Optimizing Firefighter Nutrition: Average Glycemic Index of Fireline Meals

Ben McLane

Idaho City Hotshots eating dinner on the 2016 Pioneer Fire, Boise National Forest, ID. Photo: USDA Forest Service.

As wildfire seasons have expanded in duration and intensity, the effort and dedication required of wildland firefighters have increased (Withen 2015). Firefighters now work from April, when fuels first become available for burning, until well into the winter months of December and January. As fire seasons have grown into "fire years," maintaining firefighter health and well-being has become a rising concern.

NUTRITIONAL REQUIREMENTS

During a 16-hour shift, wildland firefighters can burn more than 6,000 calories (Domitrovich and Sol 2017), so chronic fatigue is a constant concern (Zaske 2018). Both nutrition and fatigue can affect the physical and cognitive ability of wildland firefighters to do their jobs well and safely (Aisbett and others 2012). The National Interagency Fire Center and the Forest Service have established nutritional requirements for companies providing firefighter meals (NIFC/FS, n.d.). The requirements pertain to food type and quality, caloric content, and serving size.

This article summarizes results of a case study I did on nutritional requirements for wildland firefighters as part of completing my graduate degree at the University of Idaho. I reviewed the literature on optimal nutrition for endurance athletes, assessed the glycemic index (GI) of meals offered to the fire crew I am on, and conducted an informal survey of my fellow firefighters about their energy levels.

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My subjects were the 20 members of the Elk Mountain Interagency Hotshot Crew throughout their 2018 fire season, when they worked more than 950 overtime hours in four Western States. The crew recorded almost 1,300 hours on active fire incidents. For hotshots, the daily duration and magnitude of physical exertion can equal that of elite endurance athletes such as marathon runners (Loftin and others 2007). For endurance athletes, proper nutrition is essential for best performance (Baar 2014).

GLYCEMIC INDEX

A nutritional requirement for endurance athletes is to manage blood-sugar levels during exercise, and different carbohydrate foods can cause differing blood-sugar responses (Dunford and others 1995). One way of managing blood glucose is through the GI of food and drink. GI is a measure, on a scale of 1 to 100, of how much a food or drink will affect the level of glucose in the bloodstream. You can tell the GI of a food by measuring the blood-glucose response after eating it compared to the blood-glucose response to a reference food, usually pure sugar or white bread (Atkinson and others 2008). I used a pure-sugar reference scale, so a GI of 100 would be a blood-glucose response equivalent to the response from pure sugar.

Foods with high GI can result in hyperglycemic levels of blood sugar,

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followed by very low blood-sugar levels after the glucose has cleared away (Fabricatore and others 2011). Such rapid carbohydrate energy fluctuations can be advantageous when intense physical exertion is expected over a short period of time (Vandenbogaerde and Hopkins 2011).

However, this style of carbohydrate consumption can be less ideal for long-term physical endurance over an extended period of time (Baranauskas and others 2017). The GI of a single meal preceding physical exertion might have little influence on performance (Burdon and others 2017), but the overall pattern of GI in an endurance athlete's diet can affect performance (Durkalec-Michalski and others 2018).

The results suggest that catered meals for wildland firefighters are in the moderate to high glycemic index category.

STUDY METHODS

From June to October 2018, I collected the GI information for hot breakfasts, sack lunches, and hot dinners served by caterers to my hotshot crew. I categorized a food based on its level of impact on blood sugar as low GI (< 55), moderate GI (55–70), or high GI (> 70) (Atkinson and others 2008). For each meal, I summed up the GIs of foods containing carbohydrates in order to find an average GI for the meal. I extrapolated the values for the entire season and performed statistical significance tests.

Over the course of the 2018 fire season, the hotshot crew spent 90 shifts assigned to an active fire incident where meals were provided. Whenever the crew members ate catered meals, I used a cell phone camera to take pictures of either the menu for the meal or the food items. Although each crew member was supposed to get three meals per day (NIFC/FS, n.d.), the nature of our assignments meant that meals were skipped or that firefighters got "meals ready to eat" in place of catered meals. In such cases, I did not collect data.

I used a survey of crew members to correlate meal data with energy levels. The survey allowed the firefighters to assess their own levels of mental and physical energy after consuming a catered meal. The survey was voluntary and could be completed at any time using any device with the SurveyMonkey application. The survey comprised six questions:

1. Rate your physical energy on a scale of 1–5.
2. Rate your mental energy on a scale of 1–5.
3. How long ago did you last eat?
4. Did you consume any stimulants (coffee, tobacco, energy supplements) between eating and filling out this survey? (Yes/no.) If so, what type?
5. What parts of your most recent meal did you choose to eat?
6. What parts of your most recent meal did you choose to avoid?

