Original Research

The Effect of Breakfast Type on Total Daily Energy Intake and Body Mass Index: Results from the Third National Health and Nutrition Examination Survey (NHANES III)

Sungsoo Cho, PhD, Marion Dietrich, PhD, Coralie J.P. Brown, MPH, Celeste A. Clark, MS, and Gladys Block, PhD

Kellogg-USA, Battle Creek, Michigan (S.C., C.A.C.) and the School of Public Health, University of California, Berkeley, California (M.D., C.J.P.B., G.B.)

Key words: breakfast type, body mass index, energy intake, feeding patterns

Objective: The objective of this study was to investigate the relationship between breakfast type, energy intake and body mass index (BMI). We hypothesized not only that breakfast consumption itself is associated with BMI, but that the type of food eaten at breakfast also affects BMI.

Methods: Data from the Third National Health and Nutrition Examination Survey (NHANES III), a large, population-based study conducted in the United States from 1988 to 1994, were analyzed for breakfast type, total daily energy intake, and BMI. The analyzed breakfast categories were "Skippers," "Meat/eggs," "Ready-to-eat cereal (RTEC)," "Cooked cereal," "Breads," "Quick Breads," "Fruits/vegetables," "Dairy," "Fats/sweets," and "Beverages." Analysis of covariance was used to estimate adjusted mean body mass index (BMI) and energy intake (kcal) as dependent variables. Covariates included age, gender, race, smoking, alcohol intake, physical activity and poverty index ratio.

Results: Subjects who ate RTEC, Cooked cereal, or Quick Breads for breakfast had significantly lower BMI compared to Skippers and Meat and Egg eaters ($p \leq 0.01$). Breakfast skippers and fruit/vegetable eaters had the lowest daily energy intake. The Meat and Eggs eaters had the highest daily energy intake and one of the highest BMIs.

Conclusions: This analysis provides evidence that skipping breakfast is not an effective way to manage weight. Eating cereal (ready-to-eat or cooked cereal) or quick breads for breakfast is associated with significantly lower body mass index compared to skipping breakfast or eating meats and/or eggs for breakfast.

INTRODUCTION

Obesity has emerged as a rapidly increasing public health problem in the United States. In Healthy People 2000 and Healthy People 2010, the United States established national goals to reduce the prevalence of overweight and obesity [1,2]. Obesity is a risk factor for several chronic diseases such as cardiovascular diseases and certain types of cancers [3–6]. Obese subjects are at high risk for developing hypertension and diabetes mellitus type 2 [7–9]. Between 1960 and 1994, the age-adjusted prevalence of obesity (defined as body mass index (BMI) $\geq 30 kg/m^2$) [6] increased almost twofold among U.S. adults 20 to 74 years of age, from 12.8 percent to 22.5 percent [3].

During the same time period, more Americans began skipping breakfast despite cultural beliefs regarding the importance of breakfast eating and scientific knowledge about the meal's contribution to sufficient micronutrient intakes and a healthful macronutrient profile [10,11]. Between 1965 and 1991, the proportion of adults skipping breakfast increased from 14 to 25 percent [12]. Reasons individuals give for skipping breakfast commonly include lack of time for the preparation and consumption of food and concerns about excess body weight [10,11,13].

An inverse relationship has been found between BMI and breakfast consumption [14,15]. Breakfast eaters tend to have lower body mass index than breakfast skippers [16], and obese

individuals are more likely to skip breakfast or consume less energy at breakfast [15,17–20]. Studies have shown that the energy intake of normal and underweight persons is more evenly distributed throughout the day than that of the obese [18]. Night Eating Syndrome, characterized in part by habitual breakfast skipping, increases in prevalence with increasing severity of obesity and was associated with less weight loss in an outpatient program [21]. Moderately obese women lose more weight when they consume 70% of their daily energy intake before noon instead of in the afternoon and evening [22]. Additionally, lean individuals lose weight when consuming a 2000-calorie meal at breakfast but tend to gain weight if the meal is eaten at dinner [23].

Several hypotheses have been proposed to explain why breakfast skipping is associated with a decreased ability to lose weight. Breakfast skipping can lead to overeating later in the day—for example, having one big meal in the evening [24,25]. In contrast, eating breakfast is associated with increased eating frequency. Increased eating frequency may in turn promote less efficient energy utilization by increasing dietary induced thermogenesis, leading to lower BMI [26].

