

# Gastrointestinal Symptoms Following Consumption of Olestra or Regular Triglyceride Potato Chips

## A Controlled Comparison

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**Context.**—Olestra, a nonabsorbable, energy-free fat substitute used in snack foods, has been anecdotally reported to cause gastrointestinal (GI) adverse events, although such effects were not expected based on results from randomized trials, in which it was consumed in typical snack patterns.

**Objective.**—To determine whether ad libitum consumption of potato chips made with the fat substitute olestra results in a different level of GI symptoms than regular chips made with triglyceride (TG).

**Design.**—Randomized, double-blind, parallel, placebo-controlled trial.

**Setting.**—A suburban Chicago, Ill, multiplex cinema.

**Subjects.**—A total of 1123 volunteers aged 13 to 88 years.

**Intervention.**—Subjects were given a beverage and an unlabeled, white 369-g (13-oz) bag of potato chips made with olestra or TG during a free movie screening.

**Main Outcome Measures.**—Total and specific GI symptoms reported during a telephone interview conducted from 40 hours to 10 days after ingestion; level of potato chip consumption; and satiety level.

**Results.**—Of 563 evaluable subjects in the olestra chip group, 89 (15.8%) reported 1 or more GI symptoms, while 93 (17.6%) of the 529 evaluable subjects in the regular TG chip group did so (difference in symptom frequency between olestra and TG,  $-1.8$ ; 95% confidence interval,  $-6.2$  to  $2.7$ ;  $P=.47$ ). For specific GI symptoms (eg, gas, diarrhea, abdominal cramping), there were no significant differences between olestra and TG chips. Fewer olestra chips were consumed than TG chips (60 vs 77 g [2.1 vs 2.7 oz];  $P<.001$ ), with olestra chips receiving lower taste scores (5.6 vs 6.4 on a 9-point scale;  $P<.001$ ). Consumption levels did not correlate with the rate of symptom reporting in either the olestra or TG group. There was no difference in satiety scores between olestra and TG chips (5.7 vs 5.9 on a 9-point scale;  $P=.07$ ).

**Conclusions.**—This study demonstrates that ad libitum consumption of olestra potato chips during 1 sitting is not associated with increased incidence or severity of GI symptoms, nor does the amount consumed predict who will report GI effects after short-term consumption of either olestra or TG potato chips.

*JAMA.* 1998;279:150-152

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Dr Cheskin is a consultant to Procter & Gamble. The terms of this arrangement are being managed by The Johns Hopkins University in accordance with its conflict of interest policies.

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A DIET HIGH IN FAT is now well known to be associated with obesity and heart disease. The American Heart Association recommends a diet in which fat contributes 30% or less of total energy. One factor making it difficult for individuals to lower their fat intake is the lack of availability of low-fat foods with taste and aesthetics comparable to the full-fat varieties.

Olestra is a nonabsorbable, energy-free fat substitute approved by the US Food

and Drug Administration (FDA) for use in the preparation of snack foods, including potato chips, corn chips, and crackers.<sup>1</sup> Olestra is a mixture of hexa-, hepta-, and octa-esters of sucrose formed from long-chain fatty acids prepared from any edible oil. Because olestra is not hydrolyzed by pancreatic enzymes,<sup>2</sup> it is not absorbed<sup>3</sup> and provides no dietary energy or fat. Extensive studies in laboratory animals and humans were reviewed by the FDA in its determination of the safe use of olestra in foods.<sup>1,4</sup>

There has been considerable publicity around anecdotal reports of consumers experiencing gastrointestinal (GI) adverse events from olestra.<sup>5</sup> We were interested in conducting a carefully controlled, blinded study that would allow a large number of participants unlimited access to chips in a single sitting (about a 2-hour period).

### Participants and Methods

We studied 1123 adult and teenaged individuals who responded to recruitment flyers distributed at a suburban Chicago, Ill, multiplex cinema soliciting participants for a potato chip test at the movies. Potential subjects completed a telephone screening. The only exclusionary criteria were employment at a food or market research firm or participation of more than 2 individuals per household. Participants were scheduled for their choice of 4 first-run movies being shown on the study evenings and were instructed to eat their evening meal 1 to 2 hours prior to arriving at the theater. The theaters were closed to the public during the study.

