

# Artificial Sweetener Use among Individuals with Eating Disorders

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## ABSTRACT

Women with eating disorders report using large quantities of artificially sweetened products, but this has not been quantified.

**Objective:** The authors assessed the use of selected artificially sweetened low-calorie products among women with eating disorders compared with controls.

**Method:** Thirty women with anorexia nervosa (18 with the restricting subtype [AN-R] and 12 with the binge/purge subtype [AN-B/P]), 48 women with bulimia nervosa (BN), and 32 healthy control women completed a survey of frequency and amount of consumption of chewing gum, artificially sweetened low-calorie beverages, and packets of artificial sweetener in the previous month.

**Results:** A greater proportion of women with AN-B/P and BN reported use of each product, compared with women with AN-R and control participants. Among product users, patients with eating disorders reported using greater amounts than controls. Among patients who reported binge eating and/or purging, the quantity of each product used was inversely correlated with body mass index (BMI).

**Conclusion:** These data suggest an increased drive for sweet orosensory stimulation in women with AN and BN.  
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**Keywords:** eating disorders; artificial sweetener; anorexia nervosa; bulimia nervosa; chewing gum; diet beverages

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## Introduction

Anorexia nervosa (AN) and bulimia nervosa (BN) are psychiatric disorders characterized by abnormalities in eating behavior and an overvaluation of weight and shape. Individuals with these disorders frequently consume artificially sweetened foods (e.g., light yogurt, diet sodas), consistent with their belief that use of these energy-sparse products facilitates weight loss and/or prevents weight gain. This phenomenon is well known to clinicians treating patients with eating disorders. However, the actual prevalence and amount of use of these products, to our knowledge, have not been determined. The documentation and quantification of use of these products could potentially provide insight into a behavior that may be clinically important (i.e., may in itself be a symptom requiring treat-

ment, or may be associated with adverse effects). Furthermore, such information may ultimately help to elucidate the psychobiology of these complex disorders. The aim of the current study was to begin to assess the prevalence and quantity of consumption of selected low-calorie artificially sweetened products among women with AN and BN, as compared with controls.

Rare case reports document patients' experiencing adverse medical sequelae from abuse of such products. One study assessed the use of products containing sorbitol in a series of patients with eating disorders admitted to an inpatient treatment unit.<sup>1</sup> Eighteen of 21 consecutive patients reported daily use of such products, predominantly sugar-free gum. A number of these patients reported gastrointestinal symptoms resulting from the consumption of very large quantities of the products. A later case report described the development of headaches and flushing in a woman with BN after the intake of large amounts of aspartame during treatment with a monoamine oxidase (MAO) inhibitor<sup>2</sup> and speculated that the combination of aspartame and carbohydrates resulted in altered central nervous system (CNS) levels of amino acids.<sup>3</sup> A third case report from Japan described a woman with AN who developed iodine-induced hypothyroidism as a result of excessive intake of a particular

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(indigenous) confectionary.<sup>4</sup> The impact of artificially sweetened products on appetite and weight regulation in obese and non-eating-disordered populations has also been considered,<sup>5,6</sup> but further studies are required before drawing conclusions.

The current study was designed to assess the use of three types of artificially sweetened low-calorie products among women with AN and BN compared with women without eating disorders. The objectives were to estimate, among patients and controls, the prevalence of product use as well as the quantity consumed by product users, and to determine whether the degree of underweight was related to consumption.

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## Method

Seventy-eight women with eating disorders (18 with the AN-restricting subtype [AN-R], 12 with the AN-binge/purge subtype [AN-B/P], and 48 with BN) participated in the current study. All patients met criteria for one of these disorders as described in the 4th ed. of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV; Washington, DC: American Psychiatric Association; 1994), with the exception of the requirement for amenorrhea for patients with AN, which was waived, as the diagnostic utility of this criterion is controversial.<sup>7</sup> Diagnostic assessment was made by a semistructured interview using the eating disorders section of the Structured Clinical Interview for DSM-IV (SCID<sup>8</sup>). Thirty-two women without a history of or a current eating disorder (per clinical interview) were recruited for participation as control participants. Control participants were between 85% and 120% of ideal body weight at the time of assessment, reported no significant health problems, and had no history of psychiatric illness. All participants were  $\geq 18$  years. All patients and controls were either participants or prospective participants in other studies at the Eating Disorder Research Clinic at New York State Psychiatric Institute, and all participants (patients and controls) were recruited via referral or in response to notices in local media and on the Internet. After full description of the study, verbal (for telephone interview) or written consent was obtained from all participants. All study procedures were reviewed and approved by the institutional review board of the New York State Psychiatric Institute.

