

Caffeine, Artificial Sweetener, and Fluid Intake in Anorexia Nervosa

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ABSTRACT

Objective: This article provides an analysis of the use of artificial sweeteners, caffeine, and excess fluids in patients diagnosed with anorexia nervosa (AN).

Method: Seventy participants with AN were recruited to participate in an ecologic momentary assessment study which included nutritional analysis using the Nutrition Data Systems for Research, a computer based dietary recall system.

Results: When subtypes were compared, participants with AN-restricting subtype (AN-R) and participants with AN-Binge-Purge (AN-B/P) did not differ in quantity of aspartame, caffeine, or water

consumed. Daily water consumption was related to daily vomiting frequency in AN-B/P but not to daily exercise frequency in either participants with AN-R or AN-B/P.

Discussion: Caffeine, water, and aspartame consumption can be variable in patients with AN and the consumption of these substances seems to be only modestly related to purging behavior. © 2009 by Wiley Periodicals, Inc.

Keywords: anorexia nervosa; eating disorder; caffeine; fluid; artificial sweeteners

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Introduction

Previous empirical and case studies have documented patterns of excessive consumption of caffeine, artificial sweeteners, and fluids in individuals with eating disorders. Specifically, individuals with eating disorders seem to have a tendency to consume high amounts caffeine through soft drinks, energy drinks, coffee, and/or caffeine pills as a means to increase energy levels and suppress appetite.¹ Excessive fluid intake often takes the form of

carbonated beverages, coffee, and water. Similarly, artificial sweeteners in the form of sugar-free candies or chewing gum, foods, and drinks have been reported to be used to suppress appetite in this population.^{2,3} Understanding the relationship between fluid intake, caffeine use, and artificial sweetener use is challenging because these substances are often found in combination in the same products. For example, beverages such as diet soda, diet energy drinks, coffee, and tea often contain caffeine and artificial sweeteners.

The medical repercussions of the misuse of these substances can be significant. Caffeine overuse can lead to anxiety and tremor and discontinuation can result in withdrawal symptoms including headache and concentration difficulties.⁴ Excessive use of sweeteners, such as sorbitol or malitol, can lead to gastrointestinal symptoms such as pain, bloating, and loose stools, whereas excessive fluid consumption can result in electrolyte imbalances and seizures. In combination with these medical problems, compensatory behaviors (e.g., vomiting, restriction, laxative abuse) may result in additional adverse medical sequelae, including hypokalemia, hypochloremia, hyponatremia, and edema.^{5–8} In addition, patients with anorexia nervosa (AN) have impaired osmoregulation and difficulty concentrating urine when dehydrated.⁹ The relationship between this complication and excess fluid consumption is not well understood.

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Overuse of caffeine has been reported by several investigators. Research has suggested that caffeine use may vary over the course of an eating disorder. In comparing AN and control participants, Striegel-Moore et al.¹⁰ observed that caffeine intake increased sharply in individuals with AN after they were first diagnosed and decreased subsequently. More specifically, intake of fluids such as coffee, tea, and soda increased after AN onset, but intake of chocolate food (containing caffeine) decreased.

The research related to the overuse of caffeine has yielded mixed results when examining participants with AN-Binge-Purge (AN-B/P), AN-restricting subtype (AN-R), and bulimia nervosa (BN). Some research has suggested that participants with BN do not show increased caffeine consumption when compared with participants with AN, although it was unclear as to whether these AN participants were AN-R or AN-B/P subtype.¹¹ Others studies suggest that patients with BN, AN-B/P and EDNOS who binge eat and purge show increased caffeine consumption compared with participants with AN-R and other subgroups who do not purge.^{1,12} Additionally, Stock et al.¹³ observed that patients with AN-B/P, BN, and EDNOS with purging behavior overused caffeine (i.e., consumed three or more caffeinated drinks per day), compared with patients with AN-R. Although the exact cause of increase caffeine consumption is unknown, consuming excessive amounts of caffeine containing fluids may serve as a weight control method to mask hunger, to aid in purging behavior, or increase energy levels.¹ Alternatively, consumption may be higher in those with AN-B/P or BN because of the overall greater amount of food and beverage intake in those individuals due to binge eating behavior.

