Not Enough Fruit and Vegetables or Too Many Cookies, Candies, Salty Snacks, and Soft Drinks?

Deborah A. Cohen, MD, MPH[a]
Roland Sturm, PhD[a]
Molly Scott, MPP[a]
Thomas A. Farley, MD, MPH[b]
Ricky Bluthenthal, PhD[a,c]

SYNOPSIS

Objectives. There are many contributors to obesity, including excess consumption of "discretionary calories" (foods high in sugar and fat and low in essential nutrients), lack of fruit/vegetable consumption, and insufficient physical activity. This study contrasted physical activity, fruit/vegetable consumption, and discretionary calorie consumption from selected foods relative to the 2005 dietary guidelines.

Methods. We conducted a cross-sectional survey in 228 urban census tracts in Los Angeles County (LAC) and Southern Louisiana (SL) and estimated calories in the past 24 hours from fruit, vegetables, cookies, candy, salty snacks, sweetened soda, and alcohol among 2,767 participants.

Results. The population-weighted mean daily intake of calories from candy, cookies, salty snacks, soda, and alcohol was 438 in LAC and 617 in SL. Alcohol comprised a small portion of the calories consumed. Reported discretionary calorie consumption from a small set of items exceeded guidelines by more than 60% in LAC and 120% in SL. In contrast, the mean consumption of fruit and vegetables fell 10% short in LAC and 20% in SL. There was significant heterogeneity in consumption of cookies, candy, salty snacks, and soda across income, gender, and race.

Conclusions. The overconsumption of discretionary calories was much greater than the underconsumption of fruit and vegetables. This finding suggests that unless the excessive consumption of salty snacks, cookies, candy, and sugar-sweetened beverages is curtailed, other interventions focusing on increasing physical activity and fruit and vegetable consumption will have a limited impact on obesity control. It may be politically more expedient to promote an increase in consumption of healthy items rather than a decrease in consumption of unhealthy items, but it may be far less effective.

[a]RAND Corporation, Santa Monica, CA

[b]Tulane University School of Public Health and Tropical Medicine, New Orleans, LA

[c]California State University, Dominguez Hills, Carson, CA

Address correspondence to: Deborah A. Cohen, MD, MPH, RAND Corporation, 1776 Main St., Santa Monica, CA 90407; tel. 310-393-0411, ext 6023; fax 310-260-8159; e-mail <dcohen@rand.org>.

©2010 Association of Schools of Public Health

In public health campaigns against tobacco, alcohol, and illicit drugs, messages have been direct and explicit: don't smoke, don't drink, and don't take drugs. In contrast, campaigns addressing obesity have encouraged people to consume more fruit, vegetables, and low-fat foods in lieu of recommending abstinence from any specific food. During the past few decades, it appears that Americans have taken this advice, as the U.S. Department of Agriculture (USDA) food disappearance data show increased fruit and vegetable consumption. However, at the same time, consumption of other foods, especially items high in sugar, has increased. The largest increase in macronutrient consumption has been carbohydrates, with a smaller increase in fats, which even declined as a percentage of total calories consumed.[1]

Campaigns to improve nutrition have been launched, such as the 5 A Day campaign (now called Fruit & Veggies—More Matters™),[2] and a variety of diets are being promoted across all media, most (but certainly not all) of which stress eating healthy foods and maintaining balanced diets. These strategies rest on the assumption that if people eat more fruit and vegetables, they will reduce consumption of candy, salty snacks, and sugar-sweetened beverages. Explicit messages against soda and low-nutrient foods are rare.

According to USDA guidelines, most (and sometimes all) of the calories from foods such as cookies, candy, salty snacks, and sodas are "discretionary" and should only be consumed after people have already met the guidelines for essential nutrients through the consumption of fruit, vegetables, grains, meats or legumes, and dairy product equivalents. For the average person requiring a 2,000-calorie diet, it is recommended that discretionary calories not exceed 267 (13% of total calories) to achieve a daily energy balance, which is roughly the amount that could be burned by briskly walking 60 minutes daily. Moreover, it is recommended that people who need to lose weight forgo discretionary calories, as well as other foods, to achieve a negative energy balance.[3]

What are the biggest gaps in achieving dietary guidelines? How does the underconsumption of fruit and vegetables compare with the likely overconsumption of discretionary calories? Do people who eat more fruit and vegetables compensate by eating fewer calories of less healthy items? Does relative consumption of discretionary calories and fruit and vegetables differ by income status or by race/ethnicity? We analyzed those empirical relationships with survey data collected in Los Angeles County (LAC), California, and Southern Louisiana (SL). These cross-sectional data provide a useful snapshot of behavior and might help identify differences among subpopulations that could benefit from different approaches to obesity prevention.