In the study presented here, we hypothesized that not only is breakfast consumption itself associated with BMI, but also that the type of food eaten at breakfast affects BMI. Therefore, we investigated the relationship between breakfast type, body mass index and energy intake using data from the Third National Health and Nutrition Examination Survey (NHANES III), a large, population-based study conducted in the United States from 1988 to 1994. Because of the large body of evidence showing that both BMI and breakfast habits are highly associated with age, gender, race, socioeconomic status (SES), smoking and other lifestyle factors [11,12,14,27–30], we investigated the effects of breakfast type independently of these factors.

MATERIALS AND METHODS

Survey Design

Subjects were participants in NHANES III. The NHANES is conducted periodically by the National Center for Health Statistics, Centers for Disease Control and Prevention, to assess the health, dietary practices and nutritional status of non-institutionalized civilians in the United States aged two months or older. NHANES III was conducted in two three-year phases (1988–1991 and 1991–1994) to obtain two separate national probability samples. Forty thousand subjects were chosen randomly based on a stratified multistage probability design involving counties, blocks and households. Since precise estimates of health characteristics were needed for young children, older people, African Americans and Mexican Americans, these groups were over-sampled. Further details of the survey design and sampling methods have been described earlier [31,32].

Physical examinations, which included measurements of standing height and weight used to calculate body mass index, were conducted year-round in mobile examination centers. Food intake information was obtained via a 24-hour dietary recall. Interviews were conducted in English (86%), Spanish or English-Spanish (13%) or another language (1%). Details of the procedure utilized for interviews have been published previously [33,34].

Study Sample

Subjects who had unreliable dietary recall records, as identified by NHANES III, were excluded from our analysis. Pregnant women were excluded on the basis that a BMI over 25 kg/m^2 for a pregnant woman might not indicate overweight or obesity. Individuals younger than 18 years of age were also excluded because BMIs of adolescents are not comparable to BMIs of adults due to rapid changes in height during adolescence. Additionally, subjects whose self-reported ethnicity was not white, African American or Hispanic were excluded, because the number of persons of other races in NHANES III was too small to permit valid inferences about this subgroup. After these exclusions, the remaining sample size was 16,452 individuals.

Design of Breakfast Categories

Breakfast, in NHANES III, was defined as any food or beverage consumed in a meal occasion named by the respondent as breakfast (English) or desayuno (Spanish). Subjects that took no food or beverage at breakfast, excluding water, were categorized as breakfast skippers.

Foods consumed at breakfast were initially categorized based on the USDA food-coding scheme in order to categorize all possible foods consumed. Some further modifications were then applied to define commonly-understood breakfast types. We divided the grain products into several groups of foods: Ready-to-eat cereal, Cooked cereal, and two breads groups. We subdivided the breads into "Breads" and "Quick breads" in order to differentiate between a breakfast consisting mainly of toast from one consisting mainly of pastries, for example, which might have different implications for BMI. The ten resulting breakfast categories were "Skippers," "Dairy," "Meat and Eggs," "Fruits and Vegetables," "Ready-to-eat cereal," "Cooked cereal," "Breads," "Quick Breads," "Fats and Sweets" and "Beverages."

An individual was assigned to a breakfast category if either 1) all food and beverages consumed at breakfast were from that breakfast category or 2) food and beverages from that category contributed more calories to the meal than those of any other breakfast category. For example, a person who had a breakfast of orange juice (providing 200 kcal) and toast (100 kcal) would be assigned to the "Fruits and Vegetables" category. Additives to a food in a breakfast category were included in the calculation of calories from that category. For example, milk used on

cereal was counted as part of the cereal; cream or sugar added to coffee was counted as part of the coffee. As a result, persons assigned to the "Dairy" category usually had obtained most of their breakfast calories from milk alone (or cheese). A person who had coffee (3 kcal) with cream (100 kcal) (and nothing else) would be assigned to the "Beverages" group, not the "Dairy" group. Thus, this analysis reflects the effect of *breakfast type,* not necessarily of *food group.*

Statistical Analysis

Analysis of covariance was used to estimate adjusted mean body mass index (BMI) and energy intake (kcal) as dependent variables. Body mass index is calculated as weight in kilograms divided by height in meters squared (kg/m^2). Dietary data from the NHANES III 24-hour recall were used to estimate average daily intake of energy for each breakfast group. The energy variable represents kilocalorie intake for the entire day, not just from the breakfast meal, in order to investigate the impact of breakfast type on daily calorie intake.