Very few investigations have examined fluid intake in patients with eating disorder. Research suggests that patients with eating disorder may consume excessive amounts of fluids and that this might be used as an aid in vomiting.^{1,5} Water loading can also be a way to “make weight” for a clinical visit. However, Lowinger et al.¹⁴ presented descriptions of several cases studies of participants with AN-R who severely limited fluid consumption, purportedly to avoid the feelings of fullness, or the perceived calories in beverages, including water.

The use of artificial sweeteners such as saccharin and aspartame has also received limited attention. Ohlrich et al.² offered case reports of sorbitol abuse through chewing gum. The authors suggested that sorbitol-based gum was used as a purging technique, a way to control binge-eating episodes, or as a means to limit hunger.² Most of these patients

experienced gastrointestinal symptoms (e.g., bloating, cramping, loose stools, and distention). The use of artificial sweetener packets has been reported to be less common in individuals with AN-R compared with individuals with AN-B/P, whereas those with AN-B/P have been shown to consume significantly more artificial sweetener than controls.³

The purpose of this study was to examine the intake of caffeine, water, and artificial sweeteners throughout the day in a group of participants with AN. It was hypothesized that participants with AN-B/P would consume higher levels of caffeine, water, and sweeteners compared with those individuals with AN-R. Additionally, it was hypothesized that there would be an increase in consumption of caffeine throughout the day in both the AN-B/P and AN-R subgroups. We also anticipated that fluids would be used as an aid to purging behavior. Therefore, a relationship would exist between daily caffeine consumption and exercise frequency if caffeine was used as an energy supplement, and between daily water consumption and purging behavior.

Method

Participants ($N = 70$) were recruited from three sites in the Midwestern region of the United States. The sample included 43 AN-R and 27 AN-B/P participants. Participants were diagnosed using the SCID-I patient version.¹⁵ Participants recalled their consumption in person or over the phone on two or three separate days using the Nutrition Data Systems for Research (NDS-R), a system created at the Nutrition Coordinating Center in the Division of Epidemiology and School of Public Health at the University of Minnesota. Participants were interviewed in the evening and data from the prior 24 h were entered into the NDS-R by trained raters. The NDS-R system provides a nutrient and caloric breakdown of each food item consumed and has been shown to be a useful assessment tool.^{16,17}

Purging behaviors were assessed using ecologic momentary assessment (EMA) with palm top computers.¹⁸ Participants entered their exercise, vomiting, and laxative use episodes into the palm top computers over a 2-week period when the instrument signaled them to do so. The instrument signaled participants at six semirandom times throughout the day. Participants were also instructed to record these behaviors if they occurred at a time other than when the participant was signaled. The EMA protocol coincided with the days the NDS-R was

TABLE 1. Demographic information

	Frequency (Percent)
Marital status	
Married	8 (11.4%)
Single	57 (81.4%)
Separated	1 (1.4%)
Divorced	2 (2.9%)
Cohabiting	2 (2.9%)
Education	
Some high school	2 (2.9%)
Completed high school	2 (2.9%)
Some college	39 (55.7%)
Completed associate's degree	2 (2.9%)
Completed bachelor's degree	11 (15.7%)
Some graduate school	7 (10.0%)
Completed graduate school	4 (5.7%)
Other	3 (4.3%)
Ethnicity	
Caucasian	68 (97.1%)
African American	1 (1.4%)
Other	1 (1.4%)

administered, allowing a temporal alignment of consumption and purging patterns for each participant. This research was reviewed and approved by an institutional review board.

Results

The mean BMI of the sample was 17.3 (SD = 0.9) and the mean age was 24.8 (SD = 7.8). The BMI for the AN-R group ($M = 17.4$, SD = 1.47) and AN-B/P group ($M = 17.1$, SD = 1.7) did not differ significantly ($p = .337$). The mean age of the AN-R ($M = 23.8$, SD = 7.2) and AN-B/P ($M = 26.6$, SD = 8.5) groups did not differ significantly ($p = .147$). Additional demographic information is provided in **Table 1**.