METHODS

We collected the data as part of a study on alcohol marketing in two geographically prescribed areas. The areas selected were densely populated (more than 2,000 residents per square mile) tracts within a one-hour drive from Drew Medical Center in Los Angeles and within two hours from Tulane University in New Orleans, Louisiana. From those areas (1,328 tracts in Los Angeles; 381 tracts in Louisiana), we selected a random sample of 114 census tracts in LAC and 114 census tracts in SL. In the next stage, we conducted telephone interviews with a systematic sample of adults from geographically referenced telephone-listed households. Calling was halted early in New Orleans due to Hurricane Katrina, when 106 tracts had been completed. Participants were offered $15 to complete a 15- to 20-minute interview. Procedures were approved by the RAND Institutional Review Board.

In SL, the mean response rate per census tract was 37.9%, the refusal rate was 37.0%, and the cooperation rate was 79.8%; in LAC, the mean response rate per census tract was 34.4%, the refusal rate was 39.0%, and the cooperation rate was 76.2%. For comparison, the response rate for California in the latest wave of the Behavioral Risk Factor Surveillance System (BRFSS) was 36.9%.[4] In our survey, there were 2,885 respondents, which reduced to 2,767 (1,480 in LAC, 1,287 in SL) when we included only respondents with complete data on all variables used in this analysis. Because response rates differ across subpopulations (i.e., they are typically higher for older women and lower for younger males, especially in minority groups), we developed weights to make estimates representative of the populations in the areas (i.e., the weighted results give percentages of racial/ethnic, income, age, and gender groups that correspond to the percentages in the U.S. Census for the sampled tracts).

The questionnaire did not include an assessment of the total diet but did ask about consumption of selected food items of particular importance to obesity. The main variables studied included the consumption of fruit and vegetables, candy, cookies, salty snacks, soda, and alcohol as well as the associated estimated calories based on how many servings respondents had consumed in the previous 24 hours. On the questionnaire, we defined a serving of vegetables as ½ cup and a serving of fruit as comparable to a whole fruit (e.g., an apple or an orange). We described a serving of salty snacks as a "handful," a serving of cookies as

about three average-sized cookies, a serving of candy as equivalent to a medium-sized Snickers® bar, and a serving of soda as a 12-ounce can. Respondents were asked in a separate question whether they usually drank regular or diet soda. We estimated energy intake assuming that a serving of vegetables was about 22 calories (based on ½ cup of broccoli), 72 calories for each fruit (based on a medium apple), 140 calories per serving of salty snacks, 140 calories for each serving of cookies, 200 calories for a serving of candy, 150 calories for a 12-ounce can of regular soda, and zero calories for diet soda. We estimated calories associated with alcohol use in the last 24 hours from responses to average frequency, the amount consumed on a typical drinking occasion, and the respondent's report of the name of the drink most frequently consumed in the last 90 days. We used 150 calories per drink for beer, 100 calories per 5 ounces for wine, and 200 calories for a mixed drink.

Studies show that most people underestimate the quantity and frequency of food eaten,[5] making our estimates conservative. However, in case people overestimated consumption, we conducted a modified sensitivity analysis at the lower range, considering 100 calories per serving for salty snacks and cookies, 150 calories for candy, and 64 calories for mixed drinks/spirits (measuring only the calories of the alcohol content, which is a small part of typical mixed drinks, such as margaritas).

People reported the frequency of moderate-to-vigorous physical activity (MVPA) as well as the minutes per session (excluding work-related activities). By multiplying the number of days per week and the number of minutes per day, we estimated the weekly minutes of MVPA needed to calculate recommended discretionary calories using the dietary guidelines formula. If people were to overreport physical activity, we also would overestimate how many discretionary calories they were allowed, and the true gap between recommendation and reported consumption would increase. We show in the descriptive statistics the percentage of people with at least 150 minutes of physical activity. The items used were from the Centers for Disease Control and Prevention's (CDC's) BRFSS and have been validated.[6] Additional variables from the survey included gender, age, income, participation in the food stamp program, race/ethnicity, and height and weight, which were used to calculate body mass index.