Means were adjusted for gender, race, age, poverty level, smoking habits, alcohol intake and physical activity. These variables were chosen as covariates because they could confound the relationship between breakfast type and BMI or energy intake. Age and gender are well-established major determinants of BMI and energy intake [11,14]. The other covariates are included as control for the possibility that the type of breakfast subjects consumed could simply be an indicator for a healthy lifestyle pattern or for cultural or economic patterns, rather than having a more direct relationship with BMI and energy intake.

The physical activity variable was specified as the sum of intensity rating multiplied by times per month for each of the activities listed in the NHANES III dataset. The alcohol variable was specified as the number of times beer, wine and hard liquor (combined) were consumed per month. Smoking was a yes/no variable referring to current smoking habits. To estimate poverty, the Poverty Income Ratio (PIR) was used, with values of 0.0 to 11.889. If the PIR was less than 1.3 (less than 1.3 times the poverty level), then subjects were grouped as below the poverty level, otherwise they were grouped as above the poverty level. The level of 1.3 corresponds to government guidelines for the eligibility cut-off for economic assistance. The statistical model for BMI was additionally adjusted for age squared to improve the fit of the model and improve control of confounding by age. The covariate age squared was not significant in the energy model, thus was not included as a covariate in that model.

The adjusted mean BMI and daily energy intake of the different breakfast groups were compared with each other using analysis of covariance. Because of the large sample size, differences were considered statistically significant only if $p \leq 0.01$. All analyses included an adjustment for over-sampling and non-response and were carried out using SUDAAN for IBM PC

[35], a data analysis package for multi-stage sample designs. This method accounts for different sample weights and the effects of the complex sample design on variance estimation.

RESULTS

After weighting to adjust for over-sampling and non-response, the study cohort consisted of slightly more females than males, 53% *versus* 47%, with a mean age of 43.9 years (Table 1). The weighted proportion of non-Hispanic whites, non-Hispanic blacks and Hispanics was 79%, 11% and 10%, respectively. Table 2 describes the foods included in each breakfast category, and Table 3 shows the numbers of subjects in each of the ten breakfast categories. Of the 16,452 NHANES III participants included in this analysis, 3,652 (20.05%, weighted) skipped breakfast, 2,371 (17.14%) consumed Ready-to-eat cereal at breakfast, 2,585 (15.93%) subjects were in the

Table 1. Subjects Characteristics, Third National Health and Nutrition Examination Survey[1]

	Number in sample	Weighted percent of sample, or mean ± standard error means (SEM)[2]
Gender		
Male	7,687	47.29
Female	8,765	52.71
Race		
Non-Hispanic white	6,744	78.8
Non-Hispanic black	4,722	11.47
Hispanic	4,986	9.73
Age (years)		
18–29	4,045	24.78
30–39	3,188	23.11
40–49	2,465	18.16
50–59	1,765	11.95
60–69	2,188	11.05
70–79	1,665	7.69
>80	1,136	3.26
BMI (kg/m^2)[3]		
<18.5	379	2.60
18.5–24.9	6,249	42.63
25–29.9	5,637	32.48
>30	4,150	22.28
Energy intake (kcal)		2,199.0 ± 18.9
Poverty Index Ratio (PIR)[3]		
<1.3	4,991	18.66
≥1.3	9,899	81.34
Smoking		
Yes	4,227	28.52
No	12,225	71.48
Alcohol (drinks/month)		8.7 ± 0.34
Physical activity (intensity × times/month)		111.22 ± 3.27

[1] N = 16,452.

[2] Weighted to adjust for over-sampling and non-response.

[3] For BMI 37 missing data, for PIR 1,562 missing data.

