

Evaluation of the Nutritional Content of Food on Campus

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One in three Americans currently suffers from unhealthy weight, which can lead to conditions such as heart disease, diabetes, and depression. The causes of obesity are not limited to individual behaviors but include environmental factors, such as the availability of healthy food outlets. Understanding the influence of the food environment is especially relevant for college students living away from home, who consume most of their food commercially as they establish new eating habits. This study explored the quality, cost, and distribution of the available food at the University of Florida. Available food items and prices were obtained from Gator Dining Services for each dining location on campus in 2009, and the nutritional quality of the food was assessed using the Nutritional Quality Index (NQI). Food items were also coded based on location in order to determine if differences in nutritional quality existed that depend on the geographic area. Statistical analyses were conducted in order to determine if significant differences exist that are based on price and dining location. The average food item costs \$4.26 and contains 552 calories. The data suggest that foods high in fat and cholesterol are cheaper and more readily available than healthier foods, and the availability of healthy foods varies by location on campus.

INTRODUCTION

Review of the Literature

Currently, one in three Americans is either overweight or obese, and the rates of chronic diseases, such as diabetes, heart disease, and stroke, are increasing (Ogden, Yanovski, Carroll, et al., 2007). These trends have led researchers to predict that the average life expectancy of Americans will begin to decline (Olshansky, et al., 2005). Recent literature identifies changes in eating behavior and physical activity as partially responsible for these trends (Hill & Peters, 1998). Many prevention programs, such as exercise programs, focus on the individual; however, it is important to understand the impact that the local environment has on behavior, and changes at this level must be considered.

One element of the local environment is the food environment, which takes into consideration the availability, price, and location of foods in a community. The food environment has been shown to have a significant impact on health status (Krukowski, West, Harvey-Berino, Prewitt, 2010; Morland, Wing, Diez-Roux, 2002). Recent literature indicates that American society tends to offer foods that are higher in calories and fat at a cheaper cost and greater availability than fresh produce and other foods which are high in nutritional quality (Finkelstein, Ruhm, & Kosa, 2005). Residents living in areas with high concentrations of fast food restaurants are more likely to consume more calories, fat, saturated fat, and cholesterol (Lewis, et al., 2005). Moreover, studies have shown that providing nutrient-dense foods at the elementary, middle, and high school level increases students' daily intake of fruits and vegetables, improving their overall nutrition

(Kubik, Lytle, Hannan, Perry, & Story, 2003). These findings are reinforced by Morland, Wing, and Diez-Roux's research, which demonstrated that adults were more likely to consume diets high in fruits and vegetables and low in saturated fats when supermarkets containing these foods were in close proximity (2002). In addition, healthier foods are often more expensive than their higher calorie, fat, and sodium counterparts (Jetter and Cassidy 2006; Liese, Weis, Pluto, Smith, and Lawson, 2007).

While extensive research on American college student's eating behavior is lacking, Brevard and Ricketts reported significant differences in the serum lipid levels and nutrient quality of foods available to students living off and on campus at a northeastern university (1996). College students are just as likely to be overweight or obese as older adults, more likely to suffer from disordered eating behaviors, and lack adequate physical activity (Lowry et al., 2000). Little research has been done in the United States on the quality and cost of foods served on college campuses. Understanding the role of the local food environment is especially important on college campuses where students are at an age when life-long eating habits are being developed (Lowry et al., 2000). The scarcity of research signals a need to identify whether college campuses provide adequate access to healthy food options.

Study Aim and Hypothesis

Centrally, this project examines whether or not a college campus's food environment generally provides nutrient-

dense food that is conducive to a healthy lifestyle and convenient based on cost and location. There are two specific aims and three related hypotheses.

- **Specific Aim 1:** The first aim is to collect nutritional information about the foods served on a single college campus and describe their nutritional quality based on guidelines from the Food and Drug Agency (FDA) and United States Department of Agriculture (USDA).
- **Specific Aim 2:** The second aim is to describe variations in the cost and location of nutrient-dense versus nutrient-lacking foods on campus.
 - **Hypothesis 1:** Foods on campus will be relatively high in commonly overconsumed macronutrients like cholesterol, fat, sodium, carbohydrates, and sugar, and lower in other macronutrients like protein and fiber.
 - **Hypothesis 2:** Foods with higher levels of protein and fiber will be more costly than alternatives that are higher in sodium, fat, carbohydrates, and cholesterol.
 - **Hypothesis 3:** The nutritional quality of food will vary across campus based on location.