We calculated each respondent's daily energy requirement, recommended discretionary calories, and whether he/she exceeded the recommendation for energy consumption using the formula published in the Science Base section of the report of the Dietary Guidelines Advisory Committee and the recommendation for discretionary calories using the table in the Dietary Guidelines for discretionary calories.[7] These calculations take age, gender, and physical activity levels into account.

The main analytic approach we used included descriptive statistics stratified by site, gender, race/ethnicity, and income levels. From a statistical perspective, measurement error in individual responses does not create biases in descriptive statistics that average responses. However, some questions cannot be investigated with descriptive statistics. We also used multivariate regression, although such models are more sensitive to measurement error in individual items. We regressed caloric intake from salty snacks, cookies, candy, and sugar-sweetened beverages on sociodemographics, dieting, fruit/vegetable consumption, site, and physical activity. The beta coefficient can be interpreted as the change in the number of calories per unit change of the explanatory variable, holding all other explanatory variables constant.

RESULTS

As shown in Table 1, the samples from the two sites differed in a number of demographic characteristics. There were more Hispanic people in LAC, while SL had a larger African American population and a slightly older demographic. The reported mean daily intake of calories from cookies, candy, salty snacks, soda, and alcohol, weighted to be representative of the underlying population, was 438 in LAC and 617 in SL, with a 150- to 200-calorie difference between men and women. Excluding alcohol reduced the amount by 90 calories for men (more in SL, less in LAC), but only by 25 calories for women. This level of calorie consumption was 1.61 times the recommended intake of discretionary calories from the Dietary Guidelines in LAC (taking into account gender, age, and physical activity) and 2.20 times the recommended intake in SL.

In LAC, the mean number of fruit/vegetable servings per day was 4.5, or 10% lower than the 5 A Day target; it was 20% lower than the target in SL. While the majority of people did not achieve the 5 A Day target, most missed by a relatively small amount (i.e., median consumption was four servings, or 20% below target). While the majority of people exceeded discretionary calories, most exceeded the recommendation by a larger margin (i.e., the median was 40% higher than the target).

Figure 1 shows the breakdown of calories consumed from candy, cookies, salty snacks, soda, and alcohol stratified by the key sociodemographic variables. People

Table 1. Characteristics of participants in a study of men and women in Los Angeles County and Southern Louisiana, 2004–2005

	Los Angeles County		*Southern Louisiana*	
Characteristics	*Men (n=587)*	*Women (n=893)*	*Men (n=427)*	*Women (n=860)*
Sociodemographic				
Mean age in years (SD)[a]	37.7 (12.5)	37.5 (11.8)	38.3 (13.0)	39.9 (12.5)
African American (percent)	7.8	10.0	38.9	40.9
Hispanic (percent)	31.3	39.5	5.6	4.9
Non-Hispanic white only (percent)	22.9	19.0	50.6	50.1
Family income <$20,000 (percent)	26.7	35.8	33.4	34.6
Family income >$75,000 (percent)	27.2	19.2	22.7	18.9
Receiving food stamps (percent)	4.1	9.9	9.2	16.9
Some college education (percent)	65.0	60.8	61.6	63.8
Related health outcomes				
Mean body mass index[b] (SD)	27.0 (5.0)	25.8 (5.6)	27.5 (5.2)	26.8 (6.3)
Obese (percent)	22.2	19.9	25.9	25.5
Physical activity and fruit/vegetable consumption				
Mean servings of fruit *N* (SD)	2.4 (2.1)	2.5 (1.8)	2.0 (2.0)	2.0 (1.6)
Mean servings of vegetables *N* (SD)	2.1 (1.6)	2.1 (1.7)	1.8 (1.4)	2.1 (1.6)
≥5 servings of fruit/vegetables (percent)	41.7	45.4	35.9	39.2
Mean calories from vegetables (*N*)	46	48	41	48
Mean calories from fruit (*N*)	169	175	139	144
≥150 minutes of weekly physical activity (percent)	44.6	41.7	44.8	39.5
Discretionary calorie consumption				
Mean calories from salty snacks *N* (SD)	124 (239)	103 (206)	195 (315)	148 (224)
Mean calories from cookies *N* (SD)	81 (171)	73 (131)	98 (225)	80 (161)
Mean calories from candy *N* (SD)	104 (184)	95 (164)	120 (208)	139 (273)
Mean calories from soda *N* (SD)	129 (224)	74 (152)	199 (328)	121 (225)
Mean calories from alcohol *N* (SD)	69 (162)	24 (78)	114 (194)	29 (67)
Main dependent variables				
Mean calories from snacks, soda, and alcohol *N* (SD)	507 (506)	368 (384)	725 (682)	518 (508)
Ratio to recommended discretionary calories *N* (SD)	1.57 (1.61)	1.63 (1.85)	2.17 (2.14)	2.40 (2.48)
Mean calories from snacks and soda only *N* (SD)	438 (469)	344 (375)	611 (656)	489 (505)
Exceeding recommended discretionary calories (including alcohol) (percent)	53.8	56.4	67.1	70.1

