GEORGETOWN UNIVERSITY

Center for Food and Nutrition Policy
Georgetown Public Policy Institute

December 15, 1999

Dear Colleague,

Media coverage of new "fad diets" and a misunderstanding of the basic science have confused consumers. Last month, during the annual scientific meeting of the North American Association for the Study of Obesity (NAASO), the Georgetown University Center for Food and Nutrition Policy held a "Demeter Dialogue" breakfast briefing entitled "Added Sugars and Obesity in Children" to set the record straight.

Researchers from Georgetown University Center for Food and Nutrition Policy presented data from two studies that showed added sugars do not make a unique contribution to the rise in obesity nor diminish the quality of the diet. The data from the first study demonstrated that added sugars intake was not related to body mass index (BMI) among children. Moreover, the multivariate regression model indicated that added sugars intake was inversely associated with BMI among teens. The second study showed that added sugars intake has a minimal effect on diet quality. These data were also presented in a poster session at NAASO.

Notwithstanding current perceptions, research conducted at Michigan State University presented to the NAASO attendees strongly disputed the view that "added sugars" intake has not increased significantly during the last several years. Rather, the research concludes that the government's definition of "added sugars" has become more inclusive, and thus, does not reflect a true change in dietary intake. Indeed, the data show a "see-saw" relationship between fat and sugars intake – as fat intake decreases, carbohydrate intake increases.

The enclosed materials were provided as handouts at the briefing. We hope you find them useful in staying up-to-date on current information on this most important subject.

Sincerely,

Maureen Storey

Maureen Storey, Ph.D.
Director, Demeter Dialogues

99P-2630

RPT 1

3240 Prospect Street NW • Washington DC 20007-2197
Phone 202-965-6400 Fax 202-965-6444 Email ceres@erols.com www.ceresnet.org

GEORGETOWN UNIVERSITY

Center for Food and Nutrition Policy
Georgetown Public Policy Institute

FOR IMMEDIATE RELEASE
November 15, 1999

CONTACT: MAUREEN STOREY
202-965-6400

Georgetown University Nutrition Policy Experts Tell Obesity Conferees "Added Sugar" Intake Is Not Linked to Obesity in Children

www.ceresnet.org

(Charleston, S.C.) -- Nutrition policy researchers from Georgetown University's Center for Food and Nutrition Policy today told delegates attending the Annual Meeting of the North American Society for the Study of Obesity (NAASO) that "added sugars" intake is not linked to obesity among children and adolescents as measured by body mass index (BMI).

"Our data do not support the common view that carbohydrate consumption fuels increases in obesity. The cold hard reality is that people are eating too much and exercising too little. Portion sizes have expanded dramatically and it is simply wrong to blame increases in obesity on food or beverages that contain carbohydrates," said Dr. Maureen Storey, Associate Director of the Georgetown Center.

"While this view may not be 'politically correct' in some circles; nevertheless, the facts are the facts. As academic leaders we need to communicate the data as they are, not as some would hope them to be."

3240 Prospect Street NW • Washington DC 20007-2197
Phone 202-965-6400 Fax 202-965-6444 E-mail ceres@erols.com www.ceresnet.org

"Research to be presented tomorrow demonstrates that added sugars have no practical effect on dietary quality, including calcium intake among the general population, children, and adolescents. Our research shows that in the general population (over age two), it would take an additional 417 teaspoons of table sugar or 42 twelve-ounce cans of carbonated soft drinks to displace one serving of dairy foods. Children would have to consume an additional 588 grams of added sugars or 147 teaspoons of table sugar or 15 twelve-ounce cans of carbonated soft drinks to displace one serving of dairy foods. We need to separate marketing wishes from the science," said Rich Forshee, Ph.D., Visiting Assistant Professor and Director of Computing and Information Services with the Georgetown Public Policy Institute.

Another presenter at the Georgetown briefing for NAASO delegates, Dr. Won Song, Professor of Food Science and Human Nutrition at Michigan State University who has worked extensively with the Third National Health and Nutrition Examination Survey (NHANES III) data, explained, "Many nutrition experts have been urging consumers to increase their consumption of carbohydrates and reduce saturated fat intake. Our work indicates that a significant portion of the "so-called apparent increase" in added sugar consumption is the result of using a different, more inclusive, measurement of added sugars, not increased consumption of foods or beverages that contain sugar."

"The numbers can be misleading. You have to look at the reasons why the numbers are up. Certainly the increase [in added sugars] is in proportion to the increase in total carbohydrate consumption," Dr. Song said.

The MSU research with a cross-sectional study also shows that an inverse correlation exists between added sugars intake and body mass index. "Obese people ate a less amount of added sugar. Young people eat more sugar and more added sugar than older people, but obesity, as measured by body mass index, is more a problem for men and women over 30 years of age," concluded Dr. Song.

Editors Note: **Dr. Storey is available for interviews.**

The Georgetown Center for Food and Nutrition Policy analyzes and reports on complex issues in food and nutrition policy. The Center provides instruction and mentoring in food and nutrition policy within the graduate program of the Georgetown Public Policy Institute and services as an academic and intellectual resource in these subject areas within the Georgetown University community. In the larger community, the Center provides a nexus wherein government, industry, academia and consumer groups can openly discuss issues in food and nutrition policy.

FOX NEWS
>
>What Will Shrink America's Growing Waistline?
>Obesity Experts Provide Common-Sense Solutions
>
>Updated 9.24 a.m. ET (1424 GMT) November 21, 1999
>
>The Sweet Truth
>Sugar intake really has nothing to do with overweight, according to two >studies presented at the conference. It's a common misconception that >obesity is caused by an overdose of sweets, and doctors explained why.
>In one study, researchers at Michigan State University measured the body mass index (weight divided by height) of almost 16,000 adults. Then they asked the people to provide information on the amount of sugar, fat, carbohydrates and calorie intake.
>Obese men and women in the study consumed not only fewer total calories than their thinner counterparts, but had a lower percentage of calories from sugars and carbohydrates. They did, however, consume a higher percentage of their calories from fat.
>Researchers concluded that fat and sugars work like a seesaw: As fat intake rose, so did the BMI. But as sugar intake went up, BMI fell.
>At Georgetown University, researchers examined data from a USDA survey of how closely people follow the food guide pyramid.
>"Added sugars have a minimal negative effect on consumption of most of the food groups and nutrients," reported lead researchers Dr. Maureen Storey and Dr. Rich Forshee. However, they found, added alcohol did have a significant negative impact on diet quality.
>ïReuters contributed to this report.

NEW YORK, Reuters [HD] via NewsEdge Corporation : There is no link between obesity and sugar intake, according to two studies presented this week at the North American Association for the Study of Obesity annual meeting in Charleston, South Carolina.

``The bottom line is increased calories are the culprit'' behind obesity, not sugar, Dr. Maureen Storey said in an interview with Reuters Health. ``Choosing smaller portions is difficult,'' she added, but ``people need to eat less and exercise more.''

Storey and Dr. Rich Forshee, of Georgetown University in Washington, DC, studied data from a survey conducted by the US Department of Agriculture (USDA). They constructed a model that estimated how closely people follow the USDA Food Guide Pyramid, and the percentage of the US recommended daily allowance of selected nutrients they consume, based on the amount of added sugars, carbohydrates, protein, fat, and alcohol they consume.

According to the model, ``added sugars have a minimal... negative effect on consumption of most of the food groups and nutrients,'' Storey and Forshee report. The researchers found that alcohol had a much larger negative effect on diet than sugars.

``According to our model, it would take 1,695 additional grams of added sugars or 43.5 (12 oz.) cans of soda pop to replace one serving of dairy foods,'' the investigators explain. In comparison, ``an additional 182 grams of alcohol, the equivalent of 14 (12 oz.) cans of beer or 18 (3.5 oz.) glasses of red wine, reduced the predicted number of dairy servings by one.''

``Pragmatically, added sugars have virtually no effect on diet quality whereas other dietary components, such as alcohol, have a relatively greater negative impact on diet quality,'' Storey and Forshee conclude.

In the second study, Dr. D.R. Keast and colleagues, of the Michigan State University in East Lansing, asked nearly 16,000 adults about their consumption of sugar, fat, carbohydrates, and total calories. They also measured the participants' body mass index (weight divided by height).

Keast's group reports that obese adults consumed fewer total calories than non-obese adults, but fat made up a higher percentage of their calories. The obese adults obtained a lower percentage of their calories from carbohydrates and total sugars than the non-obese adults.

These results held true in both men and women, the investigators say. The research team concludes that there is a "seesaw" relationship between sugars and fat: as fat intake goes up, body mass index goes up, but as sugar intake goes up, body mass intake goes down.

The Associated Press State & Local Wire

November 17, 1999, Wednesday, PM cycle

SECTION: State and Regional

LENGTH: 454 words

HEADLINE: Researchers say sugar not culprit, more testing of herbals needed

BYLINE: By BRUCE SMITH, Associated Press Writer

DATELINE: CHARLESTON, S.C.

BODY:

Sugar is getting a bum rap for people gaining weight. How much you eat, how much you exercise and genetics probably have more to do with it, researchers attending an **obesity** conference said.

"Added sugar is not the magic culprit in our diets or in making people obese," said Dr. **Maureen Storey,** director of Georgetown University's Center for Food and Nutrition Policy.

During the annual meeting of the North American Association for the Study of **Obesity,** she presented research analyzing government survey data.

The study found while eating extra sugar may make people shun more healthy foods, it takes a lot to do so - almost 44 cans of soda to displace a serving of dairy food.

"My opinion is portion size, a lack of physical activity and your genetic makeup have more influence," Storey said.

She said there is no one single culprit people can blame for gaining weight.

"As hard as it is, we may have to look in the mirror," she said. "It is our choice whether we are physically active. No single dietary component is the villain. No single food manufacturer is the villain. No single fast food restaurant is the villain."

Another researcher called for more complete testing of herbal weight-loss supplements.

Millions of people use them, but there is not enough testing to know how, or even if, they work, said Dr. Steven Heymsfield of the New York **Obesity** Research Center at St. Luke's-Roosevelt Hospital.

"It's likely some of them work and that some of them are safe, but we don't know for sure," he said.

About 40 percent of the overweight people in the country use herbal supplements, sometimes in conjunction with prescription weight loss drugs, he said.

"Let's stop dispelling these things as not being worth our time to evaluate when in fact a very large percentage of the population is using these products for weight control - far more, likely, than pharmaceutical agents," Heymsfield said.

He said eight herbal agents are generally used as weight-loss aids: chromium picolinate, garcinia cambogia, chitosan, conjugated linoleic acid and ma huang, with ma huang often combined with guarana, willow bark or St. John's wort.

The supplements are considered food, not drugs, by the government, and are sold without prescription and without the same stringent testing.

There is an academic bias against studying herbal weight-loss aids when scientists concentrate on new drugs, often in studies funded by major pharmaceutical companies, Heymsfield said.

"They are all looking for Nobel prizes," he said. "This researching something that may or may not work, that doesn't have a clear mechanism of action, there is a lot of negative pressure in academia to stay away from that."

LANGUAGE: ENGLISH

LOAD-DATE: November 18, 1999

The Associated Press State & Local Wire

View Related Topics

November 16, 1999, Tuesday, AM cycle

SECTION: State and Regional

LENGTH: 449 words

HEADLINE: Doctor says herbal weight-loss compounds not adequately researched

BYLINE: By BRUCE SMITH, Associated Press Writer

DATELINE: CHARLESTON, S.C.

BODY:

While millions of people use herbal weight-loss supplements, there is not enough testing to know how, or even if, they work, a researcher said Tuesday.

"It's likely some of them work and that some of them are safe, but we don't know for sure," said Dr. Steven Heymsfield of the New York **Obesity** Research Center at St. Luke's-Roosevelt Hospital.

More complete testing of herbals, some of which have been used for thousands of years, would serve the public, Heymsfield told the annual meeting of the North American Association for the Study of **Obesity.**

About 40 percent of the overweight people in the country use herbal supplements, sometimes in conjunction with prescription weight loss drugs, he said.

"Let's stop dispelling this things as not being worth our time to evaluate when in fact a very large percentage of the population is using these products for weight control - far more, likely, than pharmaceutical agents," Heymsfield said.

He said eight herbal agents are generally used as weight-loss aids: chromium picolinate, garcinia cambogia, chitosan, conjugated linoleic acid and ma huang, with ma huang often combined with guarana, willow bark or St. John's wort.

