The Efficacy of Increased Water Consumption as a Weight Loss Strategy

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Keywords: weight loss, water, obesity, energy intake, older adults
The population of older adults continues to grow in the US, as does the prevalence of overweight and obesity within this group. Several factors may contribute to age-related weight gain, such as a reduced energy expenditure and energy intake requirements, and a susceptibility to energy over-consumption. Serious consequences result from overweight and obesity, such as increased risk of chronic disease, decreased quality of life and increased healthcare costs. Thus, effective weight management strategies are needed which target this population. Reducing energy-containing beverage intake and increasing water intake are often suggested as strategies for weight loss, yet surprisingly little data exists to support the effectiveness of these strategies. Previous studies have shown that older adults consume fewer calories at laboratory test meal following a water preload, but it is unknown whether this reduced energy intake can be sustained over time to produce weight loss. Epidemiological studies using self-reported dietary intake have shown that substituting water for energy-containing beverages decreases total energy intake, and that drinking > 1L of water is associated with greater weight loss in overweight women compared to overweight women who consumed < 1L daily. However, these studies were a secondary analysis of a trial comparing multiple weight loss strategies and increasing water consumption was not a primary outcome of interest. To directly address this issue, we hypothesized that increased water consumption would increase weight loss in healthy overweight and obese older adults in combination with a 12-week hypocaloric diet as compared to a hypocaloric diet alone. As hypothesized,
older adults randomized to the increased water intake group demonstrated greater weight loss than those randomized to the diet alone group (7.4 kg vs. 5.5 kg, respectively). Because energy-containing beverages contribute to total energy intake without a concomitant reduction in food intake, substituting water or energy-free beverages for energy-containing beverages appears to be an effective weight management strategy for older adults.
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CHAPTER 1

Introduction

The population of older adults continues to grow in the US, as well as the rate of obesity within this group. Adults over the age of 60 years are more likely to be obese than younger adults, and greater than 30% of older adults are obese \(^1\). There are a few possibilities which may explain the increased risk of obesity within this population. Older adults have a lower total energy expenditure, and a lower physical activity level than younger adults \(^2,3\). Yet, energy intake does not appear to change with advancing age \(^4\). In addition, older adults do not reduce their energy intake at a meal to compensate for an energy-containing preload, which suggests inaccurate energy intake regulation in this population \(^5,6\). Energy intake dysregulation could contribute to the weight gain commonly observed with advancing age, and provide insight towards developing effective intervention strategies.

While research may suggest obesity-related mortality rates decline in the older age ranges, active life expectancy (i.e., the amount or percent of remaining life a person can expect to live without disability) diminishes in obese older adults. Nonobese men and women can expect to live more active years, and fewer disabled years, than obese men and women \(^7\). A higher body mass index (BMI) among older adults has been associated with decreased physical functioning and vitality, which could negatively impact quality of life and the ability to perform basic personal care \(^8\). In addition, disability further decreases one’s quality of life and places more burden on family members \(^7\). For these reasons, effective intervention strategies to prevent and treat obesity among older adults are needed.
Water consumption is often recommended as a weight loss strategy, yet little data is available to support this claim. In theory, water can be consumed throughout the day in place of energy-containing beverages, which may reduce total energy intake and lead to weight loss. According to National Health and Nutrition Examination Survey (NHANES) data, males and females over the age of 60 consume 14.5 and 12.5% (298 and 189 kcals) of their total daily energy from beverages, respectively.9 Because energy from liquid beverages appears to be less satisfying than consumption of solid foods10,11, consumption of energy-containing beverages may increase energy intake, and lead to weight gain.12 Individuals who consume water on a daily basis may have healthier dietary patterns and consume more fruits, vegetables and low-fat dairy foods, which is associated with a lower habitual energy intake relative to non-water consumers.13 However, there is limited research focusing on the role of beverage consumption patterns on management among older adults. To address this issue, we conducted a literature review to investigate what is known regarding the consumption of energy-containing and energy-free beverages and weight management in adults.14