[a]Adults aged 18–65 years only

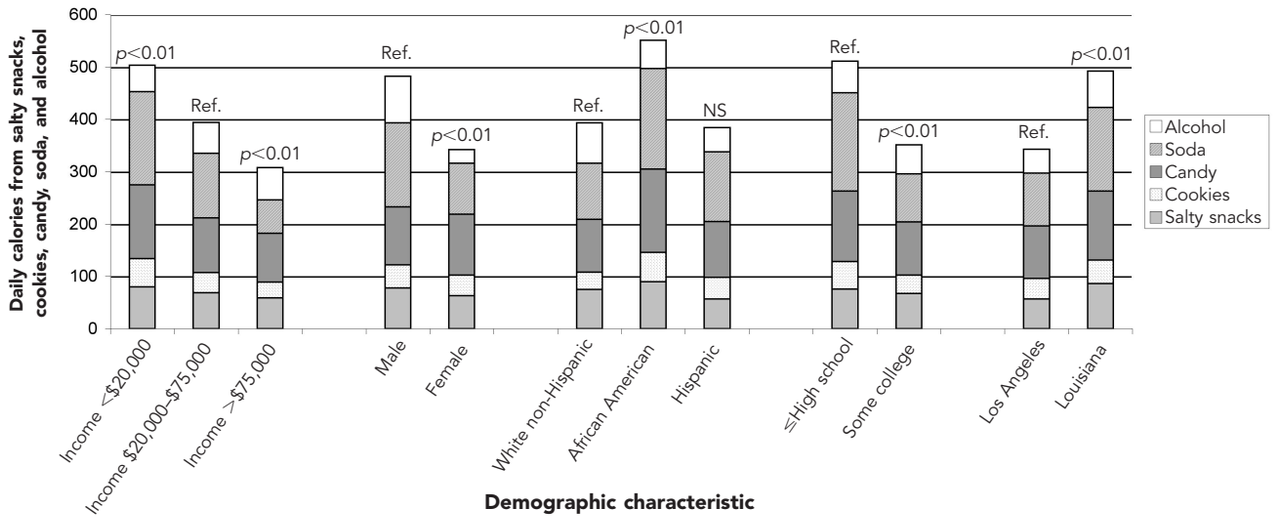
[b]Body mass index (BMI) is measured in kilograms/meter^2 (kg/m^2), where a BMI of 25.0–29.9 kg/m^2 is considered overweight and a BMI≥30.0 kg/m^2 is considered obese.

SD = standard deviation

with lower income and education, men, and residents in SL consumed substantially more calories from these sources ($p>0.01$). Alcohol comprised a small portion of the calories consumed (14% for men and 6% for women, $p<0.01$). African Americans had the highest intake of calories from these sources overall (692 vs. 496 for white and 483 for Hispanic people, $p<0.01$) and in every category except alcohol. The total number of calories consumed from these sources for Hispanic people (483) was similar to non-Hispanic white people (496), but with fewer calories from alcohol and salty snacks and more calories from sodas. The sample sizes for other ethnic groups were too small to make detailed comparisons and are not shown, although people of Asian descent had the lowest consumption levels overall (i.e., 302 discretionary calories, including alcohol).

Figure 2 shows consumption of fruit and vegetables by race/ethnicity and sociodemographic characteristics. In contrast with calories from candy, cookies, salty snacks, and soda, there were no significant differences in fruit and vegetable consumption by income group, men vs. women, or between non-Hispanic white and African American populations. Hispanic people had a higher consumption than non-Hispanic white people ($p=0.03$). We also found significant differences by educational status ($p<0.01$) and location ($p<0.01$).