The supplements are considered food, not drugs, by the government, and are sold without prescription and without the same stringent testing.

About 1,200 researchers, doctors, dietitians and others are attending the conference where they also heard that sugar is gaining a bum rap for weight gain and that oatmeal for breakfast can leave you less hungry at lunch.

Researchers who analyzed government survey data said eating extra sugar may make people shun more healthy foods, but it takes a lot to do so - almost 44 cans of soda to displace a serving of dairy food.

"Added sugar is not the magic culprit in our diets or in making people obese," said Dr. **Maureen Storey,** director of Georgetown University's Center for Food and Nutrition Policy. "My opinion is portion size, a lack of physical activity and your genetic makeup have more influence."

The word on oatmeal also came from the New York **Obesity** Research Center. That study compared high-fiber oatmeal with a breakfast of sugared corn flakes or plain water and found that those who ate oatmeal were less hungry at lunch.

There is an academic bias against studying herbal weight-loss aids when scientists concentrate on new drugs, often in studies funded by major pharmaceutical companies, Heymsfield said.

"They are all looking for Nobel prizes," he said. "This researching something that may or may not work, that doesn't have a clear mechanism of action, there is a lot of negative pressure in academia to stay away from that."

LANGUAGE: ENGLISH

LOAD-DATE: November 17, 1999

'Added sugars' not connected to obesity in children and adolescents, say researchers

"Added sugars" in food and beverage products are not connected to obesity among children and adolescents as measured by body mass index, several nutrition researchers told the annual meeting of the North American Society for the Study of Obesity.

"Our data do not support the common view that carbohydrate consumption fuels increases in obesity," said Maureen Storey, associate director of the Georgetown University Center for Food and Nutrition Policy.

"The cold hard reality is that people are eating too much and exercising too little. Portion sizes have expanded dramatically and it is simply wrong to blame increases in obesity on food or beverages that contain carbohydrates," she said.

"While this view may not be 'politically correct' in some circles, nevertheless, the facts are the facts. As academic leaders we need to communicate the data as they are, not as some would hope them to be," Storey said.

Storey's study was one of several presented at the meeting Nov. 15 that supported the finding that "added sugars" do not contribute to obesity. Her research was based on data from the Continuing Survey of Food Intakes by Individuals (CSFII), taken by the USDA from 1994 to 1997. The survey, popularly known as the "What We Eat in America Survey," collected data from a representative sampling of more than 16,000 people.

Robin Woo, the center's deputy director, said the research was "most definitely" a response to a petition to FDA by the Center for Science in the Public Interest and other health advocates which calls for "added sugars" to be included on food labels.

"We think labeling is ridiculous because the public doesn't need to be confused even further," Woo said in an interview with *Food Labeling & Nutrition News*. "They don't need to necessarily avoid sugars. Adding that extra line [on labels] — when there are other things we need to have information about on what might be less-than-healthful in foods — just makes the label even more confusing."

"We just have not found that sugar is the big bugaboo. It's basically [physical] inactivity that's the big bugaboo," Woo said.

"Those who do not like sugar feel that sugar should not be added to foods because it's not good for you. They ... have been saying 'it makes you fat, it's wasted calories; we're eating too many calories, and calories are what make people fat.' What we thought was that sounded pretty simplistic. It just didn't ring true. [We wanted to] see if people who eat sugar are eating more calories. Are they eating a less valuable diet as far as nutrients go?"

"Overall, what we found with children, for instance, is that children who eat a little more sugar tend to have more nutrients in their diet. That has been found by a couple of different groups. Honestly it's because they're eating cereal in the morning that has a little sugar on it, and the cereal is fortified [with] all sorts of grains, vitamins, and minerals ... and they're also drinking their milk. In fact, children who eat more sugar actually tend to get calcium," Woo said.

Woo said that in doing the research "we asked the question: 'Do children who drink lots of soda also drink lots of milk and orange juice?' In other words, are there high drinkers? Big volume drinkers? Which subgroups are at risk? [Are] there any subgroups that would replace 'good drinks' with 'bad drinks'?"

The center's Rich Forshee told the conference that the research indicated that "added sugars have no practical effect on dietary quality, including calcium intake among the general population, children, and adolescents.

"Our research shows that in the general population (over age two), it would take an additional 417 teaspoons of table sugar or 42 twelve-ounce cans of carbonated soft drinks to displace one serving of dairy foods. Children would have to consume an additional 588 grams of added sugars or 147 teaspoons of table sugar or 15 twelve-ounce cans of carbonated soft drinks to displace one serving of dairy foods. We need to separate marketing wishes from the science," he said.

Won Song, a professor of food science and human nutrition at Michigan State University, told conference attendees that "many nutrition experts have been urging consumers to increase their consumption of carbohydrates and reduce saturated fat intake. Our work indicates that a significant portion of the 'so-called apparent increase' in added sugar consumption is

the result of using a different, more inclusive, measurement of added sugars, not increased consumption of foods or beverages that contain sugar."

Song, noting her experience with the Third National Health and Nutrition Examination Survey (NHANES III) data, said "The numbers can be misleading. You have to look at the reasons why the numbers are up. Certainly the increase [in added sugars] is in proportion to the increase in total carbohydrate consumption."

Song's research included a cross-sectional study that showed an inverse relationship between the intake of added sugars and body mass index. "Obese people ate a lesser amount of added sugar. Young people eat more sugar and more added sugar than older people, but obesity, as measured by body mass index, is more a problem for men and women over 30 years of age," Song said.

CSPI challenges conclusions

CSPI Executive Director Michael Jacobson said in an interview with *Food Labeling & Nutrition News* that he questioned the validity of the Georgetown research because the center receives industry funding and that Storey's work in particular was sponsored by the Sugar Association.

"As for the details of her work, it's not published," Jacobson said. "I have no idea what she's talking about. The U.S. Department of Agriculture has highlighted the correlation between high intake of added sugars and reduced intake of 14 different vitamins and minerals. So I would take her so-called study with a grain of salt."

Jacobson added that "people in their teens and twenties are consuming far more refined sugar than is good for their health. And better labeling would help them better control their sugar intake."

The labeling petition to FDA argues, he said, "that many children are drinking much more soda pop and much less milk than they used to. And [the researchers] are apparently saying that that's not true. I have no idea where they get their numbers."

The center's Woo strongly challenged Jacobson's allegation of bias in favor of the industry.

"We are independent of our sponsors and we feel very strongly about that," Woo told *Food Labeling & Nutrition News*. "That is part and parcel of our agreement with them. They only want to make sure that the center is here to be an impartial judge, to be a forum for them to deal with these issues."

University Study Reports Added Sugar Not Linked to Childhood Obesity

11/16/99 Nutrition policy researchers from Georgetown University's Center for Food and Nutrition Policy told those attending the Annual Meeting of the North American Society for the Study of Obesity (NAASO) yesterday that "added sugars" intake is not linked to obesity among children and adolescents as measured by body mass index (BMI).

"Our data do not support the common view that carbohydrate consumption fuels increases in obesity. The cold hard reality is that people are eating too much and exercising too little. Portion sizes have expanded dramatically and it is simply wrong to blame increases in obesity on food or beverages that contain carbohydrates," said Dr. Maureen Storey, associate director of the Georgetown Center.

"While this view may not be 'politically correct' in some circles; nevertheless, the facts are the facts. As academic leaders we need to communicate the data as they are, not as some would hope them to be."

"Research to be presented today demonstrates that added sugars have no practical effect on dietary quality, including calcium intake among the general population, children, and adolescents. Our research shows that in the general population (over age two), it would take an additional 417 teaspoons of table sugar or 42 twelve-ounce cans of carbonated soft drinks to displace one serving of dairy foods. Children would have to consume an additional 588 grams of added sugars or 147 teaspoons of table sugar or 15 twelve-ounce cans of carbonated soft drinks to displace one serving of dairy foods. We need to separate marketing wishes from the science," said Rich Forshee, Ph.D., Visiting Assistant Professor and Director of Computing and Information Services with the Georgetown Public Policy Institute.

Another presenter at the Georgetown briefing for NAASO delegates, Dr. Won Song, professor of Food Science and Human Nutrition at Michigan State University who has worked extensively with the Third National Health and Nutrition Examination Survey (NHANES III) data, explained, "Many nutrition experts have been urging consumers to increase their consumption of carbohydrates and reduce saturated fat intake. Our work indicates that a significant portion of the "so-called apparent increase" in added sugar consumption is the result of using a different, more inclusive, measurement of added sugars, not increased consumption of foods or beverages that contain sugar."

"The numbers can be misleading. You have to look at the reasons why the numbers are up. Certainly the increase [in added sugars] is in proportion to the increase in total carbohydrate consumption," Dr. Song said.

The Michigan State research with a cross-sectional study also shows that an inverse correlation exists between added sugars intake and body mass index. "Obese people ate a less amount of added sugar. Young people eat more sugar

and more added sugar than older people, but obesity, as measured by body mass index, is more a problem for men and women over 30 years of age," concluded Dr. Song.

The Georgetown Center for Food and Nutrition provides instruction and mentoring in food and nutrition policy within the graduate program of the Georgetown Public Policy Institute and serves as an academic and intellectual resource in these subject areas within the Georgetown University community.

Edited by Pam Ahlberg

Do Added Sugars Affect Overall Diet Quality? ***R. Forshee and M. Storey.*** **Georgetown University Center for Food and Nutrition Policy**

There has been much debate about the role of added sugars and foods containing added sugars on overall diet quality and potential health implications including overweight and obesity. The goal of our study was to examine the effect of added sugars on the diet quality of Americans age two and older. **Method:** In this study, we developed a multivariate regression model using the U.S. Department of Agriculture's (USDA) 1994-96 Continuing Survey of Food Intake by Individuals (CSFII). The model predicts the consumption (in servings) from the USDA Food Guide Pyramid (FGP) and the percentage of the U.S. Recommended Dietary Allowances (RDA) for selected nutrients based on the consumption (in grams) of added sugars, carbohydrates (less the grams of added sugars), protein, fat, and alcohol. We also controlled for age and gender. **Results:** Grams of added sugars have a minimal but statistically significant negative effect on consumption of most of the food groups and nutrients examined in this study. The effect of added sugars on the consumption of dairy foods and milk is typical of our results. For example, an additional gram of added sugars reduced predicted number of dairy serving by 0.00059 servings. According to our model, it would take 1,695 additional grams of added sugars or ~43.5 (12-oz.) cans of soda pop to replace one serving of dairy foods. Alcohol consumption had a greater negative effect on consumption of most of the food groups and nutrients we examined. The effect of alcohol consumption on dairy servings is typical of our results. For example, an additional 182 grams of alcohol, the equivalent of 14 [12 oz.] cans of beer or 18 [3.5 oz.] glasses of red wine reduced the predicted number of dairy servings by one. **Conclusion:** Pragmatically, added sugars have virtually no effect on diet quality whereas other dietary components, such as alcohol have a relatively greater negative impact on diet quality. This research was supported by The Sugar Association.

In the box below, provide: (1) corresponding author's name, (2) address, (3) office phone number, (4) fax number, and (5) E-mail address.

Maureen L. Storey, PhD
Associate Director
Center for Food and Nutrition Policy
Georgetown University
3240 Prospect Street, NW
Washington, DC 20007
Phone: 202-965-6400
Fax: 202-965-6444
Email: mlstorey@erols.com

NAASO - North American Association for the Study of Obesity

Annual Meeting
Charleston, South Carolina
November 14-18, 1999

Abstract Receipt Deadline:
July 1, 1999

Send the following items to:
NAASO
8630 Fenton St., Suite 412
Silver Spring, MD 20910
(301) 563 - 6526

- [x] $35.00 processing fee--check made payable to NAASO, US dollars only
- [x] Original abstract form
- [x] 6 copies of abstract form
- [x] 2 Stamped self addressed postcards

- [ ] Size of Abstract Box is 11.2 cm wide and 18.3 cm long. **Title is bold, not all caps.** *Authors in italics.* Institution in normal font without address. Minimum font size is 10 point.

- [ ] Circle Preferred Means of Presentation:
None (Oral) Poster

- [ ] Each abstract form must indicate the one thematic track for which it should be considered. Circle the one track you have selected:
1. Adipose Cell Biology
2. Genetics of Obesity
3. Behavioral Aspects
4. Metabolic Aspects
5. Epidemiology and Health Implications
(6. Prevention, Management and Treatment)

- [ ] NAASO sponsors a young investigator competition at each annual meeting for students and those less than 3 years post doctoral in one of the NAASO countries. The mentor must be a NAASO member. If you wish to be considered, please circle:
Young Investigator
Please provide a reproduced copy of your abstract with names and institution removed.

