBQ assesses 3 eating styles: 1) emotional eating, which is eating in response to negative emotions (such as depression and discouragement) as an atypical response to distress; 2) external eating, which is eating in response to food-related stimuli (such as sight, smell, and taste of food) regardless of the internal status of hunger and satiety; and 3) restrained eating, which is a potential side effect of dieting, specifically the disinhibition effect. Intuitive eating has been defined as "eating in response to physiological hunger and satiety cues rather than external and/or emotional cues, in addition to low preoccupation with food."[23] The French version of IES-2 assesses 3 central features of intuitive eating: 1) eating

for physical rather than emotional reasons, 2) unconditional permission to eat, and 3) reliance on hunger and satiety cues. A higher score indicates greater levels of intuitive eating or its dimensions.

General health and characteristics questionnaire

An online questionnaire evaluated the familial context, smoking habits, supplements intake, and health problems including diabetes, allergies, intolerances, and digestive disorders. Participants reported their perceived health on a 100-point Likert scale using a slider.

Intervention-evaluation questionnaire

In an online questionnaire given after the intervention, participants reported their participation in and awareness of the intervention components. Following the transtheoretical model,[24] 2 questions evaluated readiness to change regarding 2 national recommendations (5 portions of fruits and vegetables and limited sugar-sweetened beverages). Participants estimated if their eating habits were healthy or not on a 10-point scale. Participants reported if they had tried to improve their diet or to maintain an overall diet in the last few months. An open-ended question detailed barriers or facilitators for that task. Barriers to healthy eating were further investigated using questions from the Swiss Health Survey.[25] Finally, participants evaluated if they had sufficient knowledge and skills to eat healthily as well as their support for healthy eating at the private and professional level.

Anthropometrics

Participants, with clothes (empty pockets) but without shoes, were weighed on a scale to the nearest 0.1 kg. We took 1 kg off the measured weight to account for clothes. Height was measured standing to the nearest 0.1 cm using a portable stadiometer. Body composition was assessed using a 4-point bioelectrical impedance analysis and the local validated Geneva formula.[26] Obesity or an overweight status was defined using the World Health Organization definition for BMI,[27] the Fat Mass Index (FMI),[26] and the American Council on Exercise cut-off for percent of body fat (max 25%).[28] The same investigator (SBDT) performed all measures.

Analyses

Data are presented as mean (standard deviation). Paired *t* tests were performed to compare variables at baseline and follow-up. Relations between quantitative changes between follow-up and baseline in respectively physiological measurements and behavioral (dietary) measurements were analyzed using linear regression. Sub-groups were compared based on participant's perceived changes collected at the end of the intervention.

Results

Population and intervention process

Twenty-eight firefighters allocated in 4 rotating crews participated in the baseline and follow-up measurements. Their mean age was 40.2 ± 6.3 and their mean years of service within the company 17,0 ± 6.3. We had no dropouts, but 2 participants did not fill out the online general and eating-behavior questionnaires at baseline and follow-up, and 2 participants did not fill the electronic food record at follow-up.

Regarding the intervention, 17 (63%) participants took part in the 1-hour educational class on eating for shiftworkers, and 16 (59%) of them took part in the cooking workshop. All received 1-hour of individual coaching on nutrition. Four of them registered for a workshop outside work hours that was open to all airport employees. The majority of the participants noticed the seasonal poster (n = 20, 74%) and the fruit basket distribution (n = 23, 85%).

Anthropometrics

At baseline, 10 participants (36%) had a BMI between 18.5 and 24.9 kg/m^2, 12 had a BMI between 25.0 and 29.9 kg/m^2 (43%) and 6 had a BMI over 30.0 kg/m^2 (21%). Using FMI and percentage of body fat, 8 (29%) and 15 (54%) were respectively classified as having excess weight.

The mean weight and BMI did not change between the baseline and the follow-up (Table 2). During that time, 10 participants increased their weight by 2 kg or more and 6 decreased their weight by 2 kg or more. The mean percentage of body fat mass and the FMI were not statistically different at baseline and follow-up.