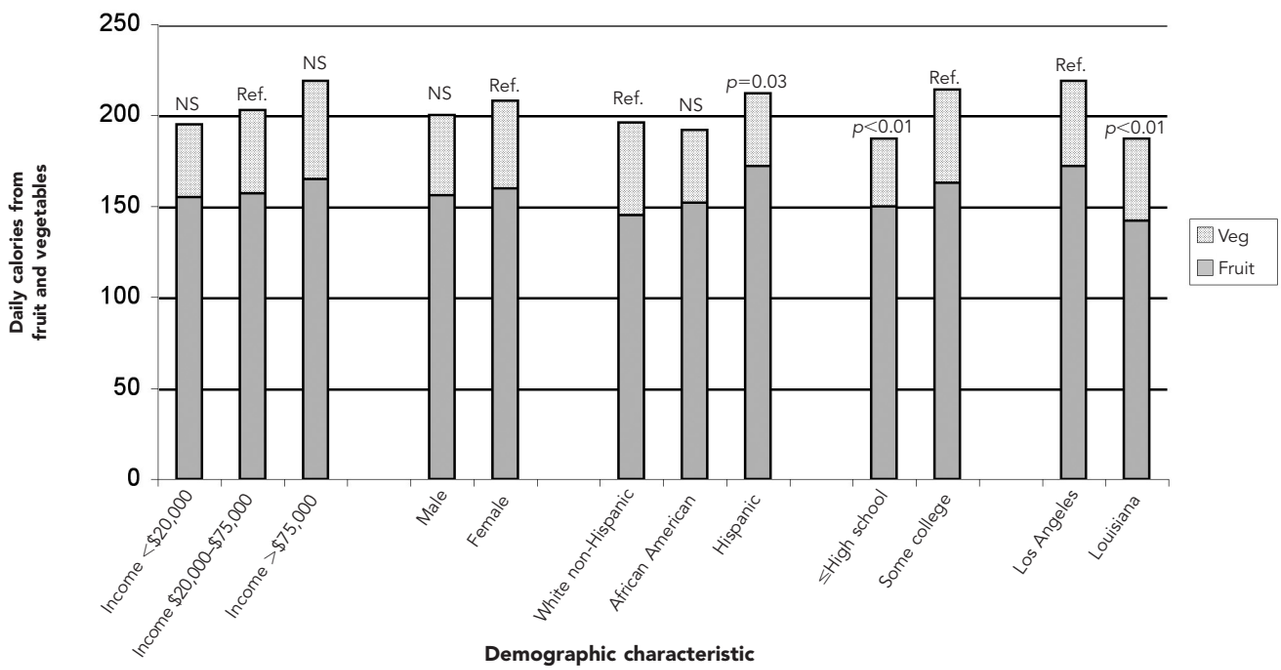
Figure 1. Estimated number of calories consumed in the past 24 hours from salty snacks, cookies, candy, soda, and alcohol, by sociodemographic group, in a study of men and women in Southern Louisiana and Los Angeles County, 2004–2005