- [ ] If you have **a potential conflict of interest** about your presentation (for example, reporting on a drug whose company sponsors the research), you should circle this paragraph.

- [ ] If your presentation may have interest for the popular media, please indicate by

Do Added Sugars Affect Overall Diet Quality?

By Richard A. Forshee, Ph.D. and Maureen L. Storey, Ph.D.
The Center for Food and Nutrition Policy,
Georgetown University

Abstract

There has been much debate about the role of added sugars and foods containing added sugars on overall diet quality and potential health implications including overweight and obesity. We examined the effect of added sugars on the overall diet quality of Americans age two and older. Our results show that added sugars have a very small, but statistically significant, effect on consumption of most of the food groups and nutrients we examined. The effect of added sugars is usually, but not always, negative.

Data and Methods

Our data were drawn from the publicly released CD-ROM of the USDA's 1994-96 Continuing Survey of Food Intakes by Individuals (CSFII). Data used in this study were collected in USDA's 1994-96 CSFII, a nationally representative sample of noninstitutionalized persons of all ages residing in the United States.

A series of multiple linear regression models were developed to predict: (1) consumption of servings of the major food groups in the USDA Food Guide Pyramid and (2) the percentage of the Recommended Dietary Allowance (RDA) of selected vitamins and minerals consumed by all individuals over age two years. The models are based on the grams of added sugars, carbohydrates minus added sugars, protein, fat, and alcohol. The models also controlled for age and gender.

Table 1
The Effect of Nutrients on Food Group Servings for All Individuals Two and Older

Unstandardized Regression Coefficients
(t-ratio in parentheses below)

Variable Name	Grains	Vegetables	Fruits	Dairy	Lean Meat
Constant	-0.0592	-0.389**	0.0536	0.5655**	-0.1401*
	(-0.659)	(-5.526)	(0.741)	(13.279)	(-2.767)
Added Sugars (g)	0.0052**	-0.0014**	-0.0021**	-0.0006*	0.0007*
	(13.797)	(-3.697)	(-8.860)	(-2.291)	(2.342)
Protein (g)	-0.0058**	0.0091**	-0.0066**	0.0088**	0.1022**
	(-3.481)	(8.177)	(-3.561)	(10.519)	(95.012)
Total Fat (g)	0.0176**	0.0120**	-0.0151**	0.0018**	-0.0081**
	(13.326)	(11.572)	(-13.269)	(2.763)	(-8.823)
Carbohydrates less Added Sugars (g)	0.0314**	0.0087**	0.0181**	0.0041**	-0.0172**
	(58.801)	(17.606)	(35.810)	(15.352)	(-51.086)
Alcohol (g)	-0.0146**	0.0015	-0.0080**	-0.0054**	0.0053**
	(-9.095)	(1.279)	(-8.681)	(-8.450)	(5.239)
Age (in years)	0.0003	0.0169**	0.0035**	-0.0129**	0.0053**
	(0.515)	(21.460)	(5.378)	(-27.384)	(10.614)
Female	-0.0738*	0.0823*	0.1236**	0.0323	-0.1016**
	(-2.237)	(2.376)	(5.499)	(1.726)	(-4.295)
Adjusted R^2	0.6798	0.3349	0.3154	0.2780	0.8014
n	14,256	14,256	14,256	14,256	14,256

* indicates the variable is statistically significant at p<.05
** indicates the variable is statistically significant at p<.01

Source: Analysis by authors using data from CSFII.

Table 2
The Effect of Nutrients on Vitamin and Mineral Consumption as a percentage of the US RDA for Individuals Two and Older

Unstandardized Regression Coefficients
(t-ratio in parentheses below)

Variable Name	Vitamin A	Vitamin C	Calcium	Iron	Folate
Constant	33.0170**	63.1424**	22.5819**	9.9070**	179.6709**
	(5.993)	(8.8596)	(12.443)	(4.414)	(47.325)
Added Sugars (g)	-0.1992**	0.0112	-0.0316**	0.0493**	-0.2457**
	(-7.076)	(0.340)	(-3.363)	(5.526)	(-12.444)
Protein (g)	0.6399**	0.0296	0.3498**	0.7513**	0.0014
	(4.252)	(0.233)	(10.883)	(15.304)	(0.025)
Total Fat (g)	-0.7610**	-0.9865**	0.1677**	-0.2557**	-0.5697**
	(-7.475)	(-11.039)	(7.065)	(-6.628)	(-10.347)
Carbohydrates less Added Sugars (g)	0.7667**	1.2199**	0.2445**	0.5308**	0.8713**
	(18.503)	(34.358)	(28.176)	(40.489)	(34.661)
Alcohol (g)	-0.5564**	-0.3736**	-0.1487**	-0.2384**	-0.3495**
	(-4.956)	(-4.428)	(-8.047)	(-8.945)	(-5.246)
Age (in years)	0.0371	-0.8009**	-0.1845**	0.2366**	-2.3651**
	(0.464)	(-19.009)	(-10.743)	(10.468)	(-44.172)
Female	30.5171**	5.7394*	-1.6509*	-25.3402**	-12.8199**
	(9.182)	(2.341)	(-2.267)	(-22.906)	(-6.061)
Adjusted R^2	0.1021	0.2688	0.4001	0.5635	0.3363
n	14,256	14,256	14,256	14,256	14,256

* indicates the variable is statistically significant at p<.05
** indicates the variable is statistically significant at p<.01

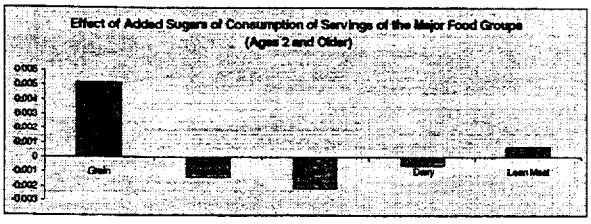
Source: Analysis by authors using data from CSFII.

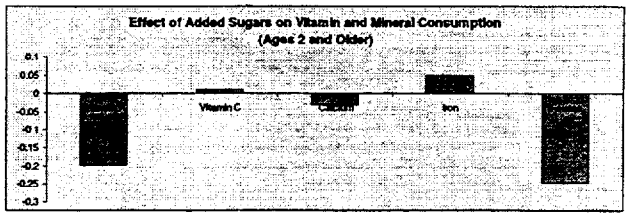
Results and Discussion

Overall, the results presented in Tables 1 and 2 support the following general conclusions:

- The effect of added sugars on the consumption of the major food groups and the vitamins and minerals examined is inconsistent and varies with age group (Figure 1). The results range from no association to a miniscule, albeit statistically significant, association that may be positive or negative.
- Carbohydrates minus added sugars have a consistently positive, statistically significant, and relatively larger effect than added sugars on the examined variables.
- Protein and fat have mixed effects on the consumption of the major food groups, vitamins, and minerals examined in this paper. The effects are usually statistically significant, but the size and direction of the effects vary depending on which food group, vitamin, or mineral examined.
- Alcohol has a consistently negative, statistically significant, usually moderate, and relatively greater effect on consumption of the major food groups, vitamins, and minerals examined in this paper. Moderate alcohol consumption is unlikely to have any serious effect on an individual's diet, but heavy alcohol consumption tends to be associated with a poor diet.

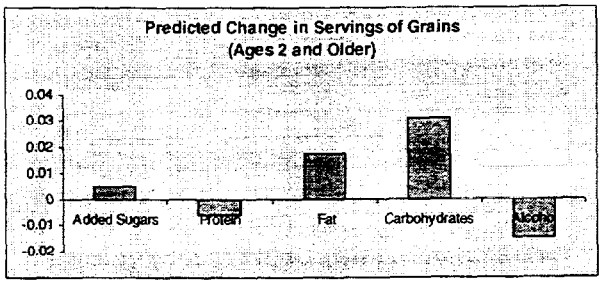
The Effect of Added Sugars on the Consumption of Food Groups and Selected Nutrients

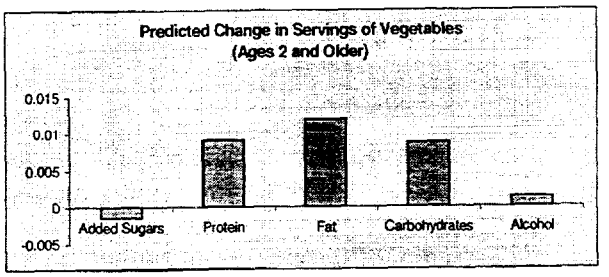


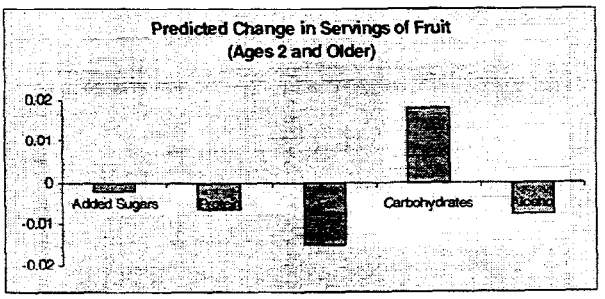


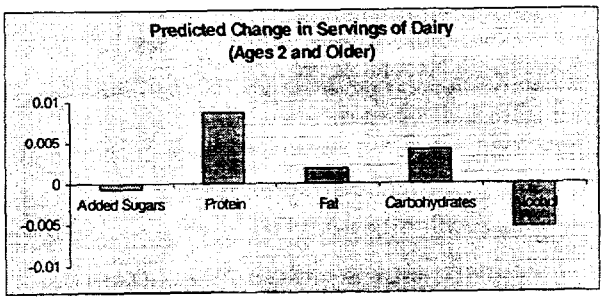
Each bar in the charts above represents the estimated coefficient for added sugars for the associated food group, vitamin, or mineral. Added sugars in the diet has a positive association with consumption of Grains, Lean Meats, Vitamin C, and Iron. Added Sugars have a negative association with consumption of Vegetables, Fruit, Dairy, Vitamin A, Calcium, and Folates. In all cases, the practical impact is very small.

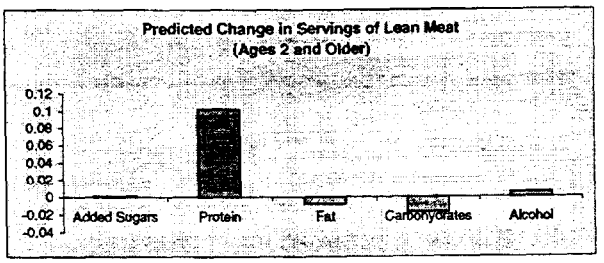
The Relative Effect of Added Sugars and Other Calorie Sources on the Consumption of Food Groups and Selected Nutrients

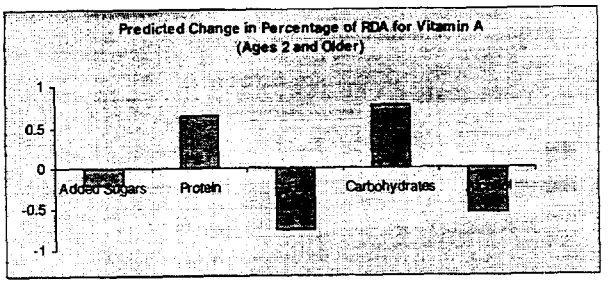


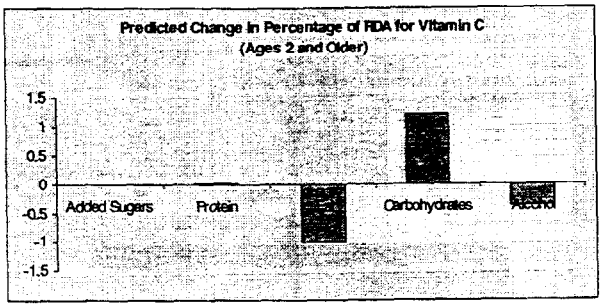


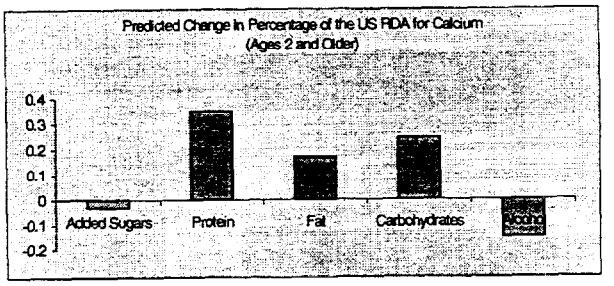


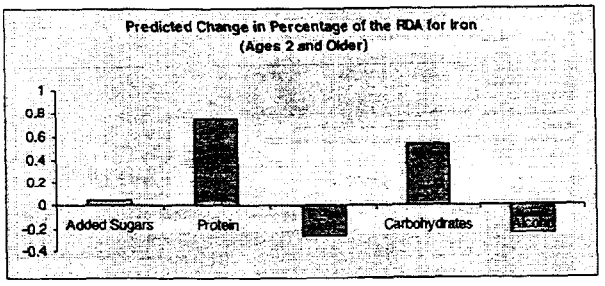


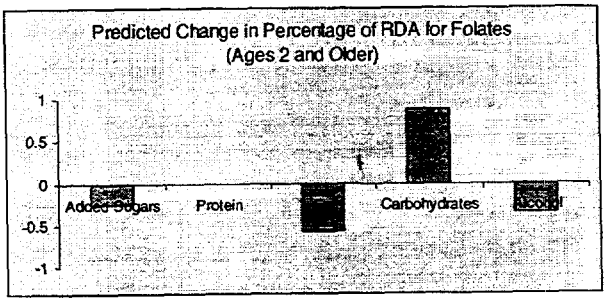












These charts show the relative effect of added sugars compared to other calorie sources. Other sources of calories have a greater impact on overall dietary quality than do added sugars. Alcohol has a particularly strong negative impact.