METHODS

Nutrition Data Collection

This study took place on the University of Florida campus using data collected between November 2009 and August 2010. All dining locations that sold food from national brands were included in the analysis. Only national brands were included in order to gather nutritional information. A list of the food items and their prices was collected from Gator Dining Services, the department responsible for providing food services on campus. The food items and their prices were entered into a spreadsheet and nutritional values for each item were collected from the corporation's official website. Information for calories, carbohydrates, sodium, fat, saturated fat, sugar, fiber, protein, and cholesterol were included. Each dining location was then visited to gather data on serving sizes. Information about beverages and meals served in all-you-can-eat style dining halls on campus were excluded from the data set due to inadequate nutritional and serving size information. A total of 495 food items were included in the final dataset.

Calculating Summary Nutrition Values

The importance of diet in the prevention of chronic disease and obesity has been documented and incorporated

into dietary recommendations by the United States Dietary Association (U.S. Food and Drug Administration, 2002). However, these recommendations do not provide a comprehensive method of categorizing foods by their nutritional content. When taking into consideration the portion size as well as all of the nutritional factors of the food—which would include calories, fat content, fiber, protein, percent of vitamins, etc.—it becomes increasingly complicated to create a summary nutrient profile. For this study, the Nutrient Quality Index (NQI) was used, which describes the ratio between the amount of nutrients in a food and the portion that meets the energy recommendations for a 2,000 k/cal diet (Drewnowski & Fulgoni, 2008). NQI is calculated through dividing the amount of a nutrient in a food item by the USDA recommended daily intake (RDI) of that nutrient, and then by the calories in the food item divided by 2,000k/cal. If a food has an NQI value of one for a particular nutrient, then that nutrient is represented as a proportionally appropriate amount based on the RDI. For example, the RDI for sodium is 1200mg. If a 1,000 calorie food item contains 600mg of sodium, then that food has an NQI of 1 because it has 50% of the daily recommended sodium and 50% of the daily recommended total calories. Food items with nutrient NQI values greater than one have more of a given nutrient per calorie than is recommended.

Analysis

The second aim of this project involved the identification of cost and convenience disparities between different areas on campus. The prices of food items, which were collected from the on-campus dining services office, were compared to the nutritional data. Convenience was measured using location data: a grid system was used to divide the campus based on one-tenth mile increments, which correspond to roughly two to three minute walk times. The website campusmap.ufl.edu was used to calculate distances.

Once the data was collected, a one-way analysis of variance (ANOVA) was performed to test the three hypotheses. The tests were run using Minitab software. In addition, Tukey's method was used post-hoc to reveal further differences in the data. The number of food items for each test ranged from 415-495, due to the fact that some food items were offered at more than one location.

RESULTS

Tables 1 and 2 chart the price, nutritional characteristics, and NQI of on-campus food items. The average price of an item served on campus was \$4.26 with a range from \$0.50 to \$16.79. Most foods contained 552 calories (about ¼ of the RDI) and 1384mg of sodium (greater than 100% of the RDI). The average NQIs of food ranged from 0.74 for cholesterol to 4.37 for sodium. The average food was most likely to contain a proportional amount of fiber (NQI=0.78)

and sugar (NQI=1.09) in relation to calories. A one-sample t-test was used to determine if the average NQIs of food items on campus were significantly greater than one, which corresponds to the USDA-recommended nutrient proportions. Fat ($t(414)=33.37$, $P<0.001$), carbohydrates ($t(414)=13.99$, $P<0.001$), sodium ($t(414)=27.49$, $P<0.001$) and protein ($t(414)=17.76$, $P<0.001$) had average NQIs

significantly greater than one, while fiber, sugar and cholesterol NQI values were not significantly greater than one. Table 3 describes the cost of each nutrient in relation to its recommended daily intake. Calories and carbohydrates are cheapest to purchase on campus, while cholesterol and fiber are most expensive.

Table 1. Characteristics of Food Served on Campus

	Average	Standard Deviation	Median	Minimum	Maximum
Price (\$)	4.26	2.33	3.99	0.50	16.79
Calories	552.09	364.33	450	40	2130
Fat (g)	28.30	24.73	21	0	139
Saturated Fat (g)	8.93	9.20	6	0	62
Cholesterol (mg)	61.72	59.35	45	0	540
Carbohydrates (g)	48.83	59.35	44	0	178
Sodium (mg)	1384.04	1027.18	1160	0	6460
Protein (g)	25.73	19.17	21	0	122
Fiber (g)	5.47	4.96	4	0	26
Sugar (g)	7.02	8.04	5	0	68

Table 2. Average Nutrient Quality Index (NQI) of Nutrients in Food

	Fat	Carbohydrates	Sodium	Protein	Fiber	Sugar	Cholesterol
NQI	3.14	1.50	4.37	1.87	0.78	1.09	0.74

