DIETARY GLYCEMIC INDEX AND GLYCEMIC LOAD: THEIR RELATIONSHIP TO ADIPOSITY IN COLLEGE STUDENTS—PILOT STUDY

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Abstract: This study investigated the relationship between dietary GI, GL, intakes of macronutrients and fiber with adiposity (measured by BMI) of a convenience sample of healthy young college students. Pearson correlation analysis, t-test and analysis of variance were employed for data management. The findings indicated that fruit juices, cereals and white bread constituted the highest sources of carbohydrate among the 66 food categories consumed by the students. There was a significant inverse relationship between BMI and intake of carbohydrate and fiber. The positive correlation between GI and GL was highly significant. The GI did not correlate neither with the BMI or any of the dietary variables. Differences between low-,medium-,high-GL categories for energy, carbohydrate, fiber, protein, fat, saturated fats, and cholesterol were highly significant. Mean GL of the normal-weight subjects was significantly higher than that of the overweight participants. This could be partially explained by the fact that in normal-weight individuals, the intake of carbohydrates and fiber were significantly higher than those of the overweight subjects. In conclusions, the current study findings suggest that the GL seems to be a more specific parameter for the assessment of glycemic effect of food intakes than the GI. Further research is needed, including long-term clinical trials, in a representative sample of college students.

Keywords: College age students; Food; Glycemic index; Glycemic load

INTRODUCTION

The obesity rate continues to escalate in epidemic proportions in almost all age groups in the majority of the developed and developing world (Flegal 1999; Seidell 2000; World Health Organization 2000; Flegal et al. 2002; Brand-Miller 2002; James 2004; Naser , Gruber and Thomson 2006; Ogden 2006; Hjartåker, Langseth, and Weiderpass

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2008). Obesity is a complex, multifaceted chronic disease involving genetics, lifestyle, environmental, physical and metabolic components, and it is not well illuminated. In the United States (US), a significant rapid increase in obesity and related diseases has occurred among college-age population, with most of the increase occurring in the last two decades (Mokdad, et al. 1999; Lowry et al. 2000; Mokdad et al., 2001; U.S. Department of Health and Human Services 2001; Centers for Disease Control and Prevention (CDC) 2006; Sparling 2007). Although there is a wide consensus that dietary intervention is an important component for treatment of overweight/obesity, best prescriptions for managing lasting weight loss remain vague (Casazza and Thomas 2009).

Recently, the role of carbohydrate quality in body weight management has gained wide attention as an important contributor to obesity and related diseases (Poniachik et al., 2002; Martos et al., 2006; Adam-Perrot et al., 2006; Cañete et al., 2007). Total carbohydrate consumption in the diet of an average American has increased over the last 30 years due mainly to a focus on low-fat diets and an amplified consumption of refined carbohydrates (Bell and Sears 2003; Gross, Ford and Lui 2004; Aston 2006). Sources of carbohydrates in the American diet are typically derived from refined grains, starches, and sugar. These food sources, known as high glycemic index (GI) foods, are absorbed at a speedy rate upon digestion and provoke initial periods of elevated blood glucose and insulin levels followed by a rapid drop in blood glucose. Consequently, the release of free fatty acids generates an insulin resistant environment and diminished glucose tolerance (Bell and Sears 2003; Ludwig 2002; Augustin 2002). These conditions may then cause hunger and promote excessive food intake, dyslipedemia and endothelial dysfunction (Ludwig 1999; Wahlqvist, Wilmshurst and Richardson 1978; **Liu** et al. 2001). Therefore, a diet consistently high in GI may increase the risk for overweight/obesity (Davis et al. 2007), type 2 diabetes (Willet, Manson and Liu 2002), coronary heart disease (Beulens et al. 2007) and some types of cancers (Higginbotham 2004; Lajous 2008; Wen 2009).

The GI is a classification index that ranks carbohydrate-containing foods based on blood glucose response; hence, they may have an effect on postprandial blood insulin levels (Jenkins 1981). The GI represents the quality of carbohydrate intake, as the amount of carbohydrate in a food or overall diet can vary. The glycemic load (GL), which is the arithmetic product of the GI and the quantity of carbohydrate consumed, has been also introduced (Salmeron et al. 1997). Thus, the GL intended to illustrate the overall glycemic effect of a diet (Brand-Miller 2003). However, dietary carbohydrate impacts on postprandial glucose level and insulin responses vary widely depending on several factors including its physical forms, chemical structures and method of preparation as well as fiber content, macronutrient composition and co-ingested foods (Pi-Sunyer 2002; Brand-Miller 2003; Willett 2001). Protein, fat, and fiber content of the diet may influence the gastric emptying, glucose absorption and insulin secretion and as these components increase, the GI of the food/meal decreases (Bjorck et al. 1994).