Table 2:

Energy and nutrient intake

Participants reported a mean energy intake of 2251 ± 117 kcal at baseline and 2131 ± 145 kcal at follow-up. At baseline, participants reported nutrient intakes within Swiss recommendations for proteins, at the high end for lipids, and lower than recommended for carbohydrates and fibers (Table 3). The mean intake of alcohol followed the recommendations, however, seven participants (25%) had an intake greater than the maximum 20 g/d recommended. Figure 1 describes the intake of micronutrients at baseline compared to the Swiss recommendations. Mean intakes of all but vitamin B12 were below the recommended intakes. At 1 year, at the group level, participants reported a decrease of 120 kcal in energy intake (difference nonsignificant). Protein and lipid intake did not significantly change, but participants reported a lower intake of carbohydrates and fibers as well as a higher intake of alcohol (10 participants reported an intake greater than 20 g/d).

Table 3

Figure 1: Coverage of micronutrients needs (100% = Swiss recommendations) at baseline (n = 28)

Food groups, food quality

The qualitative analysis of participants' food intake indicated an unbalanced food intake (Table 4). In particular, their consumption of fruit, vegetables, whole grains, and dairy was below recommendations. On the other hand, their mean consumption of meat, fish and eggs, as well as sugar-sweetened beverages was higher than recommended. Nine participants (7 at follow-up) did not drink any sugar-sweetened beverage. None of the participants followed the 7 main Swiss Food Guide Pyramid recommendations and 3 of them (4 after the intervention) followed 3 or more guidelines. The mean PNNS-GS score, summarizing the extent to which each participant followed the national French nutritional recommendations, was 6.53 ± 0.28 at baseline and 6.06 ± 0.33 at follow-up, out of a maximal score of 15. The median PNNS-GS score (IQR) was 6.5 (5.5; 7.4) at baseline

and 6.3 (5.3; 7.05) at follow-up. There was no statistically significant difference in the mean PNNS-GS score between the 4 rotating firefighters crews and none of the crews significantly changed their mean score at baseline and follow-up.

Table 4:

After the intervention, 15 participants (56%) reported that they tried to improve or maintain their eating habits during the previous months. We compared behavior changes in this sub-group to the participants who reported no particular efforts regarding their eating habits in the previous months. There was no statistically significant difference in the evolution of PNNS-GS score or fruit and vegetables consumption between participants who reported having tried to improve or maintain healthy eating habits compared to those who did not try. However, the first group reported significantly less energy intake at follow-up (- 353 kcal, ± 512) compared with the second group (+340 kcal, ± 458) ($p<0.005$). In a second step, we assessed anthropometric changes of all participants, as a function of behavior changes (food intake). In this analysis, an increase in fruit and vegetables intake was associated with a decrease in weight ($p=0.03$) and BMI ($p=0.04$). However, changes in energy, sugar-sweetened beverages, fibers or alcohol intakes were not associated with anthropometric measures.

Eating behavior

DEBQ at baseline and follow-up revealed no change in emotional and external eating (Table 5). However, the mean level of restrained eating increased. At baseline, 6 participants had a high score (score ≥ 3) for "restrained eating," 3 for "emotional eating," and 12 for "external eating." After the program, these numbers were respectively 9, 2, and 11.

The Intuitive Eating Scale (IES) overall score decreased between baseline and follow-up (Table 5). Reliance on hunger and satiety cues did not change, unconditional permission to eat decreased, and the scale for eating for physical rather than emotional reasons also decreased.

Table 5

Perceived health and digestive disorders

When asked to give a score to their overall health, zero being a very poor health and one hundred the best health possible, the mean score at baseline was 83.6 ± 20.5 and 87.1 ± 10.7 ($p = 0.2$) after the program. Before the program, 10 participants (35.7%) reported having weekly digestive problems (heartbuns, bloating, diarrhea, constipation, or abdominal pain) and 12 (42.9%) reported those disorders monthly. After the program, these prevalences were 2 (7.1%) and 20 (71.4%), respectively. Eight participants reported a decreased frequency of digestive disorders from weekly to monthly. Results not presented in main manuscript can be found as Supplemental Digital Content (Supplemental_Digital_Content_Questionnaire_R1.pdf).

Self-evaluation and perceived barriers and facilitators for healthy eating

Two questions evaluated the readiness to change of participants on 2 national recommendations using the transtheoretical model.[24] Regarding eating 5 servings of fruits or vegetables per day, 5 participants were in the

precontemplation stage, 5 in contemplation, 3 in preparation, and 13 reported already being in action (4 of them in the last 6 months and 9 for more than 6 months). Regarding limiting sugar-sweetened beverages, 3 were in precontemplation, 2 in contemplation, 1 in preparation, and 21 in action.