Previous research has demonstrated that pre-meal water consumption acutely reduces meal energy intake in older nonobese adults,15,16 however, no randomized controlled intervention trials have investigated increased water consumption as a weight loss strategy for older adults. Therefore, the primary aim of this research was to determine the effectiveness of increased water consumption as a weight loss strategy among older overweight and obese adults consuming a hypocaloric diet for 12 weeks, as compared to a hypocaloric diet alone. A secondary aim was to determine whether the acute reduction in meal energy intake induced by premeal water consumption is sustained.
over a 12-week intervention period among those who increase their daily water consumption. We hypothesized that pre-meal water consumption would facilitate weight loss, and that the effect would be sustained over the intervention period.

This research provides novel findings regarding beverage consumption patterns and weight management within the older adult population. Water is widely available at little or no cost, and given the high prevalence of obesity, these findings provide insight on a practical strategy to reduce body weight.

References


**Abstract References**


CHAPTER 2

Beverage Consumption and Adult Weight Management: A Review

Abstract

Total energy consumption among United States adults has increased in recent decades, and energy-containing beverages are a significant contributor to this increase. Because beverages are less satiating than solid foods, consumption of energy-containing beverages may increase energy intake and lead to weight gain; trends in food and beverage consumption coinciding with increases in overweight and obesity support this possibility. The purpose of this review is to present what is known about the effect of beverage consumption on short-term (i.e., meal) energy intake, as well as longer-term effects on body weight. Specific beverages addressed include water, other energy-free beverages (diet soft drinks, coffee and tea), and energy-containing beverages (soft drinks, juices and juice drinks, milk and soy beverages, alcohol). Existing evidence, albeit limited, suggests that encouraging water consumption, and substituting water and other energy-free beverages (diet soft drinks, coffee and tea) for energy-containing beverages may facilitate weight management. Energy-containing beverages acutely increase energy intake, however long-term effects on body weight are uncertain. While there may be health benefits for some beverage categories, additional energy provided by beverages should be compensated for by reduced consumption of other foods in the diet.

Key Words: adult weight management, beverage, water, soft drinks, obesity, energy intake
Introduction

Caloric intake has increased over the past 20 years, with the majority of the increase derived from snacks foods \(^1\) and beverages \(^2\). Beverage consumption patterns in children and adolescents are an important target for promoting body weight management \(^3\)-\(^5\), yet until recently, less attention has been directed at beverage consumption and adult weight management. The potential negative public health consequences of sweetened beverage consumption have led some to suggest a sugar-sweetened beverage tax \(^6\), which is controversial due in part to a lack of direct evidence linking changes in sweetened beverage intake to weight outcomes \(^7\). Thus, the purpose of this article is to review literature addressing beverage consumption and adult weight management.

Though beverages of all types satisfy thirst \(^8\), caloric (i.e., energy-containing) beverages do not effect food intake during acute meal settings \(^8\)-\(^15\). However, when compared to water or energy-free, artificially-sweetened beverages, consumption of energy-containing beverages increases total meal energy intake \(^8\),\(^10\). The low satiety value of beverages may be explained by the fact that for most of human evolutionary history, water was the only beverage consumed \(^16\); therefore, regulation of beverage energy was not of biological importance. Though the exact mechanism of this weak satiety response is unclear, there are several possibilities. First, relative to solid foods, beverages take less time to consume and are rapidly emptied from the stomach \(^17\). This is supported by research demonstrating that consumption of an isocaloric liquid compared with solid food given prior to an ad libitum meal increases food intake \(^18\). Second, food form (i.e. solid vs. liquid) influences appetite-related hormonal response \(^19\). Finally, energy-containing beverages are largely comprised of carbohydrates, which stimulate fewer satiety signals than fat or protein \(^16\).
Because energy from beverages is less satiating than consumption of solid foods\textsuperscript{18, 20-22}, consumption of energy-containing beverages may produce weight gain\textsuperscript{4}. Trends in beverage consumption coinciding with increases in overweight and obesity support this possibility, as energy intake from sweetened beverages (i.e., soft drinks and fruit drinks) has increased by 222 kcal in recent decades\textsuperscript{2}. Adults with a high energy-containing beverage intake consume less healthy diets\textsuperscript{23, 24}, while water consumers ingest less total energy\textsuperscript{23, 24}. Soft drinks are the single greatest energy source (i.e., 7\% total energy) in the American diet\textsuperscript{25}; average daily consumption of soft drinks is > 12.3 fl oz per person\textsuperscript{16}. Therefore, beverage consumption patterns may be an important dietary factor influencing adult weight management.