Table 3. Cost of Recommended Nutrients in On-Campus Food

Nutrient	RDI	\$/Nutrient	(\$/Nutrient)*RDI
Calories	2000	\$0.01	\$19.31
Fat (g)	30	\$0.27	\$7.98
Sodium (g)	12	\$0.56	\$6.69
Carbohydrates (g)	130	\$0.14	\$18.23
Cholesterol (g)	3	\$8.65	\$25.94
Sugars (g)	31	\$0.84	\$26.06
Protein (g)	51	\$0.27	\$13.97
Fiber (g)	30	\$1.14	\$34.09

Finally, the nutritional quality of food was compared based on its location on campus. Since there are multiple locations of the same dining outlet, food items were included more than once in the analysis. Based on the one-way analysis of variance, foods varied in the NQI of fat ($F(5, 489)=9.78$, $P<0.001$), cholesterol ($F(5, 489)=10.13$, $P<0.001$), carbohydrates ($F(5, 489)=12.81$, $P<0.001$), sodium ($F(5, 489)=6.97$, $P<0.001$), protein ($F(5, 489)=45.63$, $P<0.001$), fiber ($F(5, 489)=11.76$, $P<0.001$), and sugar ($F(5, 489)=31.63$, $P<0.001$) across the six areas

of campus. Post-hoc tests using Tukey’s method indicated which areas on campus offered foods with significantly different NQIs. Area 1, the northern side of campus which is near a gym and dorm halls, had significantly greater NQIs for fat, cholesterol, carbohydrates, sodium, protein, fiber, and sugar when compared to other areas on campus (see Figures 1 and 2). As shown in Figures 1 and 2, the average NQI for fat and protein vary across campus: the lowest average NQIs for each of these nutrients are located at the center of campus, while the higher average NQIs are

located on the northern side of campus. Figures 1 and 2 also reveal the concentration of food locations on the north side of campus, with fewer dining options in the southern portion.



Figure 1. Distribution of average fat NQI across campus



Figure 2. Distribution of average protein NQI across campus

DISCUSSION

The first hypothesis, which looked at the NQI of food on campus, was partially supported. The average food items were high in fat, carbohydrates, sodium, and protein. The foods highest in these nutrients include the Big Mouth Bites from Chili's Too, a side of Frings (onion rings and French fries) from Cheeburger Cheeburger, and the Steak House Beef Dip from Quiznos. Other nutrients like fiber, sugar, and cholesterol were not found to have NQIs significantly greater than one. The second hypothesis, that foods higher in protein and fiber would be more expensive, was also partially supported. Obtaining the recommended daily allowance of fiber was most expensive, but protein was the third least expensive nutrient. This may be due to the fact that many of the foods used in this study, such as Burger King's Tender Crisp Sandwich and Chik-fil-A's Chicken Nuggets, contained fried meat, which is likely to be high in fat and protein. Fat and sodium were the two

least expensive nutrients based on recommended daily allowance.

Finally, the third hypothesis, which proposed differences in the nutritional quality of foods across campus, was supported. All of the tested nutrients varied significantly in their NQI based on their location on campus. The results indicated that foods on campus are higher in unhealthy macronutrients, such as fat, sodium, and carbohydrates, and lacking in fiber, which is relatively expensive to buy. The results also substantiated the claim that the nutritional quality of food is partially dependent on geographic location. These results have significant implications for planning dining locations and restaurants on campus. Since a university is populated by many young adults who are establishing eating habits that will last them into the future, it is imperative that healthy, reasonably priced foods be provided at convenient destinations around campus. Convenience and cost significantly influence people's purchasing decisions, and these factors should be considered when universities locate or contract food vendors. The results of this study support the work of Brevard and Ricketts (1996), which found disparities in the quality of food offered to students on a college campus.

This study is not without its limitations. All-you-can-eat style dining halls fulfill a significant portion of students' diet on UF's campus, but neither the nutritional information nor reliable portion information was available for these locations. Similarly, information on the consumption of food items in campus dining halls or at on-campus restaurants was not available, so it is unknown whether or not the availability of healthy foods is related to actual consumption in the environment studied. Also, food items sold in campus convenience stores were not included. On UF's campus, dining halls and convenience stores are the main areas one can purchase fruits and other dry goods, which may be higher in protein and fiber and lower in fat, cholesterol, and sodium. In addition, although nutrient data was obtained from each corporation's website, many nutrients (like vitamins and minerals) could not be found, and thus could not be used in the analysis. Finally, experts have yet to agree concretely upon a way to classify foods as either healthy or unhealthy. This study used the published NQI measure to assess the "healthiness" of food items, although other measures should be considered in future work. Through a detailed analysis of over 400 food items available on a university campus, this study indicated that general availability as well as cost and geographic convenience may be barriers to college students' healthy eating behaviors.

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