Conclusion

The effect of added sugars on overall diet quality varies across food groups, vitamins, and minerals. Additional grams of added sugars are associated with an increase in grain and lean meat consumption and an increase in the percentage RDA of iron. Conversely, increased consumption of added sugars is associated with decreased servings of vegetables, fruit, and dairy and a lower percentage RDA of Vitamin A, calcium, and folates. However, the practical effects of added sugars are very small. In our models of food group consumption for all ages, added sugars have the greatest negative effect on consumption of fruits (b = -0.0021, t-ratio = -8.860), but it would require the consumption of more than 476 additional grams of added sugars to reduce the predicted number of fruit servings by one. That amount of sugars translates to 119 teaspoons of table sugar or nearly 12 twelve-ounce cans of soda pop. The effect of added sugars on the consumption of dairy foods and calcium is much smaller. An additional gram of added sugars reduces the predicted number of dairy servings by 0.0006 servings. In order to reduce the servings of dairy by one, individuals would need to consume an additional 1,667 grams of added sugars or approximately 43.5 (12 oz.) cans of soda pop to displace one serving of dairy foods.

Our data cast serious doubt on the validity of the "displacement theory." It is true that added sugars are associated with certain food groups or micronutrients, but the association is always small and may be positive or negative. Pragmatically, added sugars have virtually no effect on diet quality whereas other dietary components, such as alcohol, have a relatively greater negative impact on diet quality. As learned statisticians sagely conclude, a difference isn't a difference unless it makes a difference.

This research was supported by The Sugar Association.

Relationship between Sugars Intake and Measures of Obesity and Nutrient Adequacy

Background

In 1994, the International Life Sciences Institute's North American branch organized an expert panel to review all available literature on the role of dietary sugars and health. The proceedings of this panel's deliberation were published in the *American Journal of Clinical Nutrition* (62:161S-296S, 1995). One of the papers written for this panel examined intake patterns of the U.S. population using the 1987-88 Nationwide Food Consumption Survey (NFCS) and compared these data to those generated by the Food and Drug Administration in its review of sugars published in 1986 (J. Nutr. 116:S1-S216). The panel concluded that there was no evidence that sugars intake (56 grams per day or 10-12 percent of calories, based on the 1987-88 NFCS)) was related to risk of chronic disease.

The relationship between sugars intake and obesity was not evaluated with the NFCS data. Since the recent Third National Health and Nutrition Examination Survey (NHANES III) provided an opportunity to look carefully at the relationship between sugars intake and body mass index (BMI), the ILSI Human Nutrition Institute provided a grant to Dr. Won Song and Debra Keast at Michigan State University to undertake such an analysis. Dr. Harvey Anderson, who addressed the Dietary Guidelines Advisory Committee at its March meeting, served as an external advisor to the project. The analysis was designed to address the issue of nutrient adequacy as well. The data on the relationship between body mass index and sugars consumption were presented by Debra Keast at the EB'99 meeting (abstract attached).

Methods:

The NHANES III data files include food composition values for total carbohydrate and for total sugars. The latter are defined as the sum of mono- and disaccharides (sucrose + fructose + glucose + galactose + lactose + maltose). These values came from the database of the Dietary Data Collection of the Nutrition Coordinating Center at the University of Minnesota.

To determine the value for so-called "added sugars", the foods reported in the NHANES III 24-hour recall were linked to the Food Guide Pyramid Servings database for added sugars. In this database, definition for added sugars is expanded beyond mono- and disaccharides to cover all sweeteners including:

> white sugar, brown sugar, raw sugar, corn syrup, corn syrup solids, high fructose corn syrup, malt syrup, maple syrup, pancake syrup, fructose sweetener, liquid fructose, honey, molasses, anhydrous dextrose, crystal dextrose, saccharin, and aspartame that are eaten separately or used as an ingredient in processed or prepared foods.

For this definition of added sugars, teaspoons are the unit of measure, where 1 teaspoon is the quantity of a sweetener that contains the same amount of carbohydrate as 1 teaspoon of table sugar. This value was then converted to grams of added sugars (1 tsp = 4 g of added sugars) and to energy (1 tsp = 16 Kcal). The result is that the term added sugars now includes mono-, di- and oligosaccharides.

There were 733 foods, most of which were infrequently eaten and/or contained little or no added sweetener, in the NHANES III data base that did not match with a food in the Food Guide Pyramid Servings database. These foods were then hand coded to the closest available food in the Food Guide Pyramid Servings database.

Table 1 shows the means and quartile distribution for energy, fat and carbohydrate intake for some of the age/sex categories examined. In reporting data by quartiles, each of the 10 age/sex groups for which data were reported was stratified by these groups before placing the individuals into quartiles.

Statistical analysis was carried out with the SUDAAN package.

Results

A. How do the intake patterns of adults in the NHANES III survey compare with past surveys?

Figure 1 shows the percent of energy contributed by fat and various carbohydrate components for five nationally representative surveys. The data from the 1977-78 NFCS are the data generated by the Food and Drug Administration (J. Nutr. 116:S1-S216, 1986) For this analysis, added sugar measures only mono- and disaccharides. The values for the 1988-94 NHANES and the two CSFII surveys were generated using the expanded definition of added sugars.

It is important to note that total carbohydrate intake has increased from 43 to 51 percent of calories, as encouraged by the Dietary Guidelines. An increase of total sugars accounts for less than one-half (3.5 percent) of the increase in total carbohydrate. Yet by using the USDA data base, added sugars intake appears to have increased from 12 to nearly 16 percent of calories, more than the increase in total sugars. It seems very unlikely that added sugars account for all of the increase, let alone more than the increase in total sugars.

Because there has been a fundamental change in how added sugars are calculated, it is important to examine the contribution of the definitional change to this increase. Working with Dr. Youngmee Park, who created the Food and Drug Administration database for the analysis of the 1977-78 NFCS data, and with the USDA-ARS Survey Research Branch, we have identified two possible sources of significant differences — 1) values reported for products containing corn syrups other than high fructose corn syrup; and 2) values reported for yeast bread products.

There are 648 of the 4,744 foods in the NHANES III database for which the value of added sugars (coming from the USDA database) is greater than the total sugars value (from the NCC database) lending weight to the conclusion that at least a portion of the increase seen over the 20 year span is due to the change in definition.

The Food Guide Pyramid Servings database converts all of the carbohydrate in corn syrups to sucrose equivalents, even though corn syrups can be up to 80 percent by weight oligosaccharide (degree of polymerization (DP) 3-7+). One way to estimate the impact of this difference is to assume that the average value for the non-sugar saccharides in the two most commonly used corn syrups is 70 percent. Using disappearance data from 1991, the mid-point of the NHANES III survey, these syrups represented 13.4 percent of the total dry weight of all corn-derived sweeteners and 70 percent of 13.4 percent would represent the total non-mono- and disaccharides contributed by these syrups. The average grams of added sugars calculated using the new definition of added sugars is 85.2 g/day (from 21.3 tsp). So the ball-park over estimation due to this ingredient is 8.0 g/day (0.134 x 0.7 x 85.2 g/d). This calculation, alone, would bring the estimate of added sugars intake down to 14.3 percent kcal.

The issue with yeast breads is that the Food Guide Pyramid counts all sweeteners added during the making of yeast bread. Since a portion of that sweetener is used by the yeast to make the bread rise, it is no longer present when the bread is consumed. While the change per food item is very small, the aggregate contribution may be large because of the large amount of yeast breads consumed by the population. Based on information from the baking industry, a conservative estimate of sugar consumption by the yeast and in the Maillard reaction is 75-85 percent of the sugar added to bread dough.

The mean added sugars contributed by the category yeast breads and rolls is 5.0 tsp or 20 grams per day. If 75 percent of this amount is consumed by the yeast and the Maillard reaction, then the remaining added sugars is 5 gram/day or a loss of 15 grams per day bringing the overall mean added sugars intake from 85.2 grams per day to 70.2 grams per day. This represents a reduction in the mean percent kcal from added sugars to approximately 13 percent.

By considering only these two possible explanations for the apparent increase in added sugars consumption, it appears that the best estimate of added sugars intake is approximately 13 percent of calories, a very small if any increase from the estimates made by FDA based on the 1977-78 NFCS.

Conclusions:

- Total carbohydrate and total sugars consumption has increased over the past 20 years. Total carbohydrate is now approaching the value of 55-65 percent kilocalories recommended by a number of expert groups.

- Added sugars may have increased slightly but the bulk of the increase is more likely due to a change in the definition of the term "added sugars". Certainly the increase is in proportion to the increase in total carbohydrate and total sugars consumption.

B. Are adults with high intakes of carbohydrates, total sugars or added sugars more obese than adults with lower intakes?

These analyses were carried out only with adults (19 years of age and older) because of the uncertainty of defining obesity in children using BMI.

Figures 2 and 3 show the intake patterns for various adult age groups for fat, carbohydrate, total sugars and added sugars both in grams/day and percent kilocalories/day. Figure 4 shows the results of correlation analysis between total fat intake and various carbohydrate categories. The top half of the figure shows a positive correlation between total fat gram intake and various carbohydrate gram intakes. However, when expressed as percent of energy, there is an inverse pattern or seesaw — as percent of energy from fat goes up, the percent of energy from carbohydrate goes down and vice versa. The same pattern is apparent when the adults are arrayed by quartiles of carbohydrate intake and fat intake as percent of calories is plotted against percent calories from carbohydrate categories (Figure 5).

The average BMI for quartiles of fat intake as well as carbohydrate is shown in Figure 6. High fat (as percent kcal) consumers tend to have higher BMI than low fat consumers. The opposite is seen for carbohydrate and total sugars. For added sugars, there was no significant differences in BMI between the quartiles. Actual means are compared in Table 2.

Table 3 shows the energy, fat and sugars means for the population when arrayed by BMI category. The obese category ($\geq$ 30) reported a significantly lower total sugars and added sugars intake compared to the lean group ($<$ 25). This is true for all age/sex groups examined except men 19-30 years of age. For this group those classified as obese (BMI $\geq$ 30) had higher total sugars and added sugars than the other two BMI categories (Figure 7).

Conclusions:

- Energy intake from total fat is inversely related to energy intake from carbohydrate and sugars.

- Adult BMI is inversely associated with food energy from carbohydrate, total sugars and added sugars, with the exception of men 19-30 years of age.

C. Is a high sugars intake associated with reduced nutrient adequacy?

Figure 8 presents the percentage of the sample population falling below 2/3 of the 1989 Recommended Dietary Allowance (RDA) for the so-called "problem nutrients" by quartiles of total sugars intake (grams/day). The higher sugars intake quartiles have fewer people reporting diets with less than 2/3 the RDA. The same picture is seen with quartiles of added sugars. When the data are presented as quartiles of percent kilocalories from total sugars, individuals in the highest quartile of total sugars are more likely to fall below 2/3 of the RDA for all nutrients listed except vitamin C (Figure 9). Both vitamin A and calcium exhibit a U- shaped relationship, meaning that individuals in the lowest and highest quartiles of sugars intake had less nutrient dense diets than did those in the middle quartiles.