Table 2. Breakfast Category Contents

Breakfast Category	USDA Food Codes
2. Fats and Sweets	Fats, oils, and salad dressings
	Sugars and sweets, candy
3. Dairy	Milk and milk products
4. Meat and Eggs	Meat, poultry, fish, and meat substitutes
	Eggs
	Dry beans, peas, other legumes, nuts, and seeds
	White potatoes[1]
5. Fruits and Vegetables	Fruits
	Vegetables, excluding potatoes
	100% fruit or vegetable juice
6. Ready-to-eat cereal	Ready-to-eat cereals
7. Cooked cereal	Cooked cereals and rice
8. Breads	Yeast breads and rolls
	Crackers
	Pasta
	Grain mixed dishes
9. Quick Breads	Cakes, cookies, pies, pastries
	Pancakes, waffles, French toast
	Quick Breads
	Flour and dry mixes
10. Beverages	Coffee, tea and additives to them; all other nonalcoholic and alcoholic beverages, except water

[1] The sample size of a "Potatoes" breakfast group was too small for analysis. These individuals were grouped with "Meat and Eggs" consumers due to the dietary pattern of simultaneous consumption of potato, meat, and egg products.

Table 3. Number of Subjects in Each of the Breakfast Categories

Breakfast category	Frequency (n)	Weighted percent (%)[1]
1. Breakfast skipper	3,652	20.05
2. Fats and sweets	558	4.23
3. Dairy products	710	4.55
4. Meat and eggs	2,227	10.87
5. Fruit and vegetables	676	4.48
6. Ready-to-eat cereal	2,371	17.14
7. Cooked cereal	1,063	4.76
8. Breads	2,585	15.93
9. Quick breads	1,691	11.93
10. Beverages	919	6.06
Total	16,452	100

[1] Weighted to adjust for over-sampling and non-response.

Breads category, 1,691 (11.93%) subjects were in the Quick breads category, and 2,227 (10.87%) subjects were in the Meat and eggs category. The other five categories (n = 3,926; 24.08%) each represented less than 7% of all breakfasts consumed.

Adjusted means for BMI and energy intake are presented in Table 4 and Table 5. For the comparisons of BMI and energy intake among the breakfast categories, a *p*-value of $p \leq 0.01$ was considered statistically significant.

In the analysis of BMI by breakfast category, subjects who

Table 4. Adjusted Means for BMI by Breakfast Category[1]

Breakfast category	BMI least square means (kg/m^2)	Standard error means
1. Breakfast skipper	26.92[c]	0.20
2. Fats and sweets	26.79[b,c]	0.24
3. Dairy products	27.11[b,c]	0.40
4. Meat and eggs	27.04[c]	0.19
5. Fruit and vegetables	26.41[a,b,c]	0.35
6. Ready-to-eat cereal	26.03[a,b]	0.19
7. Cooked cereal	25.46[a]	0.22
8. Breads	26.42[b,c]	0.19
9. Quick breads	26.16[a,b]	0.19
10. Beverages	26.25[a,b,c]	0.41

[1] Due to missing values in covariates, n = 14,864 for this model.
Model is adjusted for age, age^2, gender, race, smoking, alcohol intake, physical activity, and poverty index ratio.
Means within columns not sharing a common superscript are significantly different at a 1% procedure-wise error rate.

Table 5. Adjusted Means for Energy Intake by Breakfast Category[1]

Breakfast category	Energy intake least square means (kcal)	Standard error means
1. Breakfast skipper	2027.9[a]	31.6
2. Fats and sweets	2105.7[a,b]	55.4
3. Dairy products	2300.7[b,c,d]	67.0
4. Meat and eggs	2433.7[d]	34.8
5. Fruit and vegetables	2046.0[a]	36.9
6. Ready-to-eat cereal	2241.5[b,c]	25.3
7. Cooked cereal	2324.8[c,d]	38.7
8. Breads	2226.0[b,c]	30.1
9. Quick breads	2300.0[c,d]	46.4
10. Beverages	2165.7[a,b,c]	51.3

[1] Due to missing values in covariates, n = 14,890 in this model.
Model is adjusted for age, gender, race, smoking, alcohol intake, physical activity, and poverty index ratio.
Means within columns not sharing a common superscript are significantly different at a 1% procedure-wise error rate.

ate Ready-to-eat cereal, Cooked cereal, or Quick breads for breakfast had significantly lower BMI compared to breakfast Skippers and to subjects who ate Meat and eggs for breakfast (Table 4). Individuals in the Cooked cereal group also had significantly lower BMI than subjects in the Fats and sweets, Dairy products, and Breads groups. The BMIs of the Ready-to-eat cereal, Cooked cereal and the Quick breads eaters were not significantly different from one another. Also, no significant differences in BMI were found for the Fruit and vegetable and the Beverage categories when compared to any other group, with their BMIs being close to the mean BMI of all groups (26.49 ± 0.12 kg/m^2 (lsmean ± SEM)).