Researchers have documented that foods of low-GI are associated with greater satiety leading to a decline in blood glucose levels and insulin response, improve lipid profile, reduce lipogenesis and improve insulin sensitivity when compared with high-GI foods or meals (Agus et al. 2000; Spieth et al. 2000; Jarvi et al. 1999). Researchers studied the effect of high-, medium- and low-GI breakfast meals on subsequent ad-labitum food intake in obese teenage boys (Ludwig 1999). They observed that the low- and medium-GI food groups, compared to the high-GI group, showed reduction in energy intake of 53% and 81% respectively, 5 hours after breakfast. Randomized intervention studies with adolescents showed that substituting low-GI diets for high-GI diets resulted in significantly lower body mass index (BMI), weight (kg)/height (m^2), body weight, and fat mass rather than conventional diet prescriptions restricted in fat or caloric content (Spieth et al. 2000; Ebbeling and Ludwig 2001; Ebbeling 2003).

Therefore, the objectives of this pilot study were to examine the cross-sectional associations of dietary GI, GL, intakes of macronutrients and fiber with adiposity (measured by BMI) among college students. It was hypothesized that dietary GI and GL would be more related to adiposity than overall dietary energy, a particular macronutrient component, or fiber content.

MATERIALS AND METHODS

Subjects and Design

A total of 117 subjects (males and females) enrolled in an introductory nutrition class for the first time in the Department of Human Ecology, State University of New York-College at Oneonta during spring 2003 volunteered to participate in this study. However, the number dropped to 94 after exclusion of those who were diagnosed with any chronic illnesses including type 2 diabetes; pregnant or lactating; taking medications that affect body weight, with any food habits that inhibit the study, or their dietary and/or anthropometric data were incomplete. Moreover, two female subjects were excluded who fell in the underweight category (i.e., BMI ≤18.5 kg/m^2) (National Institute of Health (NIH), 1998). The final eligible participants of 92 (26 male and 66 female) were required to record their own food intake for three consecutive 24h recalls (including one weekend day). Students were instructed to quantify portion size of their food intake based on food models as well as household utensils and fast-food glasses, cups, and bowls. Subjects were healthy young adults aged between 18 and 24 years and living on campus or nearby off campus housing. The majority of the subjects (99%) were non-Hispanic white.

Dietary Assessment

Dietary data were processed with database of the Diet Analysis Plus version 6.0 from Elizabeth S. Hands & Associates (ESHA) research, Nutrition Databases and Software System, Inc Salem, Oregon. The database contains descriptions of and codes for approximately 6,697 food items commonly consumed in the United States along with information on serving size by piece (one slice of bread), volume (cup), or by weight in grams, pound, and ounce. It generates data for about 30 nutrients along with caffeine and alcohol. Participants' three-day-dietary recalls were entered in the above Diet Analysis Plus system to facilitate analyses of their dietary patterns. Dietary analyses included the average intake of energy (kcal) and nutrients such as carbohydrate (g) and carbohydrate as % of total kcal, fiber (g), protein (g) and protein as % of total kcal, fat (g) and fat as % of total kcal, saturated fat and saturated fat as % of total kcal, and cholesterol (mg) for each participant, shown previously to be associated with adiposity.