Table 4 shows the mean nutrient intakes by quartiles of intake as percent energy from total sugars. Table 5 shows nutrient density (mean nutrient intake/1000 kcal) arrayed by quartiles of percent kilocalories from total sugars. Here the results are mixed. For some nutrients, vitamin E and zinc, there is a downward trend as total sugars goes up perhaps due to the accompanying decline in fat intake. For vitamin C, there is a clear increase as sugars consumption increases. With the other problem nutrients, the U-shaped curve appears once again.

Figure 10 shows the nutrient density for calcium by quartiles of percent of energy from total sugars for different age groups. For all 2-18 year olds, the highest quartile has significantly lower calcium density than all other quartiles, but the lower three are not significantly different from each other. The pattern is different for adults. For example for women 19 years and older, the highest quartile of percent energy from total sugars had significantly higher calcium density than all of the other quartiles. The other three quartiles were not different from each other.

Conclusions:

- Total and added sugars intake quartiles (g/day) are positively associated with total daily nutrient intake.
- Nutrient density of some problem nutrients is decreased in the lowest and highest quartiles of sugars.
- These relationships are different depending on the nutrient and the sex/age group examined.
- Prevalence of nutrient inadequacy was lower in the high sugars intake quartile (g/day) and higher in the high sugars energy intake quartile (percent Kcal).

Attachments: Abstract
Tables and Figures

Abstract of EB'99 Presentation

ENERGY INTAKE FROM SUGARS AND FAT IN RELATION TO OBESITY IN U.S. ADULTS, NHANES III, 1988-94. Keast DR, Padgitt AJ, Song WO. Michigan State University, East Lansing, MI, 48824.

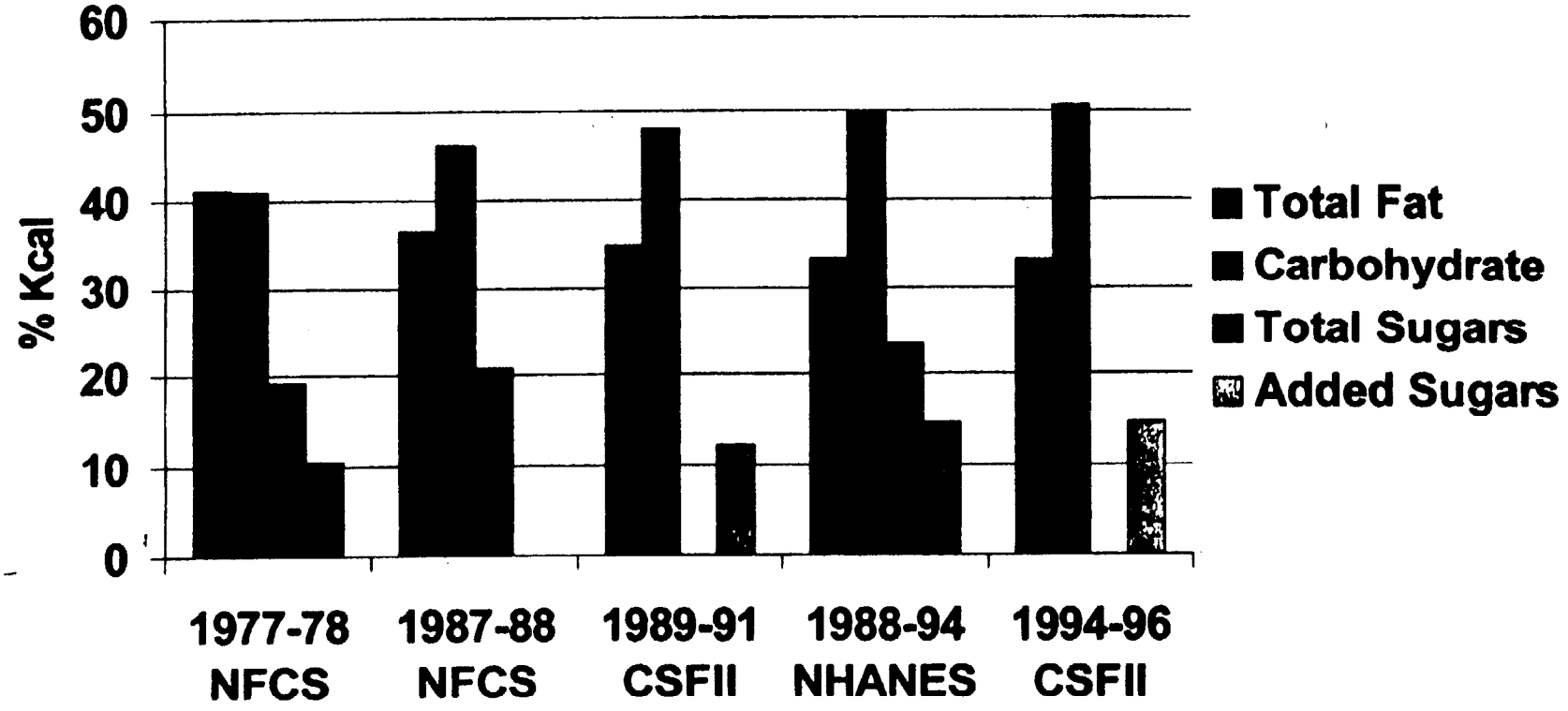
An inverse relationship between sugars and fat consumption has been implicated for obesity. Total sugars, fat and energy intakes by adults (19+y, n=15,948) in NHANES III were examined in relation to their BMI. Mean intakes of energy, fat, CHO and total sugars (sum of six added and naturally occurring sugars) were compared by age, gender and BMI subgroups. Energy intake averaged 2193±20 (SEM) Kcal/d contributed by fat (34%), CHO (50%), and total sugars (24%). The % Kcal from total sugars varied from 22% (51+y men) to 26% (19-30y women). Women age 51+y had 32% Kcal from fat and 52% Kcal from CHO; and 31-50y men had 34% Kcal from fat and 48% Kcal from CHO. 45% of U.S. adults were not obese (BMI < 25); 32% had BMI 25-29; and 22% of U.S. adults were obese (BMI ≥ 30). Compared to non-obese adults (BMI < 25), obese adults (BMI ≥ 30) had lower energy intake (2223±30 vs. 2077±35 Kcal/d), higher % Kcal from fat (33.1±0.3 vs. 34.7±0.3%), lower % Kcal from CHO (50.1±0.3 vs. 48.7±0.4%), and lower % Kcal from total sugars (23.8±0.3 vs. 22.9±0.3%). The trends were consistent for fat and CHO intakes in both men and women, and for total sugars intake in women. The dietary "sugars-fat seesaw" operates such that BMI is positively associated with % Kcal from fat, and inversely associated with % Kcal from total sugars. Fat intake was associated with obesity of men and women in U.S. (Supported by ILSI-RF)

Table 1. Mean and quartiles of food energy density and percent energy from macronutrients, NHANES III, 1988-1994[1]

Food Energy and Macronutrient	Statistic ± S.E.[2]	All 2 + y (n=25,908)	All 6-12 y (n=3554)	Male 13-18 y (n=1097)	Female 13-18 y (n=1193)	Male 19+ y (n=7632)	Female 19+ y (n=8316)
Food energy density (Kcal / 100 gram)	Mean	99.7 ± 0.4	124.5 ± 0.9	119.9 ± 1.8	118.9 ± 1.9	95.2 ± 0.7	89.9 ± 0.6
	25th %tile	75.7 ± 0.5	102.7 ± 0.8	95.3 ± 2.1	93.6 ± 2.3	73.9 ± 0.7	67.1 ± 0.7
	50th %tile	96.2 ± 0.5	120.2 ± 0.9	115.4 ± 2.1	113.0 ± 2.2	92.1 ± 0.8	85.7 ± 0.7
	75th %tile	119.4 ± 0.6	139.5 ± 1.2	138.3 ± 2.4	135.7 ± 2.5	112.1 ± 1.0	107.5 ± 0.9
Total Fat (% Kcal)	Mean	33.5 ± 0.2	33.6 ± 0.2	33.5 ± 0.4	33.9 ± 0.4	33.9 ± 0.3	33.2 ± 0.2
	25th %tile	27.6 ± 0.2	28.7 ± 0.2	28.3 ± 0.7	28.5 ± 0.4	27.9 ± 0.4	26.8 ± 0.3
	50th %tile	33.7 ± 0.2	33.6 ± 0.2	33.3 ± 0.5	33.6 ± 0.5	34.2 ± 0.3	33.4 ± 0.2
	75th %tile	39.5 ± 0.2	38.6 ± 0.3	38.8 ± 0.5	38.8 ± 0.6	39.9 ± 0.3	39.9 ± 0.2
Total Carbohydrate (% Kcal)	Mean	50.8 ± 0.2	53.7 ± 0.3	52.5 ± 0.5	54.0 ± 0.7	48.4 ± 0.4	51.0 ± 0.3
	25th %tile	43.3 ± 0.3	47.7 ± 0.4	46.0 ± 0.6	47.2 ± 0.6	40.9 ± 0.4	43.1 ± 0.4
	50th %tile	50.8 ± 0.2	53.3 ± 0.3	52.6 ± 0.5	53.7 ± 0.7	48.1 ± 0.4	50.6 ± 0.3
	75th %tile	58.0 ± 0.3	59.6 ± 0.4	58.3 ± 0.6	61.5 ± 0.7	55.7 ± 0.4	58.3 ± 0.3
Total Sugars (% Kcal)[3]	Mean	24.9 ± 0.2	28.1 ± 0.3	28.5 ± 0.5	29.9 ± 0.8	22.8 ± 0.4	24.1 ± 0.2
	25th %tile	17.1 ± 0.2	21.3 ± 0.4	21.2 ± 0.5	20.9 ± 0.7	15.1 ± 0.3	16.2 ± 0.2
	50th %tile	23.9 ± 0.2	27.1 ± 0.4	27.7 ± 0.6	28.3 ± 0.8	21.7 ± 0.3	23.0 ± 0.2
	75th %tile	31.3 ± 0.3	33.7 ± 0.4	34.4 ± 0.6	36.9 ± 0.7	28.9 ± 0.4	30.3 ± 0.3
Added Sugars (% Kcal)[4]	Mean	15.7 ± 0.2	18.1 ± 0.3	20.3 ± 0.5	21.4 ± 0.8	14.7 ± 0.3	14.7 ± 0.2
	25th %tile	7.9 ± 0.1	11.4 ± 0.3	12.9 ± 0.6	12.2 ± 0.7	7.2 ± 0.3	6.9 ± 0.1
	50th %tile	14.1 ± 0.2	17.0 ± 0.4	19.1 ± 0.6	19.6 ± 0.8	13.1 ± 0.3	12.8 ± 0.2
	75th %tile	21.4 ± 0.3	23.5 ± 0.5	[illegible].0 ± 0.6	28.6 ± 0.9	20.1 ± 0.4	20.3 ± 0.4

[1] Sample age 2 years or more includes those with reliable and complete dietary interview, and excludes pregnant and/or lactating women.
[2] Statistics are sample-weighted and standard errors are calculated by linearization variance estimation method of SUDAAN.
[3] Total sugars (g/day) is the sum of sucrose, galactose, maltose, glucose, fructose, and lactose intakes.
[4] Percentage of energy from teaspoons (1 tsp = 16 Kcal) of added sugars, where 1 teaspoon is the quantity of a sweetener that contains the same amount of carbohydrate as 1 teaspoon of table sugar.