The survey instrument consisted of a questionnaire assessing use over the previous month (or, for inpatients with AN, for the month before hospitalization) of each of the following product categories: chewing gum, artificially sweetened, low-calorie beverages, and packets of artificial sweetener. The survey was either completed in written form by participants or via telephone interview

with a research assistant. For each type of product, participants were asked whether they had used it in the past month, and, if so, on how many days per week, and how many servings per day. Beverage consumption was recorded in 12-oz serving sizes. Carbonated and noncarbonated beverage use was assessed separately to facilitate recall and combined for analyses. Weekly amounts were calculated by multiplying days per week on which use was reported by servings per day.

Differences between the proportion of participants in each group using a product category were assessed using chi-square analysis. Yates correction was performed for follow-up tests using  $2 \times 2$  tables. Two participants endorsed the use of diet beverages but did not provide interpretable quantities of use (one subject with AN-R, one with AN-B/P). These data were included in chi-square analyses but removed from subsequent analyses of beverage consumption.

A number of participants denied the use of gum, sweetener packets, or diet beverages. To avoid inordinate contribution to means of zero values from these participants, we also analyzed data only from individuals who reported use at least once in the previous month. From this information, group means were calculated for the weekly amount used in each category.

Because quantities of use were not normally distributed, for each product type, amounts of weekly use were logarithmically transformed before statistical analyses. To assess differences in average consumption among subject groups, one-way analyses of variance (ANOVAs) were performed using the Scheffe post-hoc test to determine pair-wise differences among groups. Because of the exploratory nature of these analyses, no other corrections for multiple comparisons were performed. To assess the relation between product use and body mass index (BMI) without confounding with diagnosis, participants were divided into three diagnostic groups. Women with AN-B/P and BN were considered together as a single group, based on their behavioral similarity (i.e., the presence of purging and/or binge eating).<sup>9</sup> Pearson correlation coefficients were calculated to assess the relation between BMI and (logarithm of) weekly quantity of use of each product type within groups of women with AN-R, controls, and women with binge/purge behavior (AN-B/P and BN).

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## Results

Data regarding mean age, BMI, and prevalence of the use of each product category by each subject group are presented in Table 1. There were no significant differences among participant groups with respect to age. As expected, the mean BMIs of the

**TABLE 1. Characteristics of subject groups and reported prevalence of use of gum, diet beverages, and packets of artificial sweetener**

Subject Group	AN-Restricting (N = 18)	AN-Binge/Purge (N = 12)	BN (N = 48)	Control (N = 32)
Mean Age, years ( $\pm$ SD)	25.4 ( $\pm$ 10.1)	23.8 ( $\pm$ 6.2)	26 ( $\pm$ 5.9)	24.5 ( $\pm$ 5.1)
BMI, kg/m <sup>2</sup> ( $\pm$ SD)	15.3 ( $\pm$ 1.6)*	16.3 ( $\pm$ 1.7)*	21.5 ( $\pm$ 1.8)	21.4 ( $\pm$ 1.7)
Number (% of group) reporting use of gum**	11 (61.1%) <sup>a</sup>	11 (91.7%)	44 (91.7%) <sup>a</sup>	26 (81.3%)
Number (% of group) reporting use of diet beverages	12 (66.7%)	11 (91.7%)	38 (79.2%)	21 (65.6%)
Number (% of group) reporting use of sweetener packets***	6 (33.3%) <sup>b</sup>	11 (91.7%) <sup>b,c</sup>	28 (58.3%)	14 (43.8%) <sup>c</sup>

Note: SD = standard deviation; AN = anorexia nervosa; BN = bulimia nervosa.

<sup>a</sup> Groups with this superscript differ from each other,  $\chi^2 [df = 1] = 6.738, p = .009$ .

<sup>b</sup> Groups with this superscript differ from each other,  $\chi^2 [df = 1] = 7.743, p = .005$ .

<sup>c</sup> Groups with this superscript differ from each other,  $\chi^2 [df = 1] = 6.331, p = .012$ .

\*  $p < .001$ : significant difference compared with the control group.

\*\*  $\chi^2 [df = 3] = 9.633, p = .022$ .

\*\*\*  $\chi^2 [df = 3] = 11.646, p = .009$ .