For the purpose of this study all similar consumed foods were grouped into 66 food codes and then ranked in descending order according to carbohydrate as a percent contribution to total grams of carbohydrate intakes. The top 21 (31.8 %) food *codes* were assigned GI values extracted from the International table of glycemic index and glycemic load values (2002) (Foster-Powell, Holt and Brand-Miller 2002). Following methods that were described in the literature (Wolver 1990; Wolver et al. 1994), the GI values were calculated by multiplying the GI of each food by carbohydrate content and then dividing by the total carbohydrate for the day. These individual values were summed for each day, and then averaged over three days of intake for each participant. The calculation of GL involved multiplying the grams of carbohydrate from each food by the GI value and dividing the product by 100, thus accounting for both the quantity and the quality of carbohydrates consumed. The GL values of food items were summed to give the daily GL, and then averaging overall recalls as described above (Salmeron et al. 1997; Wolver et al., 1994; **Liu** 2001). In this study a GI of ≥70 is defined high, a GI of >55 to <70 is medium, and a GI of ≤55 is low. A GL of ≥120 is high, a GL of 80 to <120 is considered medium, and a GL of <80 is low. Analysis of the GI scores of the food database showed that none of the participants fell into the high-GI category. Dietary intakes of energy, carbohydrate, protein, fats, saturated fats, cholesterol and fiber were also averaged over three days of intake for each participant.

Anthropometrics

Body weight and height as well as age in years were self reported by each of the participants. Adiposity was assessed based on calculation of BMI (kg/m^2), a measure of weight adjusted for stature. The BMI was classified into three groups: normal-weight (n=54) (BMI >18.5–24.9 kg/m^2), overweight (n=29) (BMI 25.0–29.9 kg/m^2), and obese (n=9) (BMI ≥30.0 kg/m^2) (NIH, 1998). For the purpose of the analysis the obese category was regrouped under the overweight category.

Statistical Analyses

Summary statistics and Pearson Correlation Coefficient were computed for the BMI, GI, GL, and the dietary variables. Ninety five percent confidence intervals (CI) were calculated to provide estimates for the precisions of the means. The t-test for independent samples was used to compare the means of the characteristics of interest of two groups: the normal-weight (BMI <25 kg/m^2) and the overweight (BMI ≥25 kg/m^2). The F-test for comparison of several means, with subsequent use of Tukey's HSD (High Significant Difference) was used to compare the means of the characteristics of interest among the GL categories. The SPSS Statistical Package for Social Sciences, Windows version 9.0 was used for all statistical analysis. *P* values less than 0.05 were considered to indicate statistical significance.

RESULTS

The mean [± standard deviation (SD)] of age, height (cm), weight (kg) and BMI by gender and mean BMI categories are given in Tables 1 and 2, respectively. The mean BMI of the sample was 24.78 (± 3.87). More than half (58.7%) of the participants had BMI within the normal weight category, while overweight subjects (including obese individuals) were 41.3% of the sample.

Analysis of food recalls yielded 2326 unique food items, of which 2292 food

Table 1. Mean of age, height, weight and body mass index by gender

Variables	*Male*			*Female*			*Total*		
	n	*Mean*	*SD*	*n*	*Mean*	*SD*	*n*	*Mean*	*SD*
Age (years)	26	20.62	3.645	66	21.17	6.108	92	21.01	5.510
Height (cm)	26	179.40	6.997	66	164.03	7.480	92	168.37	10.093
Weight (kg)	26	81.08	13.182	66	66.26	11.202	92	70.45	13.505
BMI*	26	25.182	3.824	66	24.628	3.906	92	24.78	3.870

*Body Mass Index (weight kg/height m^2)

Table 2. Mean body mass index (BMI)* categories

BMI categories	*n*	*Mean*	*SD*
Normal-weight BMI <25	54	22.144	1.546
Over-weight BMI ≥25	38	28.536	2.963
Total	92	24.784	3.870

*Body Mass Index (weight kg/height m^2)

items (98.5%) were carbohydrate containing foods. The top 21 food codes (1626 food items) which represent nearly 31.8% of the total food codes (66 codes) not including intake from dietary supplements, contributed 83.9 % of the total carbohydrate sources.

Summary statistics of the top 21 carbohydrate sources of foods consumed by the subjects are given in Table 3. Except for fruits and vegetables, there was a wide variation in carbohydrate content of the top 21 carbohydrate sources especially snacks and cookies as indicated by their wider CIs. Fruit juices, cereals, and white bread constituted the highest sources of carbohydrate among the 66 food groups consumed (7.6%, 7.4%, and 7.3%, respectively). Milk, fruit juices, vegetables followed by fruits had the highest food weight as percent of total food weight compared to other food items (13.95%, 11.49%, 9.08%, and 6.02%, respectively).