After the program, 15 participants declared that they had tried to improve their diet or to maintain an overall healthy diet in the last few months. The following factors helped them to succeed, even partially: providing a good example to their children currently or in a near future, pleasure in cooking, their own motivation, and self-image. For those who did not succeed, even partially, the following factors were cited: lack of motivation, lack of willpower, lack of time for meal planning, lack of priority, and social meals with friends.

Participants were asked what potential barriers prevented them from following current national nutritional guidelines. The most frequent perceived barrier was "I don't think spontaneously" (n = 14, 52%) followed by "I don't have the time" (n = 11, 41%) and "I don't want to limit myself (n = 8, 30%). Few participants thought that the investment was too high (n = 4), that it was impossible for them (n = 3), that it was too expensive (n = 1), or that they didn't believe in the recommendations (n = 1). No one answered that the recommendations were contradictory or that a healthy diet was not important for them. The majority of participants thought they had sufficient knowledge (n = 20) and skills (n = 21) to eat healthy, however, respectively, 7 and 6 felt that they lacked knowledge or skills. When asked to assess the support they perceived from their entourage at a private or professional level from 0 to 10, the mean scores were, respectively, 6.8 ± 2.4 and 4.0 ± 1.8 with a median of 8 for private and 4 for professional support.

Discussion

Firefighters participating in this study had low-quality food choices and especially low intakes of fruits, vegetables, whole grains, and dairy associated with unbalanced nutritional intakes, primarily low intakes of fibers and micronutrients. The main reported barriers for healthy eating were the lack of motivation, personal priorities, and lack of time. At the group level, eating habits and anthropometric data were not significantly changed after the intervention. However, statistically significant changes were measured in sub-groups of participants.

Comparisons of eating habits and behaviors with the general population

Firefighters have a recognized increased risk for cardiovascular diseases, and this study showed that their eating habits might constitute an additional risk factor. Actually, not only are they far from the nutritional recommendations, but they also seem to have a more unbalanced diet than the general population. In our sample, this was especially visible when comparing food group intakes to recommendations and when analyzing the number of Swiss dietary guidelines followed. Only 3 participants (10.7%) followed 3 dietary guidelines or more, compared with 37.3% of men in a national sample from Switzerland.[33] Protein, lipid, and carbohydrate intakes were closer to the recommendations, but a more detailed analysis revealed a high intake of saturated fatty acids and a low intake of fibers, indicators of poor-quality food sources for these nutrients. In a large study performed in France, the median PNNS-GS score that reflect adherence to the French dietary recommendations (higher scores meaning better adherence) was 7.55, and the lowest quartile scored 6.25 or lower.[21] In comparison, our participants had a lower median PNNS-GS score with 6.5 before and 6.3 after the intervention.

However, we noted that the participants who reported that they had tried to improve or maintain their eating habits during the previous months effectively reduced their energy intake after the intervention, even if the nutritional quality of their intakes was not changed. Nevertheless, this change was not directly related to an improvement in anthropometric measures. Among behavioral changes, only the change in fruit and vegetable intake was significantly associated with a change in weight and BMI in the desired direction.

Following the intuitive eating philosophy, one should rely on internal cues and hunger-satiety feelings to guide eating choices and regulate the amount ingested. In shiftworkers, however, an erratic work schedule and desynchronized circadian rhythms impact the hunger-satiety cues and potentially lead them to overeat.[34,35] Likewise, in the general population, dietary restriction is generally considered a risk factor for developing eating disorders.[36] In our sample, we observed a decrease in the intuitive eating scale and unconditional permission to eat and an increase in dietary restriction after the intervention. Although this might be seen as a negative outcome following the arguments above, we argue that for this population, and in an environment stimulating unhealthy food choices, dietary restriction may act as a transitory step toward healthier food choices and adapted portion sizes. In a French population sample, for example, a higher unconditional permission to eat was also associated with more unhealthy choices and higher energy intake [37].