**TABLE 2. Mean ( $\pm$  standard deviation) weekly use of gum (pieces), diet beverages (12-oz servings), and packets of artificial sweetener, as reported by participants who endorsed their use**

Subject Group	AN-Restricting (N = 18)	AN-Binge/Purge (N = 12)	BN (N = 48)	Control (N = 32)
Weekly pieces of chewing gum* ( $\pm$ SD)	30.9 ( $\pm$ 60.6)	26.7 ( $\pm$ 22.8) <sup>a</sup>	31.2 ( $\pm$ 56.2) <sup>b</sup>	7.2 ( $\pm$ 10.1) <sup>a,b</sup>
Weekly 12-oz servings of diet beverages** ( $\pm$ SD)	16.3 ( $\pm$ 13.4)	39.5 ( $\pm$ 23.7) <sup>c,d</sup>	25.4 ( $\pm$ 46.1) <sup>d</sup>	7.4 ( $\pm$ 8.0) <sup>c</sup>
Weekly packets of artificial sweetener*** ( $\pm$ SD)	350.3 ( $\pm$ 424.3) <sup>e,f</sup>	100.7 ( $\pm$ 104.2) <sup>g</sup>	38.6 ( $\pm$ 97.0) <sup>f</sup>	8.7 ( $\pm$ 11.5) <sup>e,g</sup>

Note: SD = standard deviation; ANOVA = analysis of variance.

<sup>a</sup> Means differ,  $p = .018$  (post-hoc Sheffe test).

<sup>b</sup> Means differ,  $p = .013$  (post-hoc Sheffe test).

<sup>c</sup> Means differ,  $p < .001$  (post-hoc Sheffe test).

<sup>d</sup> Means differ,  $p = .015$  (post-hoc Sheffe test).

<sup>e</sup> Means differ,  $p < .001$  (post-hoc Sheffe test).

<sup>f</sup> Means differ,  $p = .006$  (post-hoc Sheffe test).

<sup>g</sup> Means differ,  $p = .002$  (post-hoc Sheffe test).

\*Significant difference among groups by ANOVA,  $F[3,87] = 4.682, p = .004$ .

\*\*Significant difference among groups by ANOVA,  $F[3,77] = 8.500, p < .001$ .

\*\*\*Significant difference among groups by ANOVA,  $F[3,54] = 9.606, p < .001$ .

groups with AN were significantly lower than those of the other groups.

Although women with AN-B/P and BN were somewhat more likely to report the use of each of the product categories (Table 1), significant between-group differences in the proportions of participants reporting use were observed only for chewing gum and sweetener packets. Post-hoc analyses revealed that the difference in use of sweetener packets was attributable to participants with AN-B/P, who were more likely to report use than the other subject groups. The difference in gum use appears attributable to lower use among the AN-R group. The proportion of women endorsing use of diet beverages did not differ significantly among groups.

A second analysis examined the quantity of use among participants reporting any use of a product in the last month. This analysis revealed significant between-group differences in the average quantity of each product used (Table 2), including chewing gum, servings of diet beverages, and sweetener packets. A post-hoc Sheffe test revealed that (a) for both chewing gum and diet beverages,

women with AN-B/P and BN reported greater use than controls, (b) for sweetener packets, both AN groups reported greater use than controls, and (c) use among women with AN-R was greater than that among women with BN as well (Table 2).

Within the combined group of women with AN-B/P and BN, there was an inverse relation between weight (BMI) and the quantity of use of each of the product categories ( $r = -.319, n = 55, p = .010$ , for pieces of gum;  $r = -.334, n = 48, p = .020$ , for servings of diet beverages; and  $r = -.358, n = 39, p = .025$ , for packets of artificial sweetener). No such relation was observed among control participants or participants with AN-R.

## Conclusion

The current report is, to our knowledge, the first attempt to quantify the use of artificially sweet-

ened, low-calorie products by women with AN and BN. There were some suggestions that the proportion of women endorsing use of such products differed among the disorders, with women with AN-B/P and BN more likely to endorse their consumption as compared with women with AN-R and controls. However, much more striking were the quantities of substances used by participants who reported using these products. The two groups characterized by the presence of purging behavior, AN-B/P and BN, reported the use of greater quantities of gum and diet beverages, and the AN-R group reported greater use of artificial sweetener packets. Furthermore, among women who purged, BMI was inversely correlated with the use of each product surveyed. Anecdotal descriptions of use were often striking. For example, one patient described adding dozens of artificial sweetener packets to popped corn, and another reported the construction of "Equal® sandwiches." Other patients described consuming the sweetener directly from the packet, using 100 or more packets daily. Thus, both quantitatively and qualitatively, the use of artificially sweetened products appears to be abnormal in a significant proportion of women with eating disorders.

We speculate that the excessive use of these products by individuals with AN and BN is a manifestation of the dietary restraint characteristic of these disorders, and a reflection, in part, of appetitive drive. Individuals with AN are, by definition, seriously underweight, and individuals with BN typically restrict calorie intake between episodes of binge eating. Dietary restriction stimulates appetite, which, coupled with the strong motivation to resist food intake, may lead individuals to choose foods that provide maximal orosensory stimulation with minimal calories. The term *anorexia* suggests that patients with AN lack hunger, although many are indeed preoccupied with food. We suggest that these data are objective evidence of an appetitive drive in the eating-disordered populations examined.