Ref. = reference group
NS = not significant

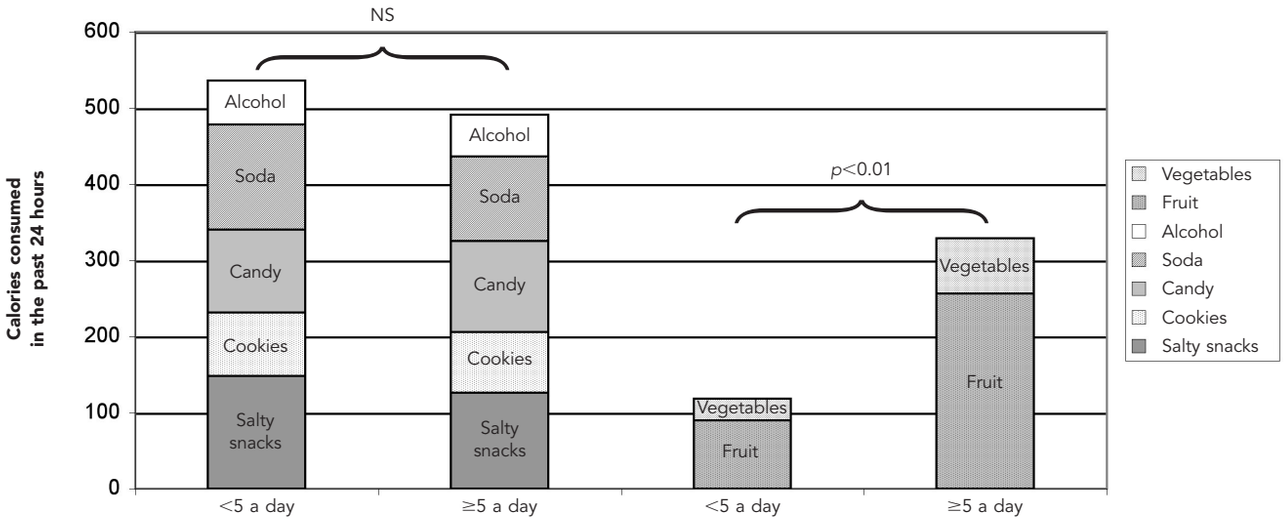
Figure 3 stratifies consumption of calories from cookies, candy, salty snacks, soda, and alcohol by whether or not people consume fewer than five fruit and vegetables a day. The mean estimated calories

Figure 2. Estimated number of daily calories consumed from fruit and vegetables, by sociodemographic group, in a study of men and women in Southern Louisiana and Los Angeles County, 2004–2005



Ref. = reference group
NS = not significant
Veg = vegetables

Figure 3. Estimated calories from salty snacks, cookies, soda, alcohol, fruit, and vegetables comparing those who consume ≥5 and <5 servings of fruit and vegetables daily, in a study of men and women in Southern Louisiana and Los Angeles County, 2004–2005



NS = not significant

from fruit and vegetables for those two groups were significantly different: 118 for those consuming fewer than five a day vs. 329 for those consuming at least five a day ($p<0.01$). However, there was no statistically significant difference between these two groups in terms of calories consumed from cookies, candy, salty snacks, soda, and alcohol. Thus, the increased calories from eating more fruit and vegetables was not offset by a similar reduction in calories from candy, cookies, salty snacks, and soda, let alone a larger reduction that would reduce weight in a healthful manner.

Because differences in sociodemographic composition could confound results, we tested associations using multivariate regression (Table 2). The first column corresponds to the results for calories from cookies, candy, salty snacks, and soda, including alcoholic beverages; the second column excludes alcoholic beverages. Our main interest was determining whether there was any trade-off between calories that are mostly discretionary and fruit/vegetable consumption at the population level. For example, in the first row, first column of Table 2, −17 means that an extra serving of fruit was associated with a reduction of 17 calories from snacks, soda, and alcohol. The standard error (SE) (in this case, SE=6) means that this figure is statistically significant at $p<0.01$. The second column shows the same effect, but omits alcohol. In this case, an additional serving of fruit was associated with a statistically significant reduction of 16 calories from candy, cookies, salty snacks, and soda (95% confidence interval 5, 28), but this small reduction was much less than a serving of fruit would add (e.g., a medium apple is 72 calories). There was no evidence of any calorie offset from more vegetable consumption in these sources of discretionary calories.

As shown in Table 2, people in SL consumed a mean of 114 more calories from candy, cookies, salty snacks, alcohol, and soda than people in LAC ($p<0.001$). If alcohol is excluded, the difference drops to 99 calories. Women consumed significantly fewer of these calories than men; however, after taking into account their lower energy needs, they consumed 26% more calories than recommended for discretionary calories (without alcohol). African American people consumed a mean of 112 more calories from candy, cookies, salty snacks, and soda than their non-Hispanic white counterparts. College education and high income were powerful predictors of lower total and relative intake of calories from these sources. Age was a highly significant predictor of reduced total intake of candy, cookies, salty snacks, and soda, but because of different energy needs, the ratio of actual to recommended intake was no different for older than for younger respondents. Food stamp participation had no statistically significant effect on intake.

We also examined whether there was an interaction between the number of servings of fruit/vegetables and race/ethnicity and income to determine whether potential offsets depended on resources or ethnic

group. Not one of the interactions of race/ethnicity with fruit or vegetables was significant, suggesting that at least there were no large differences between these groups in how the consumption of fruit/vegetables related to consumption of calories from candy, cookies, salty snacks, and soda (data not shown).