Barriers and facilitators to healthy eating

Similarly to the Swiss population,[38] our sample ranked daily habits, time, taste, and lack of willpower as the main barriers for healthy eating. In our study, however, price was rarely reported as a significant barrier. The issue of willpower relates to self-motivation and plays a key role in implementing healthy behaviors.[39] At first glance, this may appear as an individual matter. Self-motivation is, however, strongly reinforced by interpersonal influences. For example, the team's cohesion and upper management may facilitate or hamper healthy behaviors and can play a crucial role in favoring or disfavoring a prevention intervention.[39,40] Jahnke and colleagues (2012) highlighted that the food environment in fire stations was "strongly rooted in tradition and uniquely resistant to change."[41] Therefore, healthy-eating promotion may encounter unique barriers among firefighters. Several studies have described the eating culture within fire stations. On site, it is usual for professional firefighters to cook "family style" meals often based on meat and fulfilling foods. Firefighters generally cook more than enough foods to be sure to not run out. Some foods, such as salad or fish, are not seen as filling enough, and high caloric snacking is part of the culture. Desserts are systematically present at meals and snacking at night is ubiquitous to contribute to the team camaraderie, to stay alert, and to cope with fatigue.[10,42]

Prevention interventions for firefighters

Accumulation of cardiovascular risks can lead to 2 important negative occupational outcomes: 1) a diagnosis of a cardiovascular disease incompatible with medical fitness for duty and 2) the appearance of an undiagnosed cardiovascular disease raising the risk of an on-duty cardiovascular event. Prevention measures are therefore crucial. Poston and colleagues have provided evidence for an association between a well-developed health-promotion program at fire departments and the health and wellness of firefighters. They showed that, compared with departments without specific wellness and health-promotion programs, firefighters from departments with such programs had an overall better body composition; a lower prevalence of obesity, hypertension, anxiety disorders, and smoking; and greater levels of physical activity and job satisfaction.[43]

However, as firefighters face specific health risks, work conditions, and culture, health-promotion interventions traditionally implemented in workplaces may not fit the full context of firefighters' socio-cultural environment.[39] Cultural relevance and tailoring the unique organization seem to be key factors for successful programs.[39,40] Integrating firefighters' perspective is crucial for developing feasible, relevant, and acceptable worksite interventions that promote healthy eating, prevent weight gain, and go beyond individual health-promotion efforts.[5,10] Following the social-ecological framework, future interventions need to intervene at multiple levels of risk reduction: intrapersonal, interpersonal, and organizational.[39] In the literature, firefighters suggested individually focused interventions aimed at providing knowledge, tools, skills, and resources for improving their health.[44] However, numerous public-health approaches have stressed the importance of interventions at the interpersonal and environmental levels to support healthy choices.[45] In fact, an individual and a group approach appear necessary and complementary. An individual approach takes each firefighter's specific characteristics and tailors the personal objectives and advice to the firefighter's medical and weight history, eating habits, and personal situation. Occupational medical visits could, for example, constitute an excellent individual prevention opportunity. A US study, however, showed that most firefighters, obese or not, had received no weight advice while visiting a health-care professional.[46] A group approach, on the other hand, could gradually modify the "fire station culture" and change the perceived norms concerning exercise and healthy eating. To increase the uptake of an intervention, participants of focus groups emphasized the importance of leadership in fire service culture and explained that leaders' support for any health and wellness program would be critical to obtaining full adoption from all firefighters. At the same time, they cautioned against mandating participation in a health-promotion program and highlighted the importance of individual commitment.[44] Competition may also be a strategy to increase motivation for an intervention.[44]

Challenges to measure intervention impact

Our intervention did not improve quantitative measures of eating habits or anthropometric data in our population at the group level between baseline and follow-up measurements. The mean results may not reflect the individual trajectories and, indeed, we were able to identify a sub-group of participants who reported behavioral changes and those also showed significant changes in some outcomes measured.

Several factors may explain the lack of impact at the group level. First, even if spread over 1 year, the intervention had a low level of intensity. At best, each participant filled in 5 days of food records and a questionnaire at baseline, had one 1-hour individual counseling session with anthropometric measurements, and participated in 1 class on eating and shiftwork (circadian rhythms) and 1 cooking class. They had the optional opportunity to register for additional events at the company level. Secondly, participation in the study was optional and less than half of the firefighters registered. Therefore, the group effect was certainly lower than in some other interventions. The PHLAME intervention observed that the group dynamic and cohesion increased support for changes in lifestyle and social norms and led to a shared commitment and mutual accountability.[13,40] Lastly, the absence of weight gain might already be a positive outcome, as adults tend to gain weight progressively throughout middle age. With an average weight gained of 0.5 to 1 kg per year, even this modest accumulation of weight over time can lead to obesity.[47]