Participants' entries in the NDS-R database included 785 eating episodes in the AN-R group and 431 eating episodes in the AN-B/P group. Water, caffeine, and aspartame consumption did not differ significantly between groups although the AN-B/P group consumed numerically more of each type of substance compared than the AN-R group. The results are shown in **Table 2**. A mixed-effect of linear model was used with water, caffeine, and aspartame each serving as a dependent variable in three analyses. Diagnosis and the hour of the meal served as the independent variables. Results of the consumption patterns are found in **Table 3**.

Water consumption did not significantly differ across diagnoses; however, water intake increased significantly across time of day. Most importantly,

TABLE 2. Mean intake of substances

	AN-R			AN-B/P		
	Mean	SD	Range	Mean	SD	Range
Water	392.8	349.6	0–2964.1	581.1	786.1	0–5085.0
Aspartame	26.8	70.6	0–558.3	73.0	175.1	0–1480.0
Caffeine	27.4	76.4	0–999.2	48.7	124.8	0–1515.5

Water was measured in grams. Aspartame and caffeine were measured in milligrams.

TABLE 3. Water, aspartame, and caffeine consumption across time of day and diagnosis

	<i>F</i>	<i>p</i>	Estimate (SE)
Water			
Diagnosis	0.230	.631	44.36 (92.46)
Meal hour	15.94	.000	20.12 (4.87)
Diagnosis X meal	7.11	.008	–16.03 (6.01)
Aspartame			
Diagnosis	0.346	.556	–11.89 (20.21)
Meal hour	2.61	.107	2.25 (1.06)
Diagnosis X meal	3.26	.071	–2.37 (1.31)
Caffeine			
Diagnosis	0.095	.758	–5.03 (16.32)
Meal hour	13.59	.000	–1.37 (.859)
Diagnosis X meal	1.20	.273	–1.16 (1.06)

the two subtypes differed in their hourly pattern of fluid consumption. AN-R participants' consumption stayed somewhat consistent across time and AN-B/P participants' intake increased (see **Fig. 1**). No significant difference emerged in the aspartame consumption across diagnoses or time of day (see **Fig. 2**). Caffeine use, similarly, did not differ across diagnoses but decreased in both groups as the day progressed (see **Fig. 3**).

Additional multilinear modeling was used to assess the relationship between the frequency of vomiting episodes per day and the quantity of water consumed per day in participants with AN-B/P. Results suggested that daily vomiting episodes were associated with greater water consumption. Neither caffeine nor water intake was related to the number of exercise episodes of participants with AN-R and AN-B/P. The results are found in **Table 4**.

Discussion

Prior literature has suggested that individuals with eating disorders may use excessive amounts of water, caffeine, and/or sweeteners. The purpose of this study was to examine daily differences in consumption of these substances among participants with AN-R and AN-B/P. Using NDS-R to assess the

FIGURE 1. Water consumption patterns.

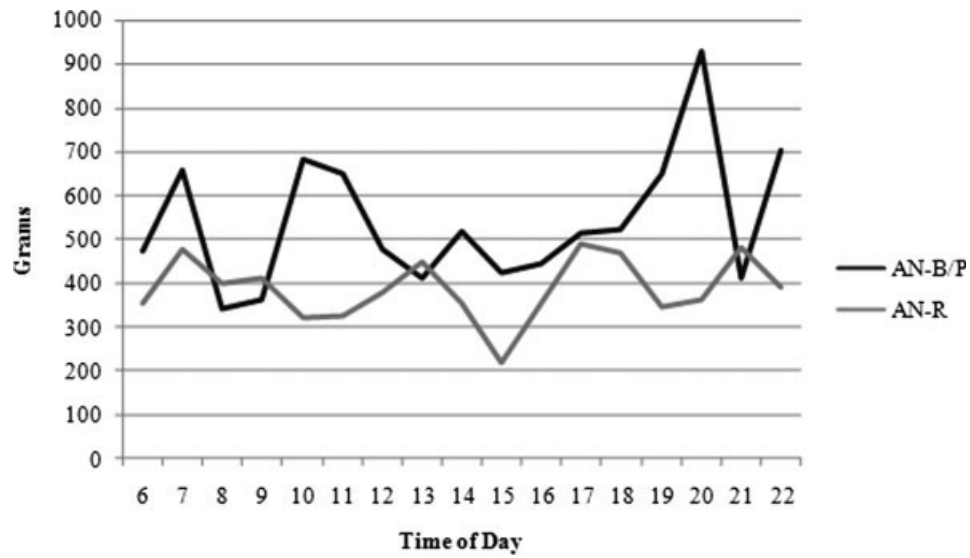


FIGURE 2. Aspartame consumption patterns.