Figure 1. Trends in Macronutrient Intake: U.S. Adults



FNDRC MSU

Figure 2. Total Fat, Carbohydrate, and Sugars Intake by Gender and Age

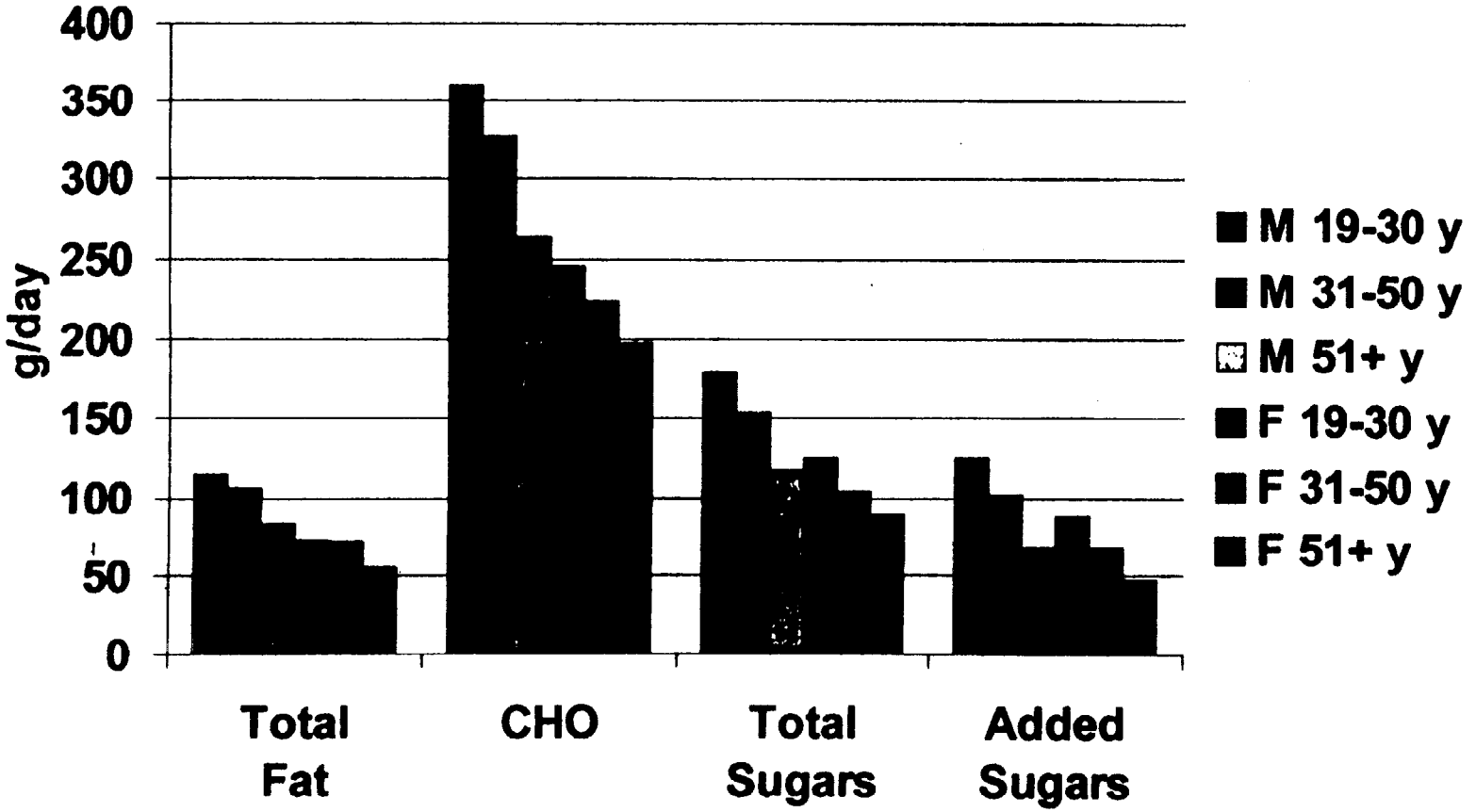
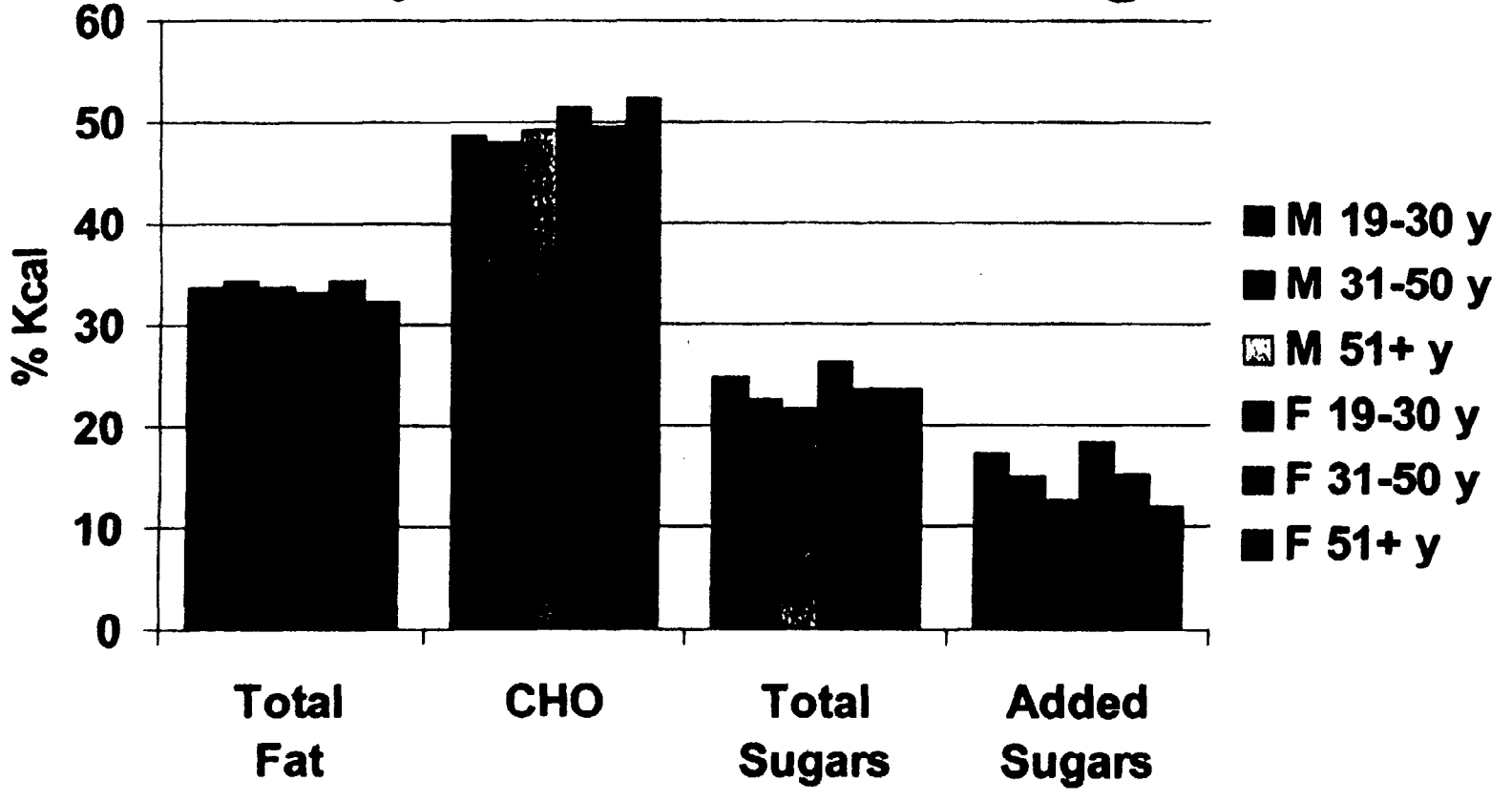


Figure 3. Percent Energy from Total Fat, Carbohydrate, and Sugars by Gender and Age



FNDRC MSU

Figure 4. Correlations of Total Fat Versus Carbohydrate and Sugars

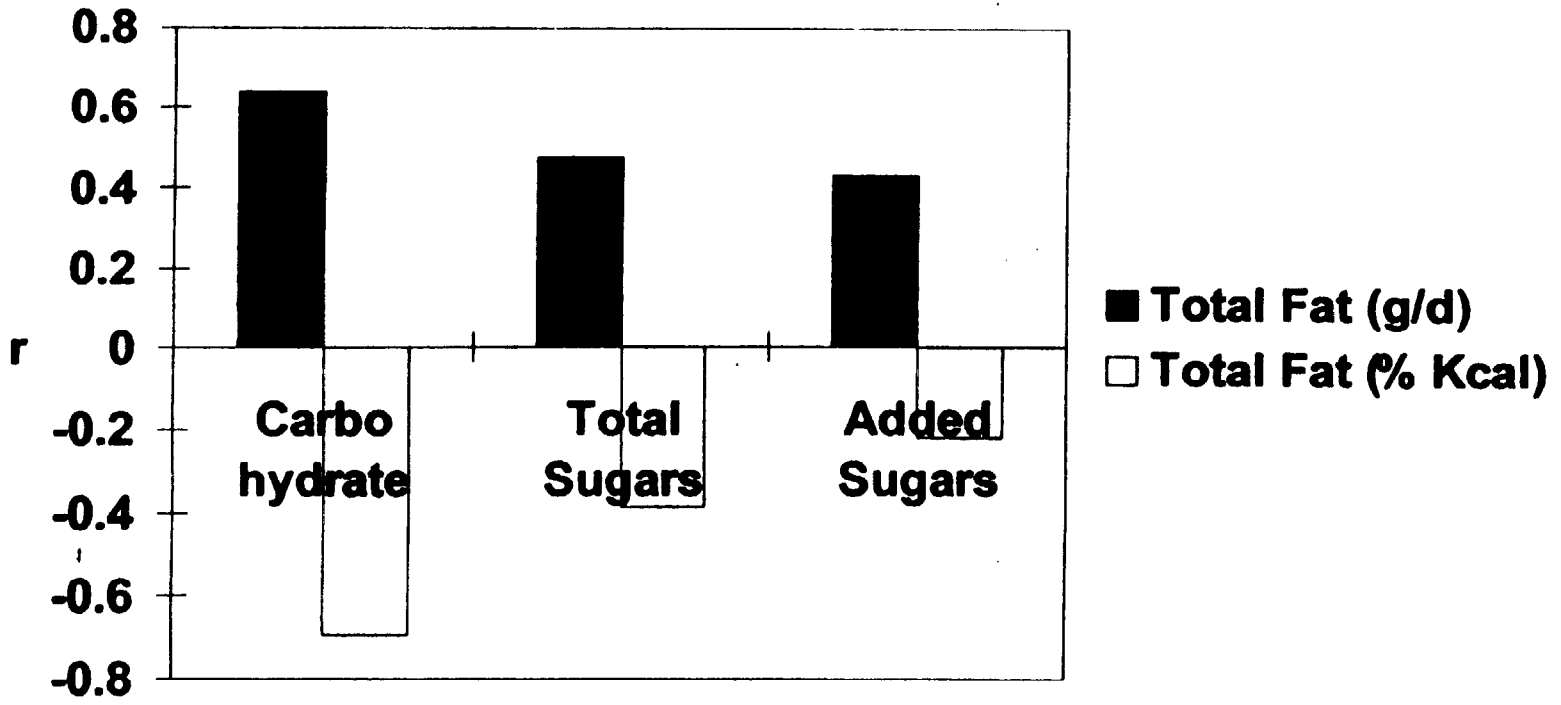


Figure 5. Carbohydrate and Sugars Intake by Quartiles of Total Fat (% Kcal)