Strengths and limitations

Our study has several limitations, including the lack of a control group that would have been needed to interpret any effect of the intervention, and the rather small sample of 28 firefighters. However, we had no dropouts and participants were strongly involved and motivated for the data collection. This resulted in high-quality data. This is especially important for the 5-day food record that otherwise represents a weak spot in data collection. The use of a food record is also an asset of the study compared to food frequency questionnaires used in many studies in the field. This method allows a detailed analysis of food intake and, in particular, precise information on food quality, structure, and quantities. However, these data were self-reported, therefore we cannot exclude under- or misreporting. The same is true regarding perceived health. Our second measures were delayed by 2 months in summer, and food records reflect this change. For example, more barbecues and more beers may explain the slight increase in alcohol intake. Lastly, other well-being interventions in this population were taking place at the same time during the employer's campaign, and a new sport-coaching program was being deployed among firefighters. This may potentially act as a confounder for the body composition and well-being subjective scale measure.

Conclusions

Firefighters face an increased risk of metabolic disorders and unhealthy eating habits may present an additional risk factor. Therefore, healthy eating and health promotion interventions are urgently needed at individual, group, and environmental levels. Culturally relevant, tailored programs have the potential to change the firehouse eating culture. Occupational medical visits constitute an opportunity to evaluate eating habits and provide individualized preventive advice. Future interventions should also address the motivation factors supporting behavior changes and the maintenance of these healthy lifestyle changes at mid- and long-term ranges.

Supplemental_Digital_Content_Questionnaire_R1.pdf

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TITLE Eating habits of professional firefighters: comparison with national guidelines and impact of a healthy eating promotion program

Clinical significance

Firefighters have an increased risk of on-duty cardiovascular sudden death, partly due to occupational and behavioral risk factors such as obesity and hyperlipidemia. Eating habits need to be assessed during health visits, and more intensive and culturally-tailored prevention interventions are needed at the individual, group, and organizational levels.

Table 1: Components of the healthy eating promotion program in the airport (in grey: components developed only for firefighters; in white: components targeting all employees).

Intervention especially targeting the Fire Department	One-hour workshop focused on healthy eating and structure of food intake for shiftworkers. Discussed topics: circadian rhythms, eating structure, choice of food for a balanced meal or healthy snack, speed of meal eating, nutrition and physical activity.
	Cooking class in the fire station with a chef and a dietitian where all the present firefighters help to prepare the meal and enjoyed it for lunch. Discussed topics: menu planning, components of a balanced meal, fruits and vegetables, choice for added fats, cooking techniques, recommended serving sizes, energy density, mindful eating.
Individual consultation for study participants	All participants of the study benefited from a one-hour individual coaching session from a dietitian at baseline and at the end of the study. The results from their food record and anthropometric measurements were discussed with a dietician in regards to their individual characteristics and goals. Participants received personalized counseling to improve their eating habits if needed.
Intranet articles	Two articles published on intranet: 1) Balanced meals and ideas for quick recipes, 2) Tips for healthy eating.
Fruit baskets	Monthly delivery of fresh fruit basket.
Recipe workshops (2 sessions)	Workshop open to all participants and their partners (outside working hours): Each participant establishes during the workshop a portfolio of healthy recipes and a meal plan for two weeks according to his taste and constraints. Themes: criteria for a balanced meal, adaptation of recipes, balance over the week.
Cooking workshops (2 sessions)	Workshop open to all participants and their partners (outside working hours): Preparation and tasting of quick, practical and balanced recipes. Themes: balanced meals, choice of fat, cooking techniques, whole grains and legumes, energy density.
Posters	4 seasonal posters, each of them with two messages: one focused on nutrition and one on physical activity.
Menus « I Feel Good »	Two restaurants serving mostly employees from the airport set up a “I Feel Good” menu or combo every Thursday since March 2016. These menus follow criteria of healthy and balanced nutrition and are checked by a dietitian.
Breakfasts with *Norbert* (cook and starguest from a French TV show)	Preparation of recipes of breakfasts by *Norbert* and his “brigade”, composed of employees of the airport: 1) Tutorials available on the intranet, 2) One-shot event for airport passengers. A dietician proposed all the recipes.