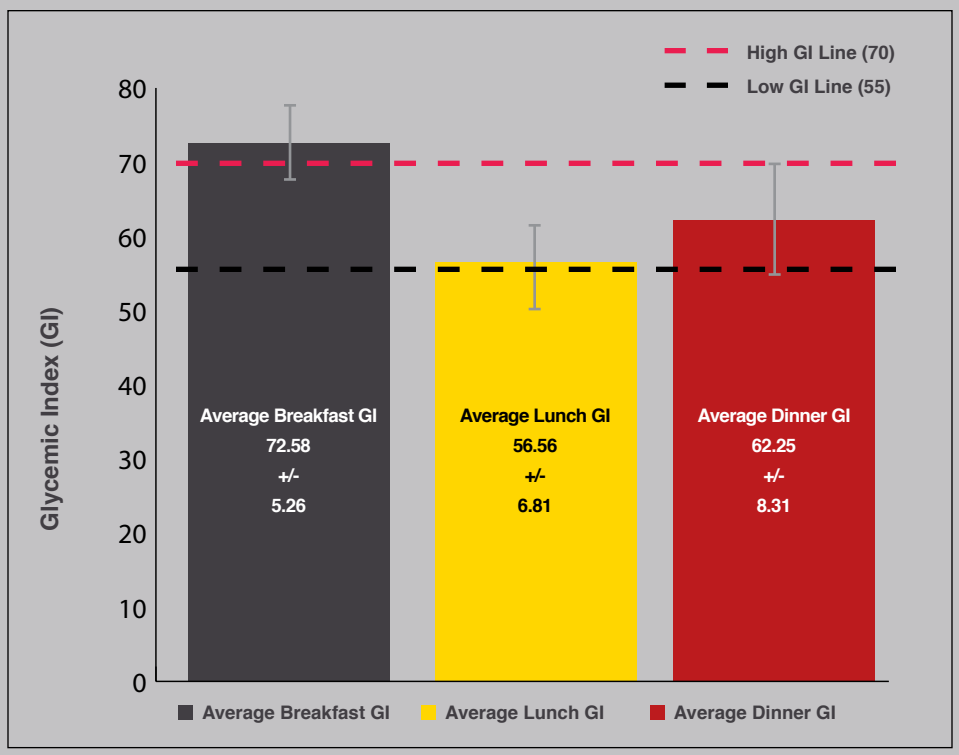

Figure 1—*Average glycemic index (GI) of catered breakfasts, lunches, and dinners eaten by members of the Elk Mountain Interagency Hotshot Crew during the 2018 fire season (including standard deviations). The GI was moderate to high on the GI scale published by Atkinson and others (2008).*

RESULTS

The nutritional information varied considerably among meals but was fairly consistent within each type of meal. For breakfasts, the average GI was 72.58 ± 5.26. For lunches, the average GI was 56.56 ± 6.81. For dinners, the average GI was 62.25 ± 8.31 (average GI ± standard deviation) (fig. 1).

Six firefighters took the voluntary survey, all from 1 to 3 hours after eating. Four of the six rated their postmeal physical energy as 4 out of 5, and five of the six rated their cognitive readiness as 4 out of 5. Only one respondent reported consuming no stimulant after eating; three consumed coffee/caffeine and two chewed tobacco. Consumed foods included

Figure 2—*A fireline dinner with a low average GI of 47.75 (left), compared to an example of a dinner with a high average GI of 69.25 (right). Photos: Ben McLane, USDA Forest Service.*

eggs, milk, and potatoes; avoided foods included breakfast cereals, breads (such as dinner rolls or sandwich breads), and desserts (such as candy, muffins, doughnuts, and cinnamon rolls).

DISCUSSION

The results suggest that catered meals for wildland firefighters are in the moderate-GI or high-GI category based on a glucose reference scale (Atkinson and others 2008), which makes firefighters subject to the highly variable blood-sugar levels of a high-glycemic diet (Kochan and others 2012). Of course, my study was limited by variability and bias. My own possible influence on the dietary preferences of my fellow hotshot crew members as well as the small number of survey responses were both limitations.

Nevertheless, my study does suggest that the GI of the diets of wildland firefighters is a possible nutritional metric that warrants further study.

Historically, research on wildland firefighter nutrition has focused on the caloric and macronutrient levels of fireline meals (Robertson and others 2017). Although such information is valuable, my study shows that GI can vary greatly between foods with very similar macronutrients (fig. 2, table 1).

Collecting GI data on fireline meals is both possible and useful for understanding nutrition in wildland firefighters. Although my study suggests that fireline meals make for a high-GI diet, the effects of high GI can be mitigated by eating low-GI foods as well (Tufts University 2017). In fact, the fireline meals I studied also contained low-GI foods like nuts and dairy products. Further study might be needed to relate the actual postmeal blood-sugar response of wildland firefighters to GI; previous research has suggested that predicted and actual blood-glucose responses to food can vary based on meal composition (Dodd and others 2011).

The survey results, though limited, suggest that wildland firefighters are inconsistent in the way they consume fireline meals: all six survey respondents chose not to eat certain parts of their latest meal. Even though fireline caterers meet nutritional guidelines (NIFC/FS, n.d.), the firefighters are not necessarily consuming the amount of food that fire management organizations recommend. Collins and others (2018) found negative changes in the body composition of smokejumpers over the course of the 2017 fire season, which can adversely affect job performance—and might be due, in part, to nonoptimal nutrition.