The study protocol was approved by the local institutional review board. Written informed consent was obtained from all participants, as well as from a parent or guardian for minors. Two free

movie passes were given to each participant as an incentive.

Prior to the movie, participants were assigned to 1 of the 2 test groups via a separate randomization schedule generated for each of 6 sex and age strata (13-17, 18-34, and >34 years) (Figure). Each participant was then given a plain, white, coded 369-g (13-oz) bag of test chips (either regular Frito-Lay Ruffles or Frito-Lay MAX Ruffles made with olestra) by study staff, who were blinded to test group assignment. Participants also received their choice of beverage (various 960-mL [32-oz] soft drinks) and were asked to be seated in the theater at least 1 seat apart from other participants. They were instructed to consume as much or as little of their potato chips and beverage as they liked and not to share with anyone else. The theaters were monitored by several study staff during the movies.

At the conclusion of the movie, participants clipped their bags of potato chips shut; noted the approximate amount of beverage they had consumed; and completed a brief questionnaire regarding product acceptance, subjective satiety, and sensory attributes. Bags of chips were subsequently weighed to determine amounts of consumption.

Beginning 40 hours after the movie, trained telephone interviewers (Elrick & Lavidge, Chicago) began collecting information on any adverse events experienced since the movie. All participants were specifically asked if they had any digestive symptoms during or since the movie and, if so, to specify those symptoms. The participant's own words were captured; additional information, including timing and severity, was completed for each reported symptom. Symptom severity, was rated on a scale of mild, moderate, or severe, based on no, partial, or complete impairment of daily activities, respectively. Each participant was also asked about preexisting food intolerances or GI medical conditions. Multiple attempts were made to telephone all participants within 4 days of the movie. Attempts to contact those individuals not reached continued for another week.

The study was designed to provide 80% power (at .05 level) for detecting true differences in proportions of symptoms of 10% vs 15%, based on 700 subjects per group. All symptoms were classified blinded according to an adverse event coding dictionary.<sup>6</sup> Incidence of GI symptoms by category was compared between the olestra and triglyceride (TG) potato chip groups using the Fisher exact test. Treatment comparisons of consumption, satiety, and preference data were made using a 2-sample *t* test or Wilcoxon rank-sum test. All *P* values listed are 2-sided

and were not adjusted for the multiplicity of variables being compared. Approximate 95% confidence intervals for the difference in 2 proportions were constructed using the standard, large-sample normal approximation method.

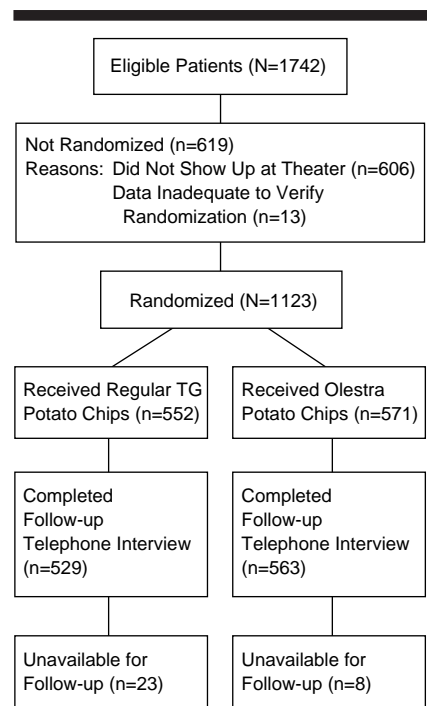
## Results

Of the 1742 individuals qualified for the study, 1123 kept their appointment times and viewed a movie. There were 31 individuals who could not be recontacted, leaving a total of 1092 evaluable subjects for data analysis. Follow-up telephone interviews had been completed by day 4 for 89% and by day 10 for 99% of these participants.