Table 2: Participants' anthropometric data at baseline and follow-up (mean ± SD)

	Baseline (n=28)	**Follow-up (n=28)**	**t-test**
Weight (kg)	85.7 ± 14.2	86.1 ±13.9	p=0.91
BMI (kg/m^2)	27.1 ± 3.7	27.2 ± 3.6	p=0.88
Percentage of body fat mass	23.8 ± 6.5	22.9 ±6.8	p=0.62
Fat Mass Index	6.62 ± 0.48	6.44 ± 0.50	p=0.80

Table 3: Participants' energy and macronutrient intake at baseline and follow-up, compared with the Swiss recommendations

Intake		Swiss recommendations	Baseline n = 28	Follow-up n = 26	Ttest
Energy			2260 ± 602	2193 ± 698	p=0.71
Proteins	g/d		95.5 ± 21.8	98.4 ± 24.4	p=0.65
	% energy intake without alcohol	10 – 20% [29]	18.4 ± 5.0	19.8 ± 4.8	p=0.33
	g/kg body weight	0.8 – 2.0 g/kg [29]	1.13 ± 0.27	1.15 ± 0.29	p=0.79
Lipids	g/d		85.3 ± 30.5	90.0 ± 33.1	p=0.58
	% energy intake without alcohol	20 – 35% (max 40%) [30]	35.4 ± 7.2	39.0 ± 6.5	p=0.06
SFA	g/d	<20g [30]	33.6 ± 13.7	36.1 ± 14.3	p=0.51
	% energy intake without alcohol	<10% [30]	13.9 ± 3.3	15.6 ± 3.1	p=0.05
Carbo-hydrates	g/d		243.7 ± 92.0	209.7 ± 88.2	p=0.17
	% energy intake without alcohol	45 – 55% [31]	44.8 ± 9.1	39.7 ± 7.6	p=0.03
Added sugars	g/d		50.8 ± 39.8	39.5 ± 28.9	p=0.24
	% energy intake without alcohol	Max 10% [31]	8.6 ± 6.6	6.9 ± 3.9	p=0.26
Fibers	g/d	30g [31]	18.0 ± 7.2	15.5 ± 7.8	p=0.24
Alcohol	g/d	Max 20g [32]	15.0 ± 23.8	16.8 ± 3.4	p=0.75
	% total energy intake		4.4 ± 6.9	5.0 ± 5.1	p=0.75

SFA saturated fatty acids
d day

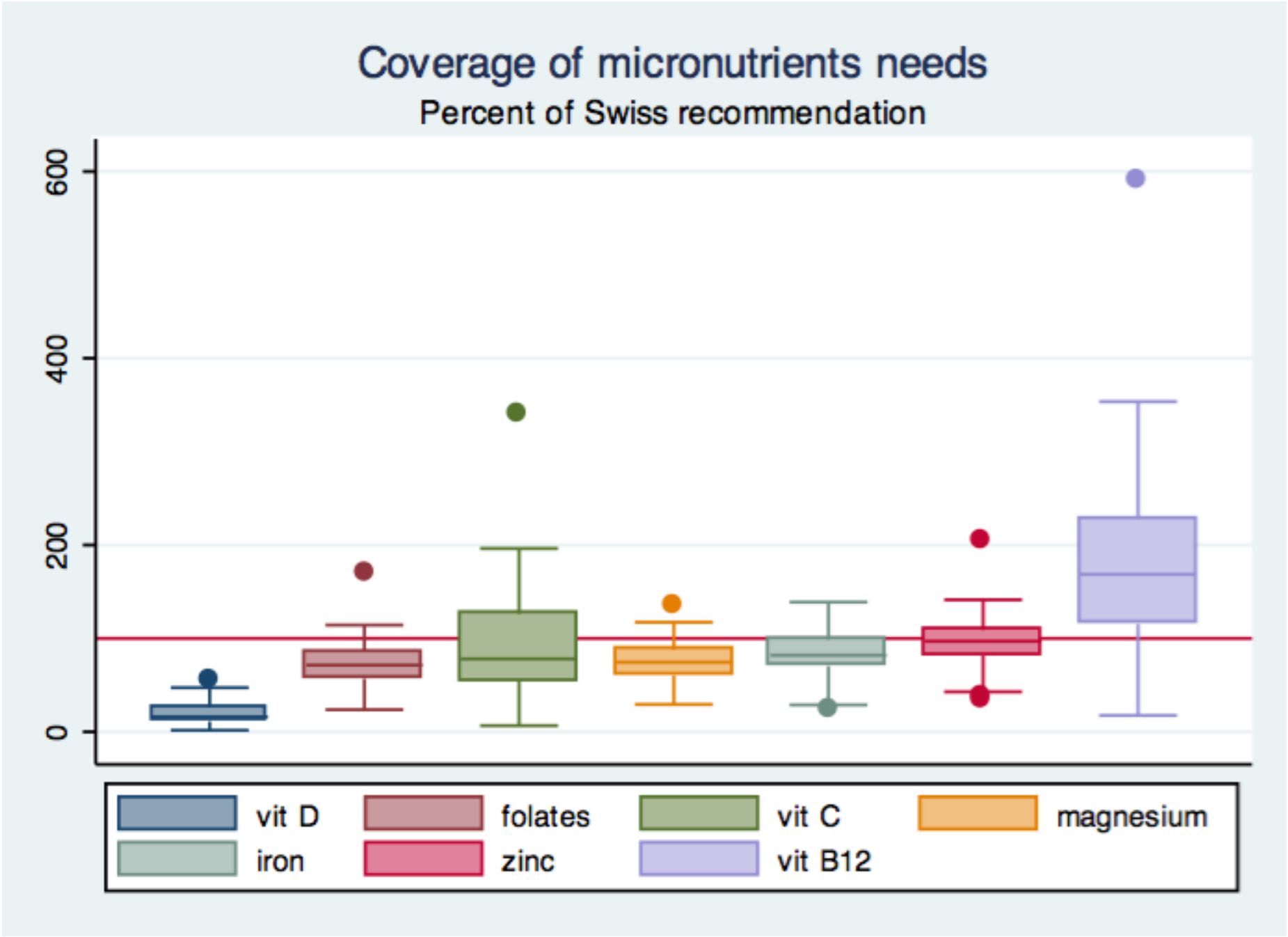
Table 4: Participant's food groups intake at baseline and follow-up, compared with the Swiss recommendations.