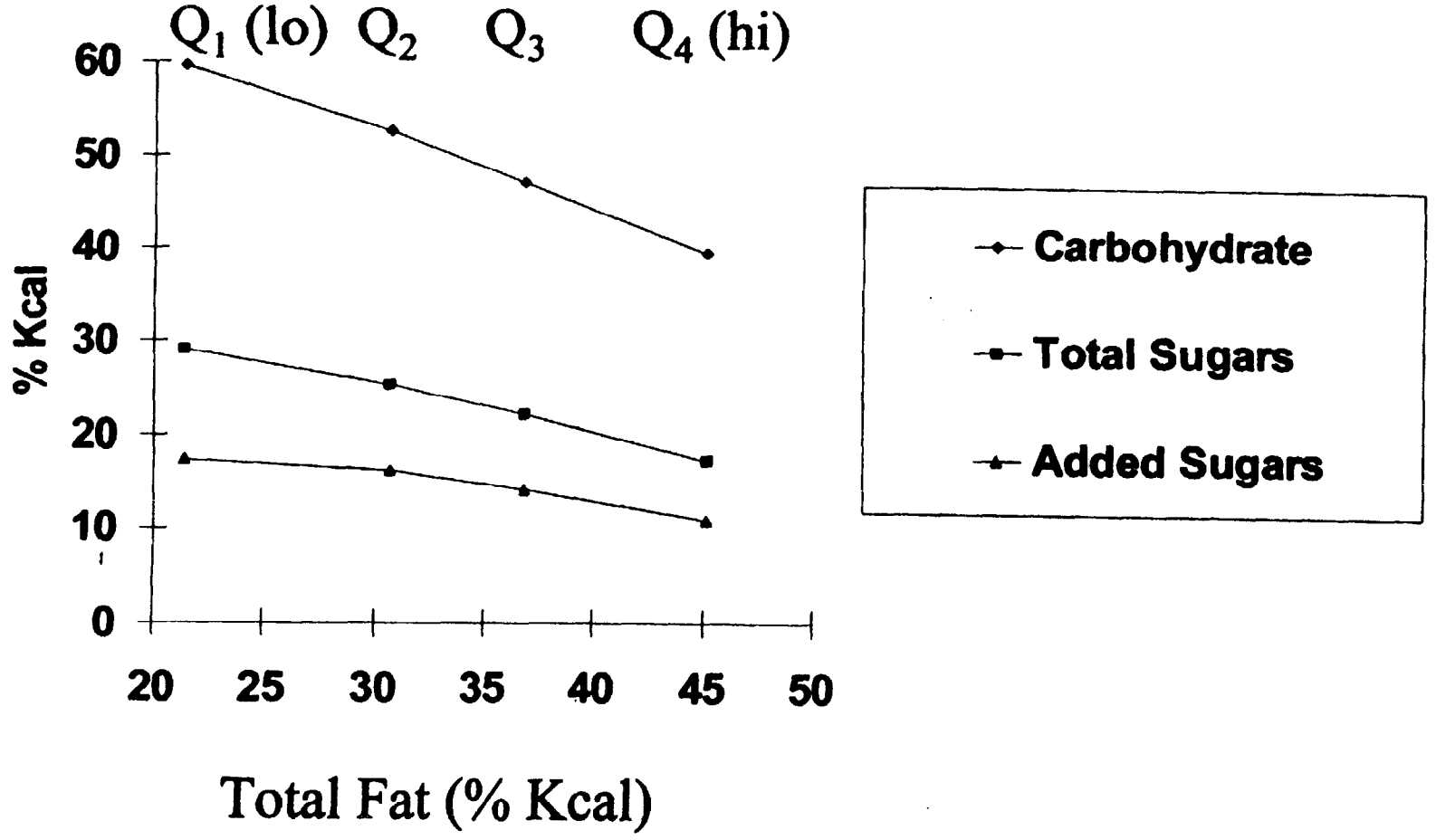
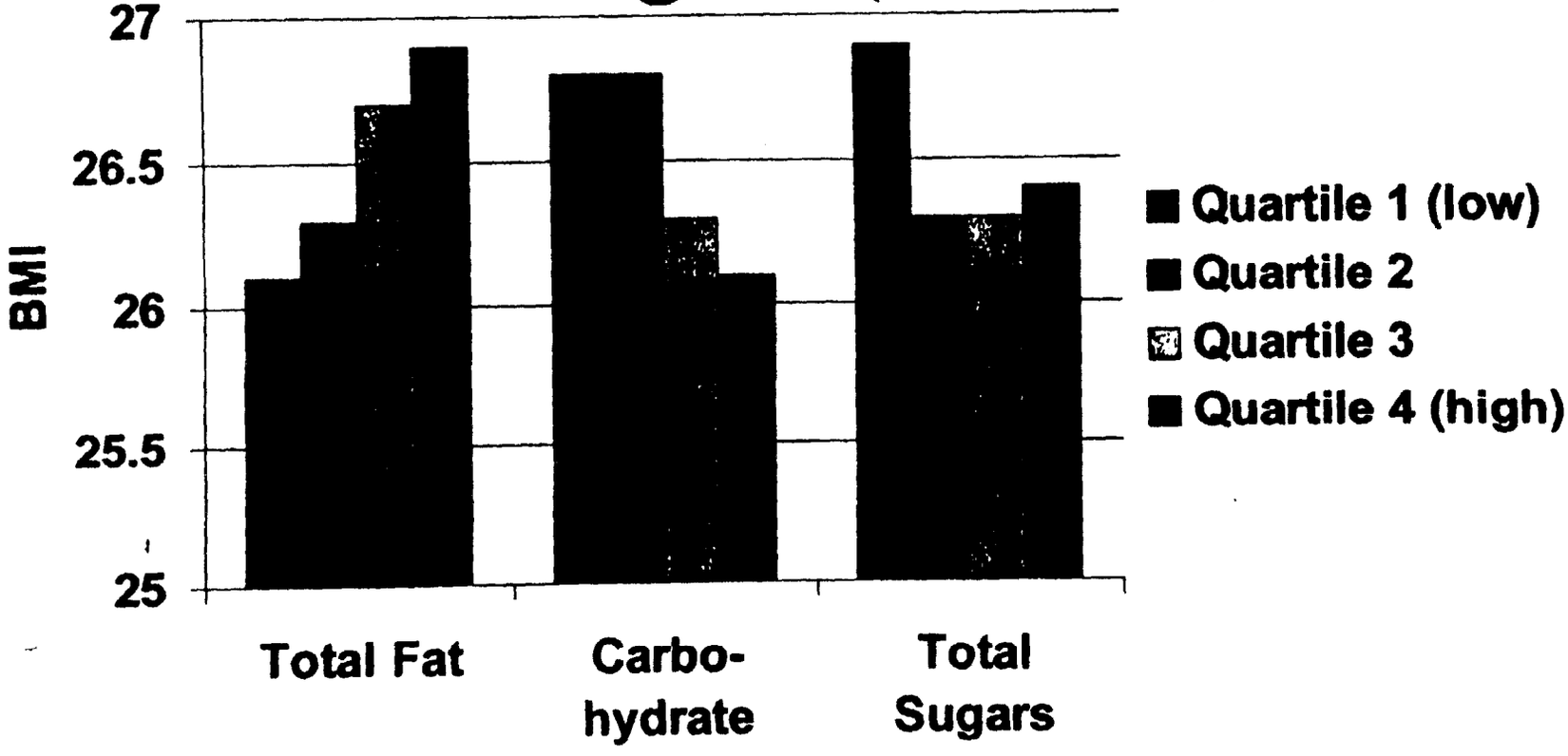


Figure 6. Body Mass Index by Quartiles of Total Fat, Carbohydrate, and Sugars (% Kcal)



FNDRC MSU

Table 2. BMI of Dietary Intake Quartiles of Adults

Quartiles	Q1(Low)	Q2	Q3	Q4(High)	P
Energy (Kcal/day)	26.6 ± 0.1	26.4 ± 0.1	26.4 ± 0.2	26.6 ± 0.2	ns
Energy density (Kcal/ 100 g)	26.6 ± 0.1	26.5 ± 0.2	26.4 ± 0.2	26.5 ± 0.2	ns
Total Fat (g/day)	26.3 ± 0.1^{a}	26.5 ± 0.1^{ab}	26.4 ± 0.2^{a}	26.9 ± 0.2^{b}	<0.05
Total Sugar (g/day)	26.9 ± 0.1^{a}	26.5 ± 0.1^{bc}	26.1 ± 0.2^{b}	26.5 ± 0.2^{ac}	<0.05
Added Sugar (tsp/day)	26.7 ± 0.1^{a}	26.3 ± 0.1^{b}	26.3 ± 0.2^{b}	26.6 ± 0.2^{ab}	<0.05
Total Fat (% Kcal)	26.1 ± 0.1^{a}	26.3 ± 0.2^{a}	26.7 ± 0.2^{b}	26.9 ± 0.2^{b}	<0.05
Total Sugar (% Kcal)	26.9 ± 0.1^{a}	26.3 ± 0.2^{b}	26.3 ± 0.2^{b}	26.4 ± 0.1^{b}	<0.05
Added Sugar (% Kcal)	26.7 ± 0.2	26.3 ± 0.2	26.3 ± 0.2	26.6 ± 0.2	ns

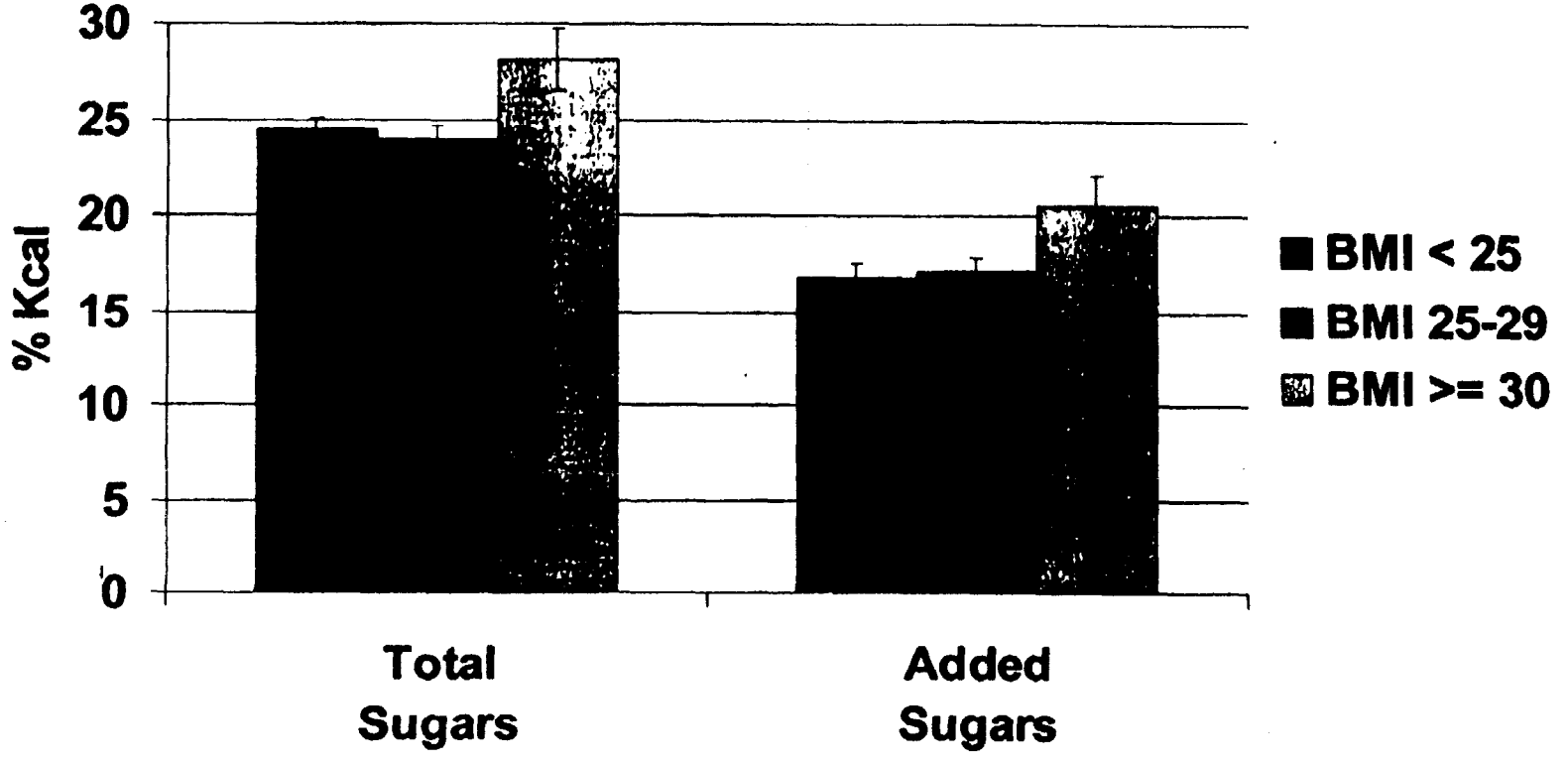
Different superscripts denote significant difference.