There were no significant differences between the olestra and TG groups in sex, race, or age composition (56% vs 58% female and 87% vs 86% white, with a mean age of 35.4 vs 34.7 years, respectively;  $P > .40$ ). There was a broad range of chip consumption in both groups, with the median consumption of TG chips somewhat higher than that of olestra chips (77 g vs 60 g [2.7 oz vs 2.1 oz];  $P < .001$ ). Overall chip consumption was similar across age groups, but males generally consumed more chips than females (median, 80 g vs 60 g [2.8 oz vs 2.1 oz];  $P < .001$ ). The overall palatability of the TG chips was also rated higher than the olestra chips, with a mean score of 6.4 vs 5.6 on a 9-point overall preference scale ( $P < .001$ ). However, there were no significant differences between the groups in satiety, as indicated by mean satiety scores of 5.9 vs 5.7 for TG and olestra chips, respectively, on a 9-point fullness scale, with 9 being "extremely full" ( $P = .07$ ), nor were any significant differences seen in beverage consumption, choice of beverage, or time since last meal prior to the movie.

There were 3 adverse events reported prior to the scheduled recall: (1) a participant had nausea and vomiting during the movie after eating 14 g (0.5 oz) of olestra chips (she reported feeling ill prior to the movie); (2) a participant had nausea and vomiting after eating 51 g (1.8 oz) of TG chips (the only individual in the study who reported seeking the care of a physician); and (3) a participant had cramping, diarrhea, and fecal incontinence the morning after the movie after eating 289 g (10.2 oz) of TG chips. The remaining experiences were collected as part of routine "callbacks."

Analysis of the incidence of GI adverse events indicated no significant difference between the 2 groups, with 17.6% and 15.8% of the TG and olestra subjects, respectively, reporting 1 or more GI complaints ( $P = .47$ ) (Table). There were also no significant differences or trends between groups in the incidence of any of the



Progress of study participants during randomization and follow-up. TG indicates triglyceride.

14 individual GI symptoms reported. The overall mean symptom severity for any GI event was not different between groups (mean, 1.3;  $P = .83$ ), nor was there a significant difference in symptom severity for any GI event between olestra and TG in individuals eating more than 113 g (4 oz) of chips (mean, 1.5 vs 1.3;  $P = .49$ ). The percentage of individuals with any GI symptom and with each of the specific symptoms (gas, diarrhea, abdominal pain, upset stomach, abdominal cramping, and loose stool) was compared between olestra and TG groups across 4 chip-consumption levels (0-57, 57-113, 113-170, and 170-369 g [0-2, 2-4, 4-6, and 6-13 oz]). There was no indication of increasing symptom incidence with greater consumption in either the olestra or TG group. Also, there were no significant differences between the 2 groups in incidence within 7 symptom and 4 consumption categories (28 comparisons), except for 2 isolated findings of increased incidence of any GI symptom for the TG group in the 57- to 113-g (2- to 4-oz) category (20.6% vs 11.3%;  $P = .001$ ) and increased upset stomach for the olestra group in the 0- to 57-g (0- to 2-oz) category (2.6% vs 0%;  $P = .05$ ).

In subjects with a history of GI disorders, there was no greater frequency of GI complaints in those receiving olestra than TG (6/33 [18%] vs 6/29 [21%],  $P > .99$ ).

## Comment

We found no increased incidence or severity of GI symptoms of any type in a

| Adverse Event      | Treatment Group |                 | P Value | Difference (95% CI)† |
|--------------------|-----------------|-----------------|---------|----------------------|
|                    | TG (n=529)      | Olestra (n=563) |         |                      |
| Any GI event       | 93 (17.6)       | 89 (15.8)       | .47     | -1.8 (-6.2 to 2.7)   |
| Gas                | 34 (6.4)        | 27 (4.8)        | .29     | -1.6 (-4.4 to 1.1)   |
| Diarrhea           | 14 (2.6)        | 17 (3.0)        | .72     | 0.4 (-1.6 to 2.3)    |
| Abdominal pain     | 19 (3.6)        | 13 (2.3)        | .22     | -1.3 (-3.3 to 0.7)   |
| Upset stomach      | 11 (2.1)        | 11 (2.0)        | >.99    | -0.1 (-1.8 to 1.5)   |
| Abdominal cramping | 10 (1.9)        | 11 (2.0)        | >.99    | 0.1 (-1.6 to 1.7)    |
| Loose stools       | 6 (1.1)         | 9 (1.6)         | .61     | 0.5 (-0.9 to 1.8)    |
| Other GI events‡   | 21 (4.0)        | 19 (3.4)        | .63     | -0.6 (-2.8 to 1.6)   |

\*TG indicates triglyceride; CI, confidence interval; and GI, gastrointestinal. All treatment group values are number (percentage) of subjects reporting 1 or more events.