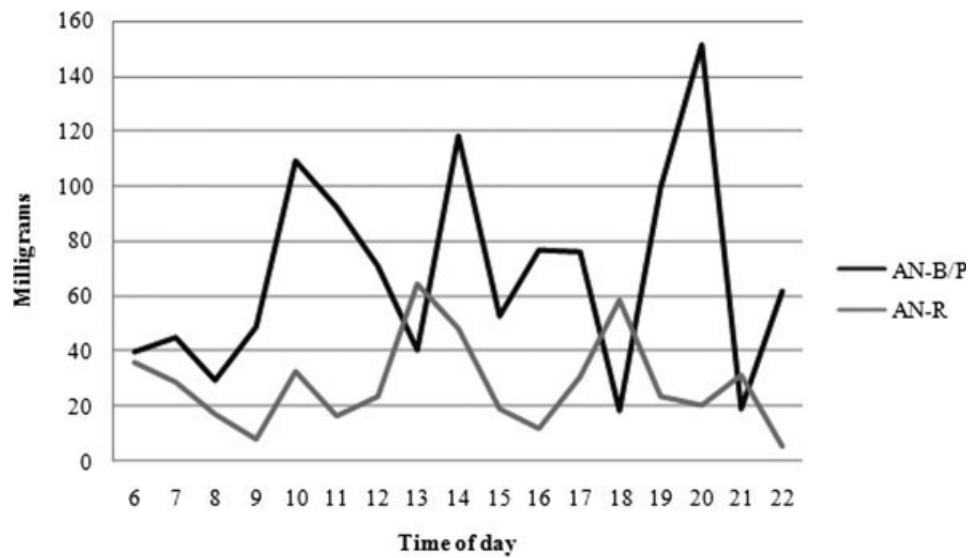


FIGURE 3. Caffeine consumption patterns.

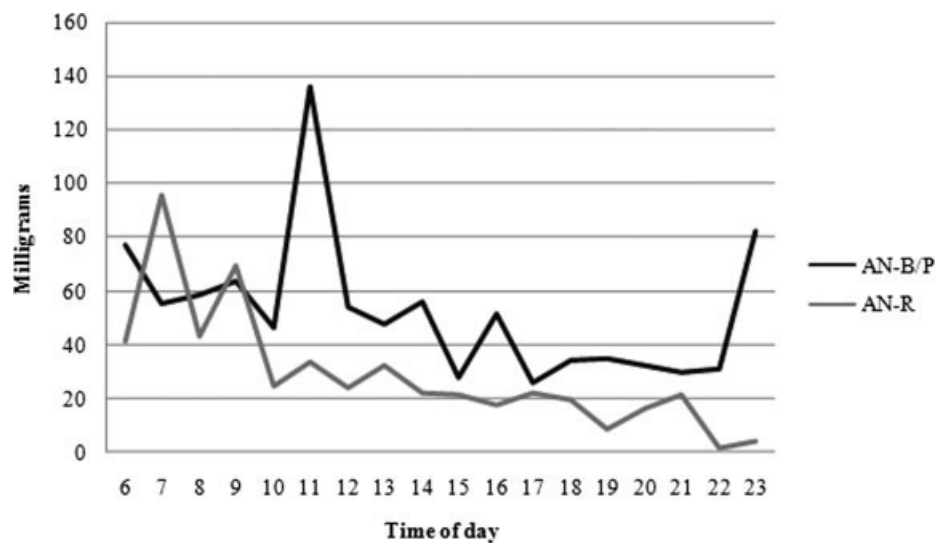


TABLE 4. Daily fluid consumption and purging behavior in AN-B/P and AN-R

	<i>F</i>	<i>p</i>	Estimate (SE)
Water X vomit frequency			
AN-B/P	8.75	.004	711.25 (240.46)
Water X exercise frequency			
AN-R and AN-B/P	0.327	.568	−87.11 (152.32)
AN-R	0.416	.520	−104.70 (162.27)
AN-B/P	0.107	.745	98.21 (300.71)
Caffeine X exercise frequency			
AN-R and AN-B/P	3.44	.065	−42.14 (22.73)
AN-R	1.67	.199	−28.27 (21.89)
AN-B/P	2.24	.139	−74.25 (49.65)