Table 3. Dietary Intake by BMI of Adults

	BMI			
	<25	25.0-29.9	≥30	P
Energy (Kcal/day)	2223 ± 30[a]	2233 ± 26[a]	2077 ± 35[b]	<0.05
Energy density (kcal/100 g food)	94.5 ± 0.6[a]	90.6 ± 0.8[b]	90.9 ± 0.3[b]	<0.05
Total fat (g/day)	83.9 ± 1.5	85.5 ± 1.2	82.2 ± 1.8	ns
Total Sugar (g/day)	129.1 ± 2.3[a]	128.0 ± 2.9[a]	118.9 ± 3.2[b]	<0.05
Added Sugar (g CHO/day)	83.1 ± 2.0[a]	83.1 ± 2.6[a]	76.0 ± 2.3[b]	<0.05
Total Fat (% Kcal)	33.1 ± 0.3[a]	33.4 ± 0.2[a]	34.7 ± 0.3[b]	<0.05
Total Sugar (% Kcal)	23.8 ± 0.3[a]	23.4 ± 0.3[ab]	22.9 ± 0.3[b]	<0.05
Added Sugar (% Kcal)	15.0 ± 0.3[a]	14.6 ± 0.3[ab]	14.2 ± 0.3[b]	<0.05

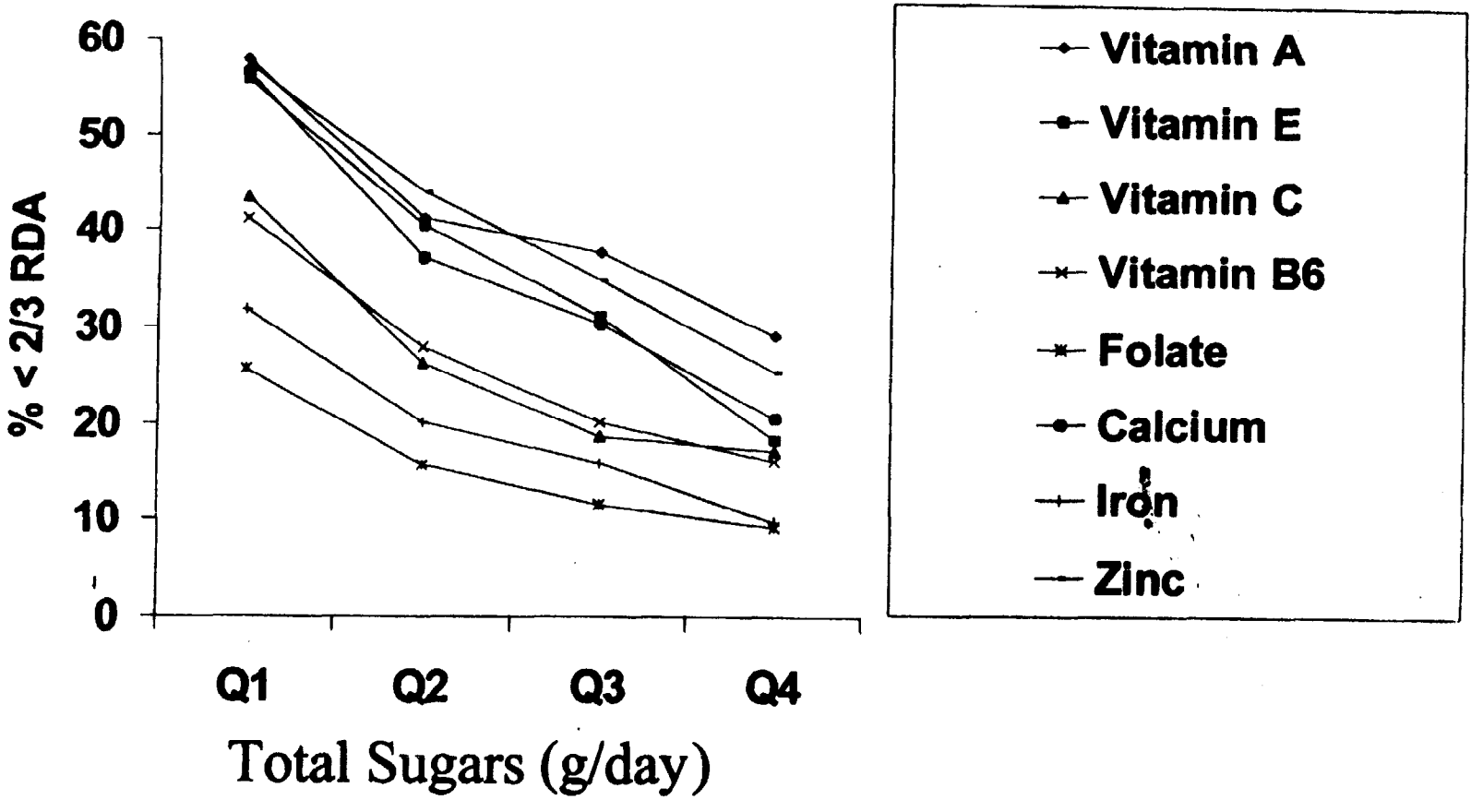
Mean ± SE

Figure 7. Total and Added Sugars Intake of Non-obese and Obese Men 19-30 y



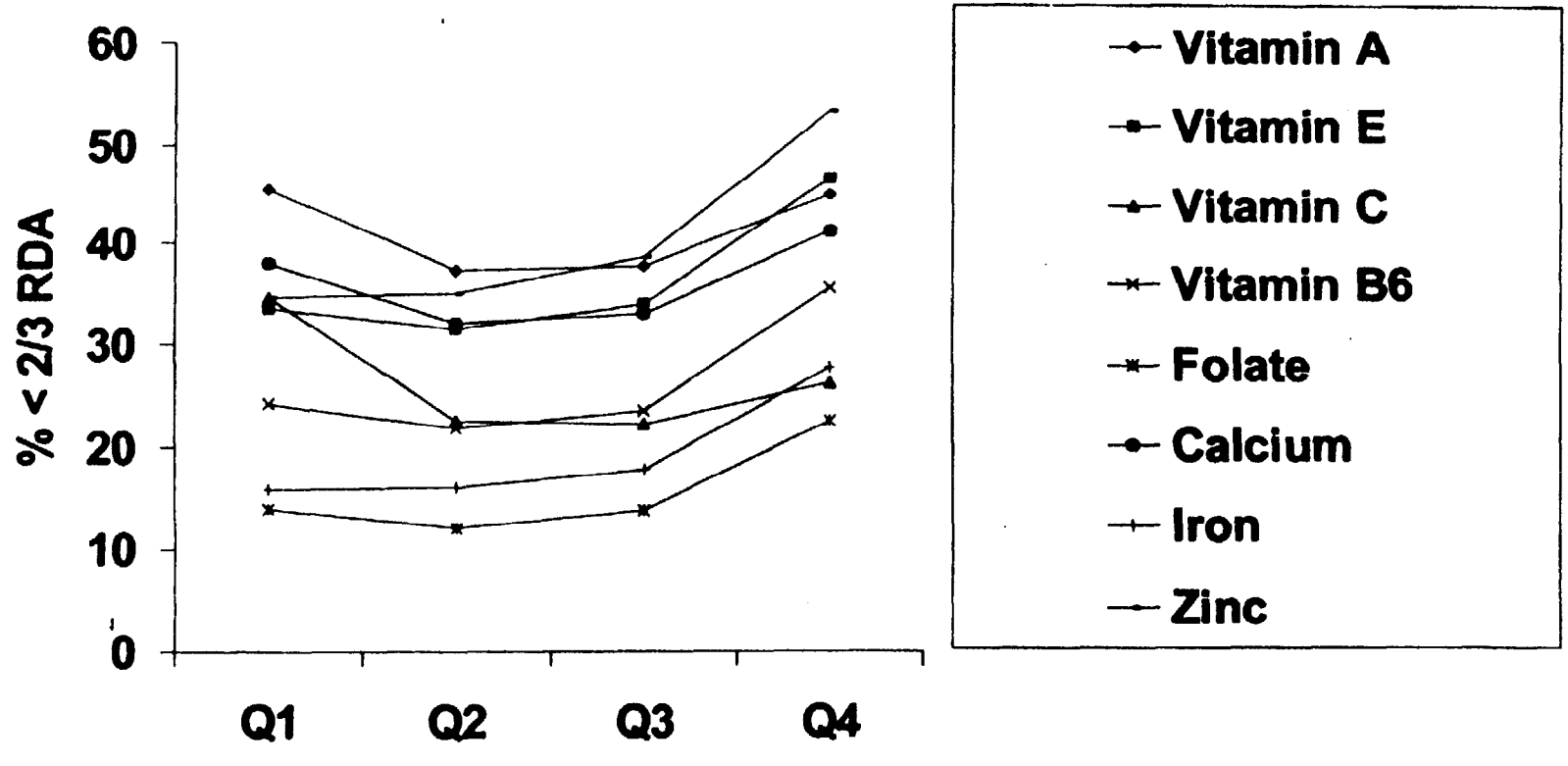
FNDRC MSU

Figure 8. Prevalence of Nutrient Inadequacy* by Total Sugars (g/day) Intake Quartiles



* <2/3 RDA

Figure 9. Prevalence of Nutrient Inadequacy* by Total Sugars (% Kcal) Intake Quartiles



Total Sugars (% Kcal)

* <2/3 RDA

Table 4. Energy and daily nutrient intake by total sugars (% Kcal) intake quartiles.

	Total sugars (% Kcal) quartiles				
	Q1(Low)	Q2	Q3	Q4(High)	P
Energy (Kcal/d)	1570 ± 19[a]	1921 ± 15[b]	2214 ± 25[c]	2912 ± 29[d]	<0.05
Vit A(RE/d)	728 ± 32[a]	939 ± 31[b]	1077 ± 25[c]	1264 ± 33[d]	<0.05
Vit E(TE/d)	6.7 ± 0.2[a]	8.4 ± 0.2[b]	9.5 ± 0.2[c]	12.5 ± 0.5[d]	<0.05
Vit C(mg/d)	64.1 ± 1.8[a]	93.2 ± 2.0[b]	116.1 ± 2.2[c]	147.3 ± 3.5[d]	<0.05
Vit B6 (mg/d)	1.41 ± 0.02[a]	1.72 ± 0.02[b]	1.96 ± 0.03[c]	2.29 ± 0.04[d]	<0.05
Folate (ug/d)	206 ± 4[a]	261 ± 4[b]	298 ± 5[c]	353 ± 7[d]	<0.05
Ca(mg/d)	602 ± 10[a]	804 ± 13[b]	906 ± 12[c]	1131 ± 19[d]	<0.05
Fe (mg/d)	11.6 ± 0.2[a]	14.1 ± 0.2[b]	16.0 ± 0.2[c]	19.4 ± 0.3[d]	<0.05
Zn (mg/d)	9.2 ± 0.2[a]	10.7 ± 0.2[b]	11.9 ± 0.2[c]	14.4 ± 0.3[d]	<0.05
Total fat (g/d)	63.3 ± 1.1[a]	75.2 ± 1.0[b]	84.1 ± 1.3[c]	106.7 ± 1.6[d]	<0.05
Dietary fiber (g/d)	12.2 ± 0.2[a]	15.0 ± 0.2[b]	16.7 ± 0.2[c]	19.6 ± 0.3[d]	<0.05
Sodium (mg/d)	2825 ± 39[a]	3240 ± 40[b]	3604 ± 55[c]	4260 ± 48[d]	<0.05

Table 5. Nutrient Density by Total Sugars (% Kcal) Intake Quartiles

	Total sugars (% Kcal) quartiles			
Nutr Density	**1 (low)**	**2**	**3**	**4 (high)**
Vit A	450 ± 17^{a}	521 ± 14^{bc}	547 ± 11^{b}	503 ± 13^{c}
Vit E	4.4 ± 0.1^{a}	4.4 ± 0.1^{a}	4.4 ± 0.1^{a}	3.9 ± 0.1^{b}
Vit C	38.7 ± 1.1^{a}	50.0 ± 1.1^{b}	57.0 ± 1.1^{c}	67.4 ± 1.9^{d}
Vit B6	0.87 ± 0.01^{a}	0.91 ± 0.01^{b}	0.92 ± 0.01^{b}	0.87 ± 0.01^{a}
Folate	129 ± 2^{a}	140 ± 3^{b}	143 ± 3^{b}	138 ± 2^{a}
Ca	386 ± 6^{a}	425 ± 6^{bc}	431 ± 5^{b}	413 ± 6^{c}
Fe	7.4 ± 0.1^{ab}	7.4 ± 0.1^{b}	7.6 ± 0.1^{b}	7.2 ± 0.1^{a}
Zn	5.7 ± 0.1^{a}	5.6 ± 0.1^{ab}	5.5 ± 0.1^{b}	5.0 ± 0.1^{c}

Figure 10. Calcium Density by Total Sugars (% Kcal) Intake Quartiles