In the analysis for energy intake by breakfast category, breakfast Skippers and Fruit and vegetable eaters had the lowest energy intake throughout the day (Table 5). These two groups were significantly different from all other categories except the Fats and sweets and Beverages groups, which also

had a low total daily energy intake. The Meat and eggs eaters had the highest daily energy intake, which was significantly different from energy intake of all groups except the Dairy, Quick breads, and the Cooked cereal consumers. The energy intakes of the Ready-to-eat cereal, Cooked cereal, Bread and Quick bread groups, all containing grain products, were close to the energy intake mean of all groups (2,199 ± 18.91 kcal), but were higher than those of the Skippers, the Fats and sweets and the Fruit and vegetable eaters, and were lower than the Meat and eggs group energy intake, with various of these pair-wise comparisons reaching significance at $p \leq 0.01$ (see superscripts in Tables 4 and 5).

DISCUSSION

This NHANES III data analysis confirms previous data indicating that persons who skip breakfast have higher mean BMI and additionally demonstrates that this is true even after adjustment for gender, age, race, socioeconomic status and other lifestyle factors. This analysis further shows that not only is eating breakfast important, but also that the particular type of breakfast may be an important influence on BMI. Eating cereal, whether cooked or ready-to-eat, or quick breads for breakfast is associated with significantly lower BMI of adults when compared to either skipping breakfast or consuming other types of breakfast. To our knowledge, this is the first study of breakfast habits in relation to BMI and energy intake to adjust for lifestyle factors such as smoking, alcohol intake, physical activity and poverty status.

Twenty percent of the subjects in this NHANES III cohort skipped breakfast, making it the largest group of all ten investigated categories. This percentage is similar to the number reported by Haines *et al.* [12], who found that in 1991 25% of US adults skipped breakfast. Also, an earlier published report by Zabik [36] found that 24% of young women regularly skipped breakfast.

The breakfast skippers were one of the three groups with the highest BMIs (breakfast Skipper, Meat and eggs, Dairy). Our finding of an association between breakfast skipping and high BMI is consistent with data in the literature showing that breakfast skipping may lead to imbalanced eating later in the day (e.g., one big meal in the evening) [24], a dietary pattern associated with obesity [5,25,37,38].

Studies by Zabik *et al.* [36] and by Resnicow *et al.* [39] found that daily energy intakes appeared not to be affected when breakfast is skipped [11]. However, we found that the skippers have the lowest total daily energy intake of all groups, despite having high BMIs. An explanation for this could be that subjects who skip breakfast are already overweight, are trying to lose weight and are also limiting their daily energy intake from other food sources throughout the day. From these data it

cannot be determined whether the association is causal (skipping breakfast leading to poor dietary patterns leading to obesity) or correlational (persons who skip breakfast are already overweight and are trying to control it by skipping breakfast). In either case, it is clear from these and other data that skipping breakfast does not lead to attaining or maintaining a healthy weight.

Of the five breakfast categories that represented, at least 10% of the population, subjects in the Meat and eggs group had the highest BMI and subjects in the Ready-to-eat cereal group had the lowest BMI, and these values were significantly different from one another at $p \leq 0.01$. The high energy intake of the Meat and eggs group throughout the day is consistent with their high BMI. It is likely that this group obtained a substantial amount of their total daily calorie intake from the fat of the breakfast itself. In contrast, the energy intake of the Ready-to-eat cereal group (2,241 ± 25.3 kcal) is actually slightly higher than the overall mean energy intake (2,199 ± 18.91 kcal), a fact that appears to be inconsistent with their low BMI. It is possible that the *composition* of the diet, particularly in terms of fat and fiber intake, may be a factor in maintaining a healthy body weight.

Among the less common breakfast types, Fats and sweets (4.2% of all breakfast types) and Dairy (4.6%) consumers averaged higher BMIs and similar or somewhat higher daily energy intakes compared to the other groups. Individuals who took Dairy products at breakfast averaged the highest BMI of all breakfast categories (27.11 ± 0.4 kg/m^2); however, this BMI only differed significantly from that of Cooked cereal consumers, but not from those of RTEC and Quick bread eaters, at $p \leq 0.01$. These groups appear to represent people "on the run," eating only candy or soda, or grabbing a glass of milk or a piece of cheese. Their higher BMI would appear to support the notion that "dysregulated" eating patterns are associated with obesity, instead of or in addition to total energy intake *per se.*

Another less common breakfast type was the Fruit and vegetable eaters (4.5% of all breakfast types). Their BMI was similar to the overall mean, while their kilocalorie intake was lower than most other categories. The lower daily energy intake may reflect subjects who tend to eat meals with low energy content such as avoiding foods high in fat, factors that may have been incompletely adjusted in our control for several factors associated with a healthy lifestyle. On the other hand, it may be that the presence of other factors, such as fiber or micronutrients, has an influence on obesity.