	Swiss recom-mendations	Baseline (n=28)	Follow-up (n=27)	t-test
Fruit and vegetables (serv/d)	5	2.63 ± 1.7	1.96 ± 1.2	p=0.10
Total starchy food (serv/d)	3	3.15 ± 1.3	2.83 ± 1.21	p=0.34
Whole grain (serv/d)	1.5	0.25 ± 0.45	0.18 ± 0.21	p=0.50
Meat, fish, eggs (serv/d)	1	2.04 ± 0.66	2.34 ± 0.89	p=0.17
Dairy (serv/d)	3	1.35 ± 0.97	1.56 ± 0.91	p=0.42
Added fats (serv/d)	2.5	3.03 ± 2.46	2.87 ± 1.92	p=0.79
Sweets, salty snacks & alcohol (serv/d)	1	3.30 ± 2.42	3.07 ± 2.25	p=0.72
All drinks (ml/d)	1000-2000	1510 ± 640	1543 ± 840	p=0.87
SSB (ml/d)	-	267 ± 456	223 ± 230	p=0.65
PNNS-GS score	-	6.48 ± 1.43	5.97 ± 1.71	p=0.24

Serv = servings
d = day
SSB = sugar-sweetened beverages
PNNS-GS = Plan National Nutrition et Santé Guideline Score (healthy eating score)

Table 5: Participant's scores of the Intuitive Eating Scale (IES) and Dutch Eating Behaviour Questionnaire (DEBQ) at baseline and follow-up.

	Baseline (n=26)	Follow-up (n=27)	Ttest (n=25)
IES - Intuitive eating scale	3.69 ± 0.54	3.36 ± 0.86	p=0.04
IES - Eating for physical rather than emotional reasons	4.00 ± 0.81	3.44 ± 0.94	p<0.005
IES - Reliance on hunger and satiety cues	3.33 ± 0.71	3.36 ± 1.00	p=0.94
IES - Unconditional permission to eat	3.59 ± 0,82	3.20 ± 0.92	p=0.05
DEBQ – Restrained eating	2.44 ± 0.79	2.59 ± 0.83	p=0.11
DEBQ – Emotional eating	1.70 ± 1.01	1.68 ± 0.79	p=0.71
DEBQ – External eating	2.87 ± 0.46	2.88 ± 0.53	p=0.72


Coverage of micronutrients needs
Percent of Swiss recommendation
600
400
200
0
vit D
folates
vit C
magnesium
iron
zinc
vit B12