The relative consumption of candy, cookies, salty snacks, and soda was generally not affected in the sensitivity analysis using lower levels of calories per serving, although with lower levels, the difference in consumption between African American and other populations was no longer statistically significant at $p<0.05$. With lower estimates of calories per serving, the mean consumption was 30% higher than guidelines in LAC and 84% higher than guidelines in SL, down from 61% and 129%, respectively, in the baseline analysis reported in Table 1. Arguably, the more likely situation was that people underreported consumption and possibly overstated physical activity. We did not conduct a sensitivity analysis for this scenario, but it would only strengthen our findings about the disconcerting gap between consumption and recommended discretionary calories.

Table 2. Predictors of total and excess discretionary calorie consumption from snacks, soda, and alcohol, in a study of men and women in Los Angeles County and Southern Louisiana, 2004–2005[a]

	Calories from snacks, soda, and alcohol	*Calories from snacks and soda only*
Sociodemographic predictors	*Beta (SE)*	*Beta (SE)*
Servings of fruit	−17 (6)[b]	−16 (6)[b]
Servings of vegetables	3 (9)	0 (8)
Louisiana	114 (28)[c]	99 (26)[c]
Female	−182 (25)[c]	−119 (24)[c]
African American	90 (37)[d]	112 (36)[b]
Hispanic	−72 (40)	−45 (38)
Other race	−54 (36)	−19 (34)
Family income <$20,000	65 (36)	72 (35)[d]
Family income <$75,000	−72 (26)[b]	−70 (24)[b]
Food stamp recipient	42 (50)	54 (49)
Some college education	−126 (34)[c]	−112 (32)[c]
Age 35–44 years	−43 (32)	−46 (30)
Age 45–54 years	−119 (30)[c]	−101 (29)[c]
Age 55–64 years	−167 (30)[c]	−150 (29)[c]

[a]Reference categories are Los Angeles County, male, non-Hispanic white, family income $20,000–$75,000, not receiving food stamps, ≤high school education, and age 18–34 years.

[b]Statistically significant at $p<0.01$

[c]Statistically significant at $p<0.001$

[d]Statistically significant at $p<0.05$

SE = standard error

DISCUSSION

We assessed a limited number of sources of discretionary calories, but daily calories from candy, cookies, salty snacks, soda, and alcohol alone already substantially exceeded the amount of discretionary calories recommended according to the U.S. Dietary Guidelines. Discretionary calorie consumption differed across subpopulations, with higher consumption levels among African American people, less educated populations, lower income groups, and people in SL—differences that parallel the sociodemographic pattern of obesity in the U.S.[8,9] The high number of discretionary calories consumed suggests that these items are important contributors to the obesity epidemic.

While fruit and vegetable consumption was significantly lower than desirable levels, the most striking discrepancy to the U.S. Dietary Guidelines was in discretionary calories. In this cross-sectional study, we found no evidence for increased fruit and vegetable consumption being offset by decreased consumption of soda, candy, cookies, and salty snacks. Of course, the absence of an association in a cross-sectional study does not mean that this would hold true in an intervention, but at a minimum, it casts doubt on the commonly held assumption that increasing fruit and vegetable consumption holds the key to preventing obesity.

While we cannot comment on total energy balance with our data, other studies have examined the contribution of discretionary calories to total caloric intake. In the National Health and Nutrition Examination Survey III (NHANES III), discretionary calories comprised more than 30% of daily calories consumed for children and young people aged 8–18 years and 27% of daily calories consumed for adults, not including alcoholic beverages—about the same magnitude as our findings.[10] Analysis of NHANES data showed that nationally, most discretionary calories come from sweetened beverages, grain-based desserts, non-skim dairy products, and fatty meats.[11] Analysis of the USDA Nationwide Food Consumption Survey for young adults indicated increases between the late 1970s and the mid-1990s in the number of snacking occasions (1.7 vs. 1.9 times per day, respectively), calories eaten per snacking occasion (247 vs. 313 calories, respectively), and calorie density of snacks (1.05 calories/gram vs. 1.32 calories/gram, respectively).[12]

Limitations

Our study had several limitations, including our focus on a small set of sources for discretionary calories. We did not measure the complete diet or all discretionary calories, such as those from cakes or doughnuts; frozen treats such as ice cream and ices; or fatty meats, pizza,

French fries, or sweetened beverages other than soda (e.g., fruit punch, sports drinks, or agua fresca). We did not ask specifically about culturally specific items such as *pan dulce* or *churros*, which may be important sources for Hispanic people. However, cookies, candy, salty snacks, and soda are easy to recognize and could be forgone, as they are typically not integrated into a meal, are eaten more for entertainment purposes, and are the most important sources of discretionary calories nationally.[13] We also assumed that calories from fruit and vegetables did not include added ingredients such as sugar or butter, which also would be considered discretionary calories.