Descriptive statistics of BMI, GI, GL and dietary variables are given in Table 4. Table 4 shows that the variability in all considered variables was within expected ranges for the studied subjects. Table 5 shows that there was a significant negative but weak correlation between both the BMI and the intake of carbohydrates and fiber per day ($P<0.05$; $r=-0.23$, $r=-0.221$, respectively). The positive correlation between GI and GL was not so strong but was highly significant ($P<0.0001$; $r=0.383$). The GI did not correlate with either the BMI or any of the dietary variables. However, highly significant correlations were found between the average daily GL values and both energy and carbohydrate

Table 3 Summary statistics of the top 21 food sources of carbohydrate consumed by college students (n = 92)

Top 21 Carbohydrate Sources	*Carbohydrate[1] mean (g)*	*S. E. of mean*	*95% CI for mean*	*Carbohydrate[2] (% of total))*	*Food weight[3] mean (g)*	*Food weight[4] (% of total)*
Fruit Juices	38.3	1.695	34.9, 41.7	7.60	366.06	11.49
Cereals	44.6	2.869	38.9, 50.3	7.39	67.77	1.78
White Bread	34.9	1.661	31.7, 38.3	7.29	72.30	2.38
Fruits	20.8	0.518	19.8, 21.8	5.80	137.20	6.02
Potatoes	44.2	2.241	39.7, 48.6	5.30	171.65	3.25
Milk	18.9	2.009	15.0, 22.9	5.20	321.88	13.95
Pasta	43.9	3.334	37.3, 50.7	4.76	139.44	2.39
Pizza	45.7	6.203	33.3, 58.1	4.73	150.53	2.46
Vegetables	9.8	0.907	7.9, 11.5	4.10	137.70	9.08
Other Breads	32.9	2.054	28.8, 37.0	3.73	67.86	1.21
Rice	60.9	6.449	47.9, 74.1	3.60	206.77	1.93
Snacks	40.6	13.45	13.6, 67.6	3.59	56.57	0.79
Sandwich White Bread	32.5	1.577	29.3, 35.6	3.52	136.97	2.35
Carbonated Beverages	43.5	2.318	38.9, 48.2	3.14	412.10	4.70
Cookies	42.4	11.08	20.1, 64.8	2.92	62.99	0.69
Tarts and Pies	46.6	6.293	33.8, 39.5	2.30	71.49	0.56
Candy	36.8	4.033	28.6, 44.9	2.23	52.16	0.50
Mixed Dishes	46.5	5.997	34.1, 58.8	1.98	330.18	2.23
Soups	36.4	8.797	18.4, 54.3	1.85	377.12	3.03
Canned fruits & Sauces	36.5	4.369	27.5, 45.5	1.62	243.63	1.71
Sandwich Wheat Bread	34.6	2.312	29.8, 39.3	1.30	155.27	0.93

[1] *Sum of carbohydrate content divided by the number of food intakes*

[2] *Sum of carbohydrate content divided by the total carbohydrate content of the 66 food categories consumed X 100.*

[3] *Sum of food weight divided by number of intakes*

[4] *Sum of food weight category divided by the total food weight consumed X100.*

intakes (P<0.0001; r=0.718 and r=0.837, respectively). Also, highly significant but lower correlation coefficients occurred with fiber, protein, fats, and saturated fat (P<0.0001; 0.545, 0.383, 0.509 and 0.511, respectively) as well as cholesterol (P< 0.002; r= 0.320).

According to t-test for statistical differences between means, analysis showed that

Table 4. Descriptive statistics of BMI, GI, GL, and nutrient intakes for college students (n=92)

Variables	*Mean*	*Std. Deviation*	*95% CI for mean*
Body mass index (kg/m^2)	24.784	3.870	23.9, 25.6
Glycemic index (GI) [a]	56.165	6.088	54.9, 57.4
Glycemic load (GL) [b]	18.989	7.109	17.5, 20.5
Energy (kcal)	1574.344	588.368	1452.5, 1696.2
Carbohydrate (g)	214.566	76.959	198.6, 230.5
Carbohydrate (% of total kcal)	55.516	9.262	53.6, 57.4
Fiber (g)	14.722	6.699	13.3, 16.1
Protein (g)	65.459	39.389	57.302, 73.6
Protein (% of total kcal)	16.408	5.311	15.308, 17.5
Fat (g)	50.573	25.906	45.208, 55.9
Fat (% of total kcal)	28.252	7.682	26.7, 29.8
Saturated fat (g)	16.943	9.359	15.0, 18.9
Saturated fat (% of total kcal)	9.428	3.003	8.8, 10.1
Cholesterol (mg)	188.115	149.289	157.2, 219.0

[a] [(Grams of carbohydrate from food item/total daily grams of carbohydrates consumed) X glycemic index of the food item]. These individual values were summed for each day and then averaged over 3 days of intake.