†Values are the difference (95% CI) in symptom frequency between olestra and TG groups.

‡Other GI events included nausea, bloating, indigestion, aftertaste, belching, constipation, vomiting, or bloody stool.

large group of subjects consuming olestra chips ad libitum during 1 sitting in a movie theater. While this setting may be unique for a clinical trial, the study was structured to meet rigorous controlled clinical trial standards under conditions typical for the use of the snack foods.

Overall preference for olestra potato chips was slightly lower, and this is probably reflected in the 22% lower chip consumption in the olestra group. Despite lower consumption, the olestra group reported being no less satiated than the TG chip group. This suggests a previously reported<sup>7</sup> possibility that olestra use will reduce energy and fat intake, aiding weight control in those who consume potato chips. While the median consumption of olestra chips was less than TG chips, it was more than 57 g (2 oz), which is more than a typical single-serving snack-sized bag of chips, and there were 155 subjects who consumed more than 113 g (4 oz) of olestra chips (>33 g of olestra). Thus, the consumption levels were adequate to ensure that enough olestra was consumed to evaluate potential GI effects. However, even in the participants consuming more than 113 g (4 oz), there were no differences observed in the frequency or severity of reported GI symptoms between groups, nor was there any indication of a dose-response relationship of increasing symptoms with higher consumption levels in either test

group. The 2 statistically significant findings (increased upset stomach in the 0- to 57-g [0- to 2-oz] olestra group and increased incidence of any symptom in the 57- to 113-g [2- to 4-oz] TG group) appear likely to be due to random variation.

The information label on olestra products states that "olestra may cause loose stools and abdominal cramping." The current study findings do not support this statement. The label primarily reflects the results from 2 clinical studies in which subjects were required to consume olestra at every meal for 56 consecutive days. In those studies there were statistically significant increases (19%-42%) in mild to moderate GI symptoms in persons eating 20 or 32 g of olestra per day in foods (equivalent to 68-111 g [2.4-3.9 oz] of chips relative to the current study) compared with placebo subjects.<sup>8,9</sup> However, in other studies conducted under ad libitum home-use conditions that included more than 3500 participants, no differences were found in the reporting of GI symptoms compared with TG snack control groups.<sup>10</sup>

The manufacturer of olestra is currently conducting postmarketing surveillance via toll-free telephone numbers on packages of olestra-containing snack products. Reporting frequency has been related to news media coverage on the controversy about potential GI effects. While the current study was designed to

evaluate symptom occurrence under conditions at 1 sitting, this type of consumption constitutes the majority of consumer complaints to the manufacturer to date (81%). These same individuals report a median consumption of 48 g [1.7 oz] of chips.<sup>11</sup> Thus, these reports would not appear to be supported by the findings in the present study.

What, then, are alternative explanations for the symptoms experienced by these consumers and by the participants in the present study? It has been demonstrated in a large-scale survey that functional GI symptoms are quite common in the general population, with up to 69% of individuals reporting 1 or more symptoms during a 3-month period.<sup>12</sup> Food intolerances are also commonly reported in the population.<sup>13</sup> Of note, however, are our findings that increased symptom rates were not observed in individuals consuming more chips and that there was a lack of association between reported history of GI problems and symptoms in the present study. Finally, because possible GI symptoms were mentioned in the informed consent, a potential "nocebo," or negative placebo effect, may be increasing the rate of reporting. For example, in 1 published study, a 6-fold increase in the number of patients withdrawing from a trial because of minor GI symptoms was found when a statement outlining these possible adverse effects was included in the informed consent.<sup>14</sup>

Regardless of the potential explanations for the high rate of GI symptoms reported, we were unable to demonstrate any increase in the frequency of GI symptoms when participants ate as many olestra potato chips as they cared to at 1 time. Previous and ongoing studies address GI symptom incidence under a variety of other consumption settings. The present findings provide practical information on the effects of olestra consumed in a typical fashion.

Funding for this study was provided by Procter & Gamble Company, Cincinnati, Ohio.

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