Subjects who ate any types of breakfast that contained or consisted of grains (cereals and breads) had energy intakes that were close to the overall mean energy intake of all groups combined. At the same time, these groups also had lower BMIs than the Skippers and the Meat and eggs eaters. These products—cereals and certain types of breads—not only provide energy, but they can also contain a substantial amount of

insoluble fiber [40,41]. This could explain why the two breakfast types with the lowest BMI were Ready-to-eat cereal and Cooked cereal consumers.

The Breads category appears to be an anomaly in this analysis. Subjects in this group consumed carbohydrate and presumably some fiber, but nevertheless had a BMI almost identical to the overall average (26.49 kg/m^2). This was in contrast to subjects who consumed Ready-to-eat cereals, Cooked cereals and Quick breads, who had lower BMIs than those of other groups. We interpret this to again represent the impact of a "dysregulated" dietary pattern: persons who were categorized in this breakfast type did not have a breakfast that contributed substantial energy from dairy or meat groups, or from cooked or ready-to-eat cereals, or from fruit. Rather, they seem to have simply grabbed a piece of toast as their "breakfast."

It is possible that fiber is an important factor in this equation. Food with moderate and high fiber content, such as cooked cereal, some ready-to-eat cereals, fruit and vegetables, stays longer in the gastrointestinal tract and therefore contributes to a longer lasting satiety feeling [42,43]. Eating foods rich in fiber therefore could possibly prevent overeating of foods with high fat contents and thus high in energy. This could prevent overweight and obesity when combined with other weight-loss efforts such as increased physical activity.

These results could also support a hypothesis that the *fat* content at breakfast influences BMI. Some research has shown that eating a diet high in carbohydrate and low in fat is helpful in successful weight-loss maintenance [44], consistent with the higher BMI of subjects eating Meat and eggs, and with the lower BMI of subjects eating cereals, cooked or ready-to-eat. A study by Stanton and Keast [45] found that individuals whose breakfasts included a ready-to-eat cereal had a significantly lower total daily intake of fat, thus received significantly lower percentages of calories from fat. This is consistent with a study by Huang *et al.* concluding that eating breakfast, especially cereals and breads, reduced fat intake and helped increase fiber intake of young adults [46]. At the same time, these results are consistent with an interpretation that high *carbohydrate,* or high *fiber,* at breakfast influences BMI, since cereals and breads tend to be simultaneously low in fat and higher in carbohydrate and fiber. The data we present cannot differentiate between these two hypotheses.

Our data do strongly suggest that skipping breakfast, or eating a high-fat, low-fiber breakfast (as in the Meat and eggs category), is associated with a higher BMI. Among the other breakfast types, however, our observations are consistent with a hypothesis that either 1) a low-fat breakfast is associated with lower BMI or 2) that it is the organized meal style typified in cereal or quick bread breakfasts, rather than the energy, carbohydrate, fiber or fat contents of the various breakfast types, that ultimately influences BMI. The most consistent pattern in these data is that it is the eating of a fairly "organized" breakfast that is associated with appropriate body mass regulation. Ready-to-eat cereals, cooked cereals and quick breads such as pancakes are typically eaten at home and represent an attempt to have a "conventional" breakfast. In contrast, a quick soda, glass of milk, piece of toast or cup of coffee represent an "on-the-run" behavior that we consider to be conducive to poor dietary habits and obesity.

CONCLUSION

People who eat cereal (cooked or ready-to-eat cereal) or quick breads for breakfast have significantly lower body mass indices than those who skip breakfast or who eat meats and eggs for breakfast. This analysis provides evidence that skipping breakfast is not an effective way to manage weight and also suggests that an "on-the-run" meal style or high-fat food choices may also lead to less healthy weight management.