[b] [(Grams of carbohydrate from food item X glycemic index value of the food item)/100]. These values of glycemic load for each of the food items were summed to give the daily glycemic load and then the average of glycemic load over 3 days was derived.

there were no significant differences in the means of BMI and dietary variables between the low- and medium-GI categories. Table 6 shows that the differences among the means of BMI and dietary variables in the three GL categories were highly significant (P<0.01) except for carbohydrate, protein, fat, and saturated fat as percent of total energy. As indicated by the Tukey's' HSD procedure, all revealed significant differences occurred between the lowest and the highest categories.

In the normal-weight individuals, the means of GL, carbohydrate and fiber were significantly higher than those of the overweight subjects (P=0.039, P=0.04, and P=0.002, respectively) (Table 7). However, these two groups of students did not show significant differences when other variables were examined. Furthermore, a higher significant intake of fiber by normal-weight than overweight subjects was also shown among male and female subjects (P=0.032 and P=0.044, respectively) (Table 8).

Table 5. Correlations between dietary variables and each of BMI, GI, and GL for college students (n = 92)

Variables	*Correlation coefficient*		
	BMI	*GI*	*GL*
Body mass index (kg/m^2)			
Glycemic index [a]	–0.002		
Glycemic load [b]	–0.210	0.383**	
Energy (kcal)	–0.190	–0.127	0.718**
Carbohydrate (g)	–0.230*	–0.054	0.837**
Carbohydrate (% of total kcal)	–0.056	0.171	0.190
Fiber (g)	–0.221*	–0.098	0.545**
Protein (g)	–0.165	–.080	0.383**
Protein (% of total kcal)	–0.048	–0.010	-0.125
Fat (g)	–0.088	–0.135	0.509**
Fat (% of total kcal)	0.069	–0.065	–0.035
Saturated fat (g)	–0.064	–0.110	0.511**
Saturated fat (% of total kcal)	0.088	–0.043	0.012
Cholesterol (mg)	–0.003	–0.144	0.320**

*P<0.05; **P<0.01

DISCUSSION

Nutrition Professionals pay much attention to the dietary practices and nutritional status of college students (Binger 1999). Numerous investigators characterized the diets of college students as low in energy, fiber, calcium, iron, vitamin A and carotinoids (Huang et al. 1994; Hertzler, Web and Frary 1995; Schuette, Song and Hoerr 1996). Moreover, college students have several behaviors that are associated with consumption of poor quality diets where they skip meals, consume large amounts of fast foods and avoid certain nutritious foods (Marietta, Welshimer and Anderson 1999). The skipping of breakfast has been linked with lower nutritional status and increased risk of cardiovascular diseases (Skata et al. 2001). It has also been reported that inadequate breakfast habits may contribute to the incidence of obesity (Ortega et al. 1996). Poor dietary practices by these students start to appear after they move away from their homes facing an unfamiliar environment and lifestyle

Table 6. Comparisons between BMI and dietary variables according to low-, medium-, and high-GL levels.