quantity of the substance consumed throughout the day and EMA to assess purging behavior, the results of the investigation were only partially consistent with our hypotheses. Specifically, consumption of caffeine, sweeteners, and fluids seemed to be greater in the AN-B/P group, compared with AN-R group, but the differences were not statistically significant. Contrary to our hypothesis, caffeine use decreased throughout the day in both groups. Similarly, caffeine consumption was not related to exercise in either of the AN subgroups. The findings suggest that daily water consumption is related to increased number of vomiting episodes, but not to compensation for daily exercise episodes.

Hart et al.¹ note, “There are currently no published descriptions of fluid consumption patterns (type and amount) in patients with AN, BN, or eating disorders not otherwise specified (EDNOS)” (p. 55) before their study. Our description of consumption patterns are similar to those of Hart et al.¹ who found no difference between fluid intake in eating disorder patients with and without purging behavior. Also consistent with Hart et al.,¹ the range of fluid consumption found in this research was quite diverse both between and within AN subtypes. This variability suggests that some patients seem to limit intake, whereas others overconsume fluids. Indeed, fluid restriction and fluid overconsumption have both been documented in the literature.^{5,14,19}

The results of this study are not consistent with previous research that suggests participants with ED (AN, BN, and EDNOS) who binge eat and purge tend to consume more caffeine.^{1,12} However, caffeine use decreased throughout the day in both AN-R and AN-B/P groups. This suggests that caffeine may not be used to increase energy throughout the day.

To the authors’ knowledge, only one other study has examined artificial sweetener use in partici-

pants with ED and our results are similar to that study.³ In terms of sweetener consumption, the consumption of aspartame varied among AN-R and AN-B/P groups. Participants with AN-B/P consumed more sweeteners than participants with AN-R. Aspartame consumption did not change significantly throughout the day. Klein et al.³ suggested that the drive for use of sweetener is likely related to “an appetitive drive in the eating-disordered populations” or “orosensory stimulation” (p. 344).

There are several limitations to this study. First, participant recall was used to enter data into the NDS-R system for nutritional analysis. The NDS-R system relies on accurate reporting of the patient’s consumption. Accurate report of consumption is especially challenging in a population that may be overly concerned about consumption patterns. In addition, our data analysis did not include a comparison of specific foods or drinks that contained sweeteners, fluids, and caffeine. Directly comparing the specific food products consumed, as opposed to only the nutritional breakdown of the foods, may provide additional information about the reasons for consumption. For example, chocolate that contains caffeine may have been ingested for the taste, and not necessarily for the stimulant effects. Moreover, an assessment of hunger and fullness rating when patients were signaled using their palm top computer would have been advantageous in examining the relationship between consumption of each substance and purging episodes. Finally, our study did not include aged-matched, healthy control participants which would have provided additional information about the severity of aberrant consumption patterns in the participants with AN.

Very little research has examined consumption of water, caffeine, and sweeteners among individuals with eating disorders and the inconsistency in the research findings thus far warrants addition investigation. It remains unclear as to the reasons for excessive consumption of these substances in patients with eating disorder and closer analysis of patients’ rationale or motivation to overconsume these nutritional components is needed.

Our findings suggest that overconsumption of caffeine may not be for the purpose of increasing energy as was hypothesized by previous authors. Water consumption seemed to be related to some purging behaviors (i.e., vomit episodes), but not exercise episodes. The medical complications that can occur from overuse of the aforementioned substances speak to the clinical relevance of querying patients as to their overuse of caffeine, sweeteners, and water. Providing patient with education related

to the medical sequelae secondary to the overuse of these substances is also indicated.

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