ACKNOWLEDGEMENTS

REFERENCES

1. U.S. Department of Health and Human Services: "Healthy People 2000: National Health Promotion and Disease Prevention Objectives: Full Report, with Commentary." Washington DC: U.S. Government Printing Office, 1991.
2. U.S. Department of Health and Human Services: "Healthy People 2010," 2nd ed. Washington DC: U.S. Government Printing Office, 2000.
3. Flegal KM, Carroll MD, Kuczmarski RJ, Johnson CL: Overweight and obesity in the United States: prevalence and trends, 1960–1994. Int J Obes Relat Metab Disord 22:39–47, 1998.
4. Suwaidi JA, Higano ST, Holmes DR, Lennon R, Lerman A: Obesity is independently associated with coronary endothelial dysfunction in patients with normal or mildly diseased coronary arteries. J Am Coll Cardiol 37:1523–1528, 2001.
5. Lissner L, Heitmann BL: Dietary fat and obesity: evidence from epidemiology. Eur J Clin Nutr 49:79–90, 1995.
6. National Heart, Lung and Blood Institute: "Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: the evidence report." National Institutes of Health, 1998.
7. Harvard Medical School: Trials of hypertension prevention [unpublished]. Protocol 1987.
8. Ford ES: Body mass index, diabetes, and C-reactive protein among U.S. adults. Diabetes Care 22:1971–1977, 1999.
9. Ostrander LD, Lamphiear DE, Block WD: Diabetes among men in a general population: prevalence and associated physiological findings. Arch Intern Med 136:415–420, 1976.
10. Chapman GE, Melton CL, Hammond GK: College and university

students' breakfast consumption patterns: behaviours, beliefs, motivations and personal and environmental influences. Can J Diet Pract Res 59:176–182, 1998.

11. Ruxton CHS, Kirk TR: Breakfast: a review of associations with measures of dietary intake, physiology and biochemistry. Br J Nutr 78:199–213, 1997.

12. Haines PS, Guilkey DK, Popkin BM: Trends in breakfast consumption of US adults between 1965 and 1991. J Am Diet Assoc 96:464–470, 1996.

13. Bellisle F, Monneuse MO, Steptoe A, Wardle J: Weight concerns and eating patterns: a survey of university students in Europe. Int J Obes Relat Metab Disord 19:723–730, 1995.

14. Siega-Riz AM, Popkin BM, Carson T: Trends in breakfast consumption for children in the United States from 1965 to 1991. Am J Clin Nutr 67:748S–756S, 1998.

15. Summerbell CD, Moody RC, Shanks J, Stock MJ, Geissler C: Relationship between feeding pattern and body mass index in 220 free-living people in four age groups. Eur J Clin Nutr 50:513–519, 1996.

16. Gibson SA, O'Sullivan KR: Breakfast cereal consumption patterns and nutrient intakes of British schoolchildren. J R Soc Health 115:336–370, 1995.

17. Ortega RM, Requejo AM, Lopez-Sobaler AM, Quintas ME, Andres P, Redondo MR, Navia B, Lopez-Bonilla MD, Rivas T: Differences in the breakfast habits of overweight/obese and normal weight schoolchildren. Int J Vitam Nutr Res 68:125–132, 1998.

18. Bellisle F, Rolland-Cachera MF, Deheeger M, Guilloud-Bataille M: Obesity and food intake in children: evidence for a role of metabolic and/or behavioral daily rhythms. Appetite 11:111–118, 1988.

19. Ortega RM, Redondo MR, Lopez-Sobaler AM, Quintas ME, Zamora MJ, Andres P, Encinas-Sotillos A: Associations between obesity, breakfast-time food habits and intake of energy and nutrients in a group of elderly Madrid residents. J Am Coll Nutr 15:65–72, 1996.

20. Wolfe WS, Campbell CC, Frongillo EA, Haas JD, Melnick TA: Overweight schoolchildren in New York state: prevalence and characteristics. Am J Public Health 84:807–813, 1994.

21. Gluck ME, Geliebter A, Satov T: Night eating syndrome is associated with depression, low self-esteem, reduced daytime hunger, and less weight loss in obese outpatients. Obes Res 9:264–267, 2001.

22. Keim NL, Van Loan MD, Horn WF, Barbieri TF, Mayclin PL: Weight loss is greater with consumption of large morning meals and fat-free mass is preserved with large evening meals in women on a controlled weight reduction regimen. J Nutr 127:75–82, 1997.