Variables	GL†	Mean	S. E.	F-ratio (df)	P-value
Body mass index (kg/m²)	a (31)	25.61	0.753		
	b (37)	24.99	0.666	2.380	P>0.05
	c (24)	23.39	0.566	(2,89)	
Energy (kcal)	a (31)	1179.01	73.63		
	b (37)	1496.72	55.60	38.453**	P<0.0001
	c (24)	2204.65	118.41	(2,89)	
Carbohydrate (g)	a (31)	154.66	9.517		
	b (37)	204.62	6.025	65.645**	P<0.0001
	c (24)	307.28	12.421	(2,89)	
Carbohydrate (as % of kcal)	a (31)	53.64	1.767		
	b (37)	55.99	1.484	1.084	P>0.05
	c (24)	57.20	1.797	(2,89)	
Fiber (g)	a (31)	10.82	0.787		
	b (37)	14.65	0.847	16.615**	P<0.0001
	c (24)	19.88	1.617	(2,89)	
Protein (g)	a (31)	52.69	6.929		
	b (37)	62.12	4.292	5.979**	P<0.004
	c (24)	87.11	10.007	(2,89)	
Protein (as % of kcal)	a (31)	17.47	1.228		
	b (37)	16.24	0.657	1.168	P>0.05
	c (24)	15.29	0.975	(2,89)	
Fat (g)	a (31)	37.44	3.242		
	b (37)	47.94	3.372	16.079**	P<0.0001
	c (24)	71.59	6.011	(2,89)	
Fat (as % of kcal)	a (31)	28.23	1.456		
	b (37)	28.18	1.295	0.006	P>0.05
	c (24)	28.40	1.453	(2,89)	
Saturated fats (g)	a (31)	12.71	1.158		
	b (37)	15.62	1.237	14.649**	P<0.0001
	c (24)	24.45	2.217	(2,89)	
Saturated fats (as % of kcal)	a (31)	9.64	0.591		
	b (37)	9.09	0.492	0.378	P>0.05
	c (24)	9.67	0.549	(2,89)	
Cholesterol (mg)	a (31)	138.68	18.343		
	b (37)	171.81	19.583	7.001**	P<0.001
	c (24)	277.12	41.017	(2,89)	

† [(Grams of carbohydrate from food item X glycemic index value of the food item)/100].
These values of glycemic load for each of the food items were summed to give the daily glycemic load and then the average of glycemic load over 3 days was derived.

a=low-GL (< 80, n=31); b=medium-GL (80-< 120, n=37); c=high-GL (≥120, n=24).

** Highly significant

Table 7. Glycemic index, glycemic load and nutrient composition in normal-weight and overweight college students.

Variables	*BMI* ‡	*Mean*	*S. E.*	*t-value (df)*	*Comment*
Glycemic index *	a (54) b (38)	47.29 47.18	1.090 1.403	0.066 (90), P>0.05	a = b
Glycemic load †	a (54) b (38)	108.60 90.87	5.961 5.443	2.098 (90), P=0.039	a > b
Energy ((kcal)	a (54) b (38)	1652.27 1463.61	83.64 87.19	1.525 (90), P>0.05	a = b
Carbohydrate (g)	a (54) b (38)	228.33 195.00	10.804 11.318	2.083 (90), P=0.04	a > b
Carbohydrate (as % total Kcal)	a (54) b (38)	56.37 54.30	1.292 1.444	1.056 (90),P>0.05	a = b
Fiber (g)	a (54) b (38)	16.36 12.39	1.027 0.711	2.913 (87), P=0.002	a > b
Protein (g)	a (54) b (38)	69.58 59.60	6.189 4.566	1.200 (90), P>0.05	a = b
Protein (as % total Kcal)	a (54) b (38)	16.46 16.33	0.786 0.753	0.124 (90), P>0.05	a = b
Fat (g)	a (54) b (38)	51.86 48.73	3.697 3.931	0.569 (90),P>0.05	a = b
Fat (as % total Kcal)	a (54) b (38)	27.53 29.28	1.035 1.262	1.078 (90), P>0.05	a = b
Saturated fats (g)	a (54) b (38)	17.12 16.68	1.308 1.478	0.221 (90), P>0.05	a = b
Saturated fats (as % total Kcal)	a (54) b (38)	9.07 9.94	0.396 0.502	1.377 (90), P>0.05	a = b
Cholesterol (mg)	a (54) b (38)	183.46 194.73	20.796 23.667	0.355 (90), P>0.05	a = b

* [(Grams of carbohydrate from food item/total daily grams of carbohydrates consumed) X glycemic index of the food item]. These individual values were summed for each day and then averaged over 3 days of intake.

† [(Grams of carbohydrate from food item X glycemic index value of the food item)/100]. These values of GL for each of the food items were summed to give the daily GL load and then the average of GL over 3 days was derived.

‡ Body Mass Index (kg/m^2): a=normal-weight (BMI <25, n=54); b=overweight (BMI ≥25, n=38).

Table 8. Mean dietary fiber intakes by normal-weight and over-weight males and females.