Further study into the performance of wildland firefighters who are not taking in the recommended amounts of calories and macronutrients might be of merit. Louie and others (2012) have suggested that low-GI diets might better meet nutrient requirements than the high-GI alternatives. The findings of this study might be useful in researching the potential benefits of a low-GI diet for wildland firefighters.

Table 1—*Glycemic index (GI) and other values for two fireline meals shown in figure 2, by food item.*

Meal 1 (low GI)	Value	Meal 2 (high GI)	Value
GI			
Pork	n.a.	Pork	n.a.
Steamed sweet potatoes	46	Au Gratine potatoes	86
Mac 'n cheese	49	Fettuccine Alfredo	49
Steamed corn	52	Green beans	n.a.
Coleslaw	44	Dinner rolls	75
–	–	Apple pie	67
Average	**47.75**	**Average**	**69.25**
Other values			
Total calories	1,266	Total calories	1,209
Protein	63 grams	Protein	71 grams
Fat	55 grams	Fat	56 grams
Carbohydrate	133 grams	Carbohydrate	105 grams

Note: n.a. = not available.

In addition to prescribing diets for wildland firefighters, fire management organizations advise firefighters on how to eat. The Forest Service's Missoula Technology and Development Center recommends that firefighters consume 150 to 200 calories every 2 hours during their work shifts (Sharkey 2007). Though feasible for some endurance activities, taking frequent breaks to eat is not always possible on a fire assignment, especially for firefighters like hotshots and smokejumpers who typically get the most arduous assignments (Heil 2002). Such firefighters might rarely get a chance to eat. When they do, they are likely to eat a lot, subjecting themselves to the brunt of the effect of high-GI meals on blood sugar and energy levels.

Much work has gone into researching diets for personnel in the Armed Forces, who can also be subject to long and arduous work shifts, with scant allowance for frequent breaks to consume small amounts of food (Duffie 2015). Dietary study has also been done to optimize the performance of elite endurance athletes (Egan and D'Agostino 2016). Such research suggests that a diet with a lower intake of simple carbohydrates could provide wildland firefighters with the sustained energy they need to perform at a high level without concern about low blood-glucose levels. The prospect of a lower carbohydrate diet for wildland firefighters could merit further study, especially since firefighters might already be consuming well below the recommended levels of carbohydrates on fire assignments (Robertson and others 2017). A better understanding of how blood-sugar levels in wildland firefighters are affected by catered meals could help fire managers tailor food offerings for optimal physical and mental firefighter performance.

I intended my study only as an initial indication of whether further research into this topic is needed. My study's limited scope and duration do not allow for significant conclusions about the effect of the average GI in fireline meals on firefighter energy levels. However, my study does provide valuable information about the potential of GI as a measure of firefighter nutrition. Important recommendations can be made for further research in this area.

RECOMMENDATIONS

Additional research on the effect of fireline meals on energy levels for firefighters depends on controlling for certain variables, if possible.

One variable is the effect of overall meal composition on firefighters' blood-sugar response to the GI of foods within the meal. This study showed that collecting GI data for fireline meals is feasible, given the readily available GI indexes. However, if the actual impact of a meal's GI on blood glucose is not adequately represented by the GI value in the index because of the overall meal composition, then the GI information is not as useful.

Every survey respondent used some sort of stimulant after eating, a common practice among firefighters.

One possible way to control for this variable would be to incorporate "glycemic load" into further study. Glycemic load takes the amount of carbohydrates within a food's serving size into account in order to measure the impact of that food on blood sugar. O'Reilly and others (2010) suggest that glycemic load more accurately reflects the potential peak-and-valley effect of carbohydrates within a food on blood-glucose levels than GI alone.

The ultimate solution to the problem of controlling for this variable would be to take actual blood-glucose measurements from wildland firefighters after they have consumed fireline meals. Then the average GI of a meal could be directly correlated with the magnitude and duration of elevated blood-glucose levels.

Another variable to closely monitor in future research is the selectiveness of wildland firefighters in what they eat. Although my survey data was limited, none of the respondents entirely consumed their most recent meal. Any nutritional study on fireline meals is meaningful only if firefighters are actually eating the food that the study is about. A study that focuses not only on the food available to wildland firefighters but also on what they actually eat could help to optimize firefighter nutrition as well as control food waste.

Every survey respondent used some sort of stimulant after eating, a common practice among firefighters (Poston and others 2013). The habitual use of stimulants might be a symptom of low energy, which is consistent with recent findings of chronic fatigue and sleep deprivation among wildland firefighters (Vincent and others 2018). Deficient nutrition could also contribute to low energy levels and stimulant use, with long-term adverse effects on health (Oliveira and others 2017).

Combining the best science-based nutrition, rest, and physical preparation is the way to create a wildland firefighting force that can mitigate the continuing effects of climate change, excessive fuel loading, and expansion of the wildland–urban interface (Liu and others 2015; Pyne 2010).

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