The association between semistarvation and a heightened drive for orosensory stimulation has been described in other populations. In the Minnesota Experiment conducted during World War II, 36 men voluntarily participated in a study of the effects of starvation. These previously healthy men developed several unusual food-related behaviors, and some were reported to chew 40 or more packets of chewing gum per day.<sup>10</sup> A heightened drive for orosensory stimulation is also suggested by the behavior of laboratory animals that are food deprived, as demonstrated in the sham-feeding

paradigm.<sup>11</sup> In this paradigm, rats' stomachs are cannulated so that ingested food drains from the stomach when the cannula is opened. Despite the fact that this "sham" feeding provides no nutritive benefit, these animals sham consume sucrose solutions for hours after a period of caloric deprivation. Furthermore, the rate of consumption is proportionate to the concentration of sucrose in the solution. These phenomena suggest that oral ingestive behavior per se is inherently reinforcing and, furthermore, that food deprivation potentiates its reinforcing effects. The consummatory behavior described in the current report, as well as the practice of chewing and spitting out food also reported among persons with eating disorders,<sup>12</sup> resembles sham feeding, in that oral stimulation is sought independent of any nutritive benefit. That sweet orosensory stimuli in particular are sought is consistent with findings from some investigations of increased hedonic preferences for sweet tastes in women with AN and BN,<sup>13,14</sup> which itself may hold psychobiologic significance.<sup>15</sup>

Also notable in regard to the above findings is the distinct pattern of product use across subject groups. The greater use of diet beverages among women who purge is consistent with a higher tolerance for gastric distension, and the use of fluids to facilitate vomiting. Diet beverages may also contain caffeine, which appears to have a higher rate of abuse among women who binge and purge.<sup>16,17</sup> However, for both of the above, it is unclear why sweetened beverages would necessarily be used. The lower overall use of artificially sweetened products among women with AN-R as compared with AN-B/P may reflect a higher degree of dietary restraint among the former. It is also conceivable that the greater use of these products among persons who binge and purge reflects some ability of artificial sweeteners to actually stimulate overeating, possibly through enhancing appetite and/or disrupting learned associations between sweet taste and caloric density of food. Binge eating and purging behavior typically develop among patients with AN-R after several years.<sup>18</sup> Mediators of this transition are not fully understood. Given the potential, at least in theory, for sweetened products to stimulate appetite and affect subsequent eating behavior,<sup>5,6,19</sup> it is possible that overuse of artificially sweetened products could contribute to this transition. Such overuse might also simply serve as a marker for this progression. Longitudinal investigation would be needed to address these possibilities.

The clinical effect of the excessive use of these products is unclear. We did not systematically

review ill effects with our participants, and none were spontaneously reported. Theoretical effects of abuse of diet beverages include further impairment of bone density with use of carbonated beverages, as carbonation is associated with reduced bone density<sup>20</sup>; caffeinism, with abuse of caffeinated beverages; and oral discomfort, including temporomandibular joint problems<sup>21</sup> and/or gastrointestinal effects (i.e., bloating, abdominal pain, diarrhea)<sup>1</sup> from prolonged gum chewing. Behavioral effects could conceivably include appetite dysregulation or worsening of the eating disorder. The psychological effects of repeated consumption of a highly reinforcing stimulus as sweet taste represents, are similarly unclear.

The current study has a number of limitations, including the nature of assessment, which was retrospective and self-report, and the modest number of participants, which limited our ability to compare among eating disorder subgroups. In addition, our reliance on two different forms of data collection (i.e., written as well as telephone interview) could have introduced further bias. It would be of interest to examine measures of dietary restraint and consumption of sugar-sweetened products, and to determine the proportion of caffeinated versus caffeine-free diet beverages consumed. It would also be of interest to assess the use of low-calorie sweetened products among individuals with eating disorders residing in countries in which these products are less readily available than in the United States and the United Kingdom, to better understand the relative contributions of culture and biology to this behavior. To better understand the clinical course and implications of these behaviors for women with eating disorders, longitudinal studies are needed. Furthermore, the adverse effects of the use of these products were not assessed, nor were their desired effects assessed, but each would be a reasonable area of inquiry. Finally, further investigation is warranted, ideally in a laboratory setting, to determine the extent to which patient preference was based on the taste of the food or patient beliefs about its dietary utility (i.e., in fostering weight loss and/or preventing weight gain).

Despite these limitations, the data presented indicate that the consumption of artificial sweeteners among individuals with eating disorders, especially AN, may be clinically striking, and may be in part a manifestation of appetitive drive induced by semistarvation.

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