BMI[1]	*Male*			*Female*		
	n	*Mean*	*S.E.*	*n*	*Mean*	*S.E.*
Normal-weight BMI <25	13	18.380	2.458	41	15.722	1.107
Over-weight BMI ≥25*	13	12.285	1.076	25	12.446	0.976
T.Val. (df)		2.271 (24)			2.050 (64)	
Sig.		P=0.032			P=0.044	

*Body Mass Index (weight kg/height m^2)

(Koszewski and Kuo 1996; Horacek and Betts 1998). Poor dietary choices and patterns formed during the early adult years increase the risk of obesity later in life and a higher prevalence of obesity-related diseases (WHO 2000).

The current study revealed that the sample of 92 College students examined had intakes of carbohydrate, protein and fat (as percent of total energy) in addition to cholesterol that were within the recent acceptable macronutrient distribution ranges (AMDRs) (Department of Health and Human Services (HHS) and the Department of Agriculture (USDA) 2005). This reflects an enhanced awareness and greater compliance with the AMDRs adopted by this group of college students regarding these macronutrients. As a percent of total food weight, milk, fruit juices, vegetables followed by fruits stood on top of their food choices reflecting awareness of College students about the importance of consuming foods rich in calcium, water and fat soluble vitamins and dietary fibers. Similar findings from previous studies reported that college students who knew about a healthy diet and who exercised regularly consumed appropriate amounts of water, milk, vegetable and fruit juices (Dennis, Ebro and Grove 1995).

Among the top 21 groups of food sources contributing carbohydrate, the study showed that food choices pattern of college students was mainly fruit juices, white bread, cereals and fruits as a source of carbohydrate and thereby energy. Although there was a strong correlation between the overall GI and GL of food, GL but not GI showed a positive association with energy, carbohydrate, protein, fat, saturated fat, cholesterol, and fiber consumption. This concurs with findings of earlier research (Huaidong et al. 2008). It is most likely because the GL measure incorporates the quantity of carbohydrate in a food multiplied by its GI, and their interaction with each other as stressed by earlier researchers (Salmeron et al. 1997). From the statistical perception, this interaction obviously implies that the GL will be more pertinent than the GI for measuring the impact of a carbohydrate containing food on postprandial glycemia. Such conclusion matches that of previous studies (Brand-Miller 2003; Willet, Manson and Liu 2002).

In addition to the genetic susceptibility (van Vliet-Ostaptchouket al. 2008), the worldwide increase in overweight and obesity might be due to several other factors including reduced physical activity, abundant easily available and energy dense and highly palatable food (Brand-Miller et al. 2002). The GI of carbohydrate rich foods is just one factor that may influence body weight regulation and induce health problems. The present work focused its attention on the dietary factors. xx The higher intake of fiber by normal-weight compared to overweight students may explain for the lower body weight (as measured by BMI) since a high fiber diet exerts a major effect on GI by enhancing satiety which is thought to be directly affected by gastric volume. Such conclusion matches that of most of previous studies in the literature (Potter et al. 1981; Cusin, et al. 1992; Holt et al. 1992; Slabber et al. 1994; Brand-Miller et al. 2002; Steffen et al. 2003; Gross, Ford and Liu 2004; Du Huaidong et al. 2010).

In the present study the incidence of obesity (9.8%) is relatively low compared with previous studies which reported that overweight/obesity account for as many as 35% of college students (Lowry et al. 2000). Such discrepancy could be attributable to the small size of the sample in the current study. However, it seems important to refer overweight and obese individuals in this sample of college students to an outpatient or on campus obesity clinic in order to increase their awareness of adopting low-GL diets containing carbohydrates from low-GI foods, is a more efficacious strategy in managing body weight than a conventional low-fat diet (VanHorn 2000; Ebbeling and Ludwig, 2001; Ebbeling et al. 2007; Ello-Martin 2007; Naveen , Sumana, and Leona, 2008; C. Davis et al. 2009; Kong et al. 2010).

CONCLUSION

This pilot study successfully investigated the application of the concept of dietary GI and GL in relation to BMI and intakes of macronutrients and fiber of a convenience sample of college students. The dietary practices of this group of college students seem to fall within the recent dietary guidelines. xx Furthermore, the dietary GL seems to be more specific parameter for the assessment of glycemic effect of food than the GI. Nevertheless, these findings encourage further research, including large-scale randomized controlled trials in typical settings. Emphasis must be set on comparing the effectiveness of a reduced-GL diet versus conventional diet prescriptions as an important prerequisite to resolve the controversy with respect to dietary therapy in the prevention/ treatment of obesity among college students.

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