23. Halberg F: Chronobiology and nutrition. Contemp Nutr 8:2pp[unpaginated], 1983.

24. Martin A, Normand S, Sothier M, Peyrat J, Louche-Pelissier C, Laville M: Is advice for breakfast consumption justified? Results from a short-term dietary and metabolic experiment in young healthy men. Br J Nutr 84:337–344, 2000.

25. Schlundt DG, Hill JO, Sbrocco T, Pope-Cordle J, Sharp T: The role of breakfast in the treatment of obesity: a randomized clinical trial. Am J Clin Nutr 55:645–651, 1992.

26. Drummond S, Crombie N, Kirk T: A critique of the effects of snacking on body weight status. Eur J Clin Nutr 50:779–783, 1996.

27. O'Dea JA, Caputi P: Association between socioeconomic status, weight, age and gender, and the body image and weight control

practices of 6- to 19-year-old children and adolescents. Health Education Research 16:521–532, 2001.

28. Smith AP: Breakfast and mental health. Int J Food Sci Nutr 49:397–402, 1998.

29. Siega-Riz AM, Popkin BM, Carson T: Differences in food patterns at breakfast by sociodemographic characteristics among a nationally representative sample of adults in the United States. Prev Med 30:415–424, 2000.

30. Nicklas TA, Myers L, Reger C, Beech B, Berenson GS: Impact of breakfast consumption on nutritional adequacy of the diets of young adults in Bogalusa, Louisiana: ethnic and gender contrasts. J Am Diet Assoc 98:1432–1438, 1998.

31. National Center for Health Statistics: Plan and operation of the third national health and nutrition examination survey, 1988–1994. Vital Health Stat 1(32), 1994.

32. National Center for Health Statistics: Sample design: third national health and nutrition examination survey. Vital Health Stat 2(113), 1992.

33. Briefel RB, McDowell MA, Alaimo K, Caughman CR, Bischo AL, Carroll MD, Johnson CL: Total energy intake of the US population: the third national health and nutrition examination survey, 1988–1991. Am J Clin Nutr 62:1072S–1080S, 1995.

34. U.S. Department of Health and Human Services: "NHANES III Dietary Interviewer's Manual." Hyattsville, MD: Westat, 1992.

35. Shah BV, Barnwell BG, Hunt PN, La Vange LM: "SUDAAN User's Manual: Release 5.50." Research Triangle Park, NC: Research Triangle Institute, 1991.

36. Zabik ME: Impact of ready-to-eat cereal consumption on nutrient intake. Cereal Foods World 32:234–239, 1987.

37. Carson TA, Siega-Riz AM, Popkin BM: The importance of breakfast meal type to daily nutrient intake: differences by age and ethnicity. Cereal Foods World 44:414–422, 1999.

38. Astrup A, Toubro S, Raben A, Skov AR: The role of low-fat diets and fat substitutes in body weight management: what have we learned from clinical studies? J Am Diet Assoc 97:S82–S87, 1997.

39. Resnicow K: The relationship between breakfast habits and plasma cholesterol levels in schoolchildren. J Sch Health 61:81–85, 1991.

40. Rawitscher M, Mayer J: Energy requirements and breakfast cereals. Food Policy 6:27–32, 1981.

41. Nicklas TA, Bao W, Webber LS, Berenson GS: Breakfast consumption affects adequacy of total daily intake in children. J Am Diet Assoc 93:886–891, 1993.

42. Turconi G, Bazzano R, Caramella R, Porrini M, Crovetti R, Lanzola E: The effects of high intakes of fibre ingested at breakfast on satiety. Eur J Clin Nutr 49(Suppl 3):S281–S285, 1995.

43. Heaton KW: Food fibre as an obstacle to energy intake. Lancet ii:1418–1421, 1973.

44. Wyatt HR, Grunwald GK, Mosca CL, Klem ML, Wing RR, Hill JO: Long-term weight loss and breakfast in subjects in the national weight control registry. Obes Res 10:78–82, 2002.

45. Stanton JL, Keast DR: Serum cholesterol, fat intake, and breakfast consumption in the United States adult population. J Am Coll Nutr 8:567–572, 1989.

46. Huang YL, Hoerr SL, Song WO: Breakfast is the lowest fat meal for young adult women. J Nutr Educ 29:184–188, 1997.