We gave descriptions of what a serving means for different items, but it remains a crude assessment. To integrate across items, we would need to use standard calorie values. This introduces error, but only reduces statistical power in dependent variables. We conducted a number of sensitivity analyses for potential biases (by changing assumptions about mean number of calories) and model misspecifications (e.g., interactions), but this did not change our qualitative results that the majority of people already far exceed recommended discretionary calories from a small set of foods.

CONCLUSIONS

While fruit and vegetable consumption and physical activity are important for health and are currently not optimal, wider gaps appear when comparing salty snacks, cookies, candy, alcohol, and sugar-sweetened beverages with discretionary calories recommended in the U.S. Dietary Guidelines. The data suggest that unless the excessive consumption of salty snacks, cookies, candy, alcohol, and sugar-sweetened beverages is curtailed, other interventions are likely to have a limited impact on obesity control.

This study was supported in part by the National Institute of Alcohol Abuse and Alcoholism #R01AA013749 and the Eunice Kennedy Shriver National Institute of Child Health and Human Development #R01HD057193.

REFERENCES

1. Department of Agriculture, Economic Research Service (US). Food availability (per capita) data system [cited 2008 Nov 4]. Available from: URL: http://www.ers.usda.gov/Data/FoodConsumption
2. Havas S, Heimendinger J, Damron D, Nicklas TA, Cowan A, Beresford SA, et al. 5 A Day for better health—nine community research projects to increase fruit and vegetable consumption. Public Health Rep 1995;110:68-79.
3. Department of Agriculture (US). Nutrition and your health: dietary guidelines for Americans: part D: science base: section 3: discretionary calories. 2005 [cited 2008 Oct 6]. Available from: URL: http://www.health.gov/DIETARYGUIDELINES/dga2005/report/HTML/D3_DiscCalories.htm
4. Centers for Disease Control and Prevention (US). 2006 Behavioral Risk Factor Surveillance System: summary data quality report [cited 2008 Oct 15]. Available from: URL: http://ftp.cdc.gov/pub/Data/Brfss/2006SummaryDataQualityReport.pdf
5. Subar AF, Kipnis V, Troiano RP, Midthune D, Schoeller DA, Bingham S, et al. Using intake biomarkers to evaluate the extent of dietary misreporting in a large sample of adults: the OPEN study. Am J Epidemiol 2003;158:1-13.
6. Yore MM, Ham SA, Ainsworth BE, Kruger J, Reis JP, Kohl HW III, et al. Reliability and validity of the instrument used in BRFSS to assess physical activity. Med Sci Sports Exerc 2007;39:1267-74.
7. Department of Health and Human Services, Department of Agriculture (US). Dietary guidelines for Americans, 2005. Washington: HHS; 2005.
8. Ogden CL, Carroll MD, Curtin LR, McDowell MA, Tabak CJ, Flegal KM. Prevalence of overweight and obesity in the United States, 1999–2004. JAMA 2006;295:1549-55.
9. Flegal KM, Carroll MD, Ogden CL, Johnson CL. Prevalence and trends in obesity among U.S. adults, 1999–2000. JAMA 2002; 288:1723-7.
10. Briefel RR, Johnson CL. Secular trends in dietary intake in the United States. Annu Rev Nutr 2004;24:401-31.
11. Bachman JL, Reedy J, Subar AF, Krebs-Smith SM. Sources of food group intakes among the U.S. population, 2001–2002. J Am Diet Assoc 2008;108:804-14.
12. Zizza C, Siega-Riz AM, Popkin BM. Significant increase in young adults' snacking between 1977–1978 and 1994–1996 represents a cause for concern! Prev Med 2001;32:303-10.
13. Nielsen SJ, Siega-Riz AM, Popkin BM. Trends in energy intake in U.S. between 1977 and 1996: similar shifts seen across age groups. Obes Res 2002;10:370-8.