This review was conducted using a PubMed (National Library of Medicine) online literature search to identify publications (within 15 years) investigating beverage consumption and either food/energy intake or body weight management. Earlier publications were included if they were a key reference for recent work. Articles were limited to those published in English, and in adults. Findings were categorized according to beverage type as follows: water, other energy-free beverages (artificially sweetened beverages, coffee and tea), and energy-containing beverages (soft drinks, juice and juice drinks, milk and soy beverages, alcohol). Details of studies reviewed are presented in Table 1 in alphabetical order by first author’s name within each subsection. Research findings are summarized within the text in the following order: epidemiological research, test meal/short-term feeding studies, and randomized controlled trials (if available). Relevant meta-analyses and reviews are also presented.

Water

There is a common belief that water ingestion facilitates weight management. Epidemiological data indicate that energy intake among water drinkers is \textasciitilde 9\% (194 kcal/d) lower
than non-water drinkers\textsuperscript{23}, yet few studies have directly addressed the effect of increased water consumption on weight management. Water consumed before or with a meal reduces sensations of hunger and increases satiety among nonobese adults\textsuperscript{26,27}. However, young, normal weight men consume the same amount of energy at an ad libitum meal when given water (8 and 16 fl. oz) as compared to no beverage 30 minutes prior to the meal\textsuperscript{14}. Pre-meal water consumption reduces meal energy intake in nonobese older adults\textsuperscript{27}, and also among middle-aged and older overweight/obese adults\textsuperscript{28}. Thus, it appears ingesting water (~16 fl oz) prior to a meal reduces meal energy intake among middle-aged and older adults by ~75-90 kcals, but may not impact meal energy intake among younger population segments\textsuperscript{27,28}.

Longer term studies have investigated changes in self-reported beverage intake to energy intake and weight during a weight loss intervention (see Table 1)\textsuperscript{29}. Over 12 months, drinking $\geq$1 L water ($>$33.8 fl oz) per day increased weight loss by ~2 kg as compared to drinking less water\textsuperscript{30}. However, these investigations relied on self-reported data and to date, no clinical intervention studies have assessed the influence of increased water consumption on weight loss in adults; the aforementioned intervention compared popular weight loss diets and water/beverage consumption was not the primary focus. Preliminary data suggests increasing daily water intake may facilitate long term weight loss among middle-aged and older adults\textsuperscript{31}, a trend (p=0.09) was detected for greater weight loss after 6 months among individuals (n=20) following a hypocaloric diet along with three 500-ml bottled water per day (16.9 fl oz) as compared to those in a diet-only control condition. Additional long term studies with larger sample sizes are needed to confirm this possibility.

There may be other benefits of water consumption for weight management, such as increasing metabolic rate\textsuperscript{32,33}. Additional research is needed to confirm these findings, as well
as to address issues of optimal volume and timing of water ingestion for managing hunger and reducing meal energy intake.

The Beverage Guidance Panel provided an overview of the nutritional benefits and risks of different beverage categories, and provided recommendations for beverage intake in relation to weight status and health\textsuperscript{34}. These recommendations were controversial, in that not all were supported by scientific data\textsuperscript{35,36}. Though there is not a Recommended Daily Allowance (RDA) for total water intake due to insufficient evidence and individual variability, the Institute of Medicine’s Food and Nutrition Board suggested a Daily Recommended Intake (DRI) for adult males and nonpregnant, nonlactating females over 19 years of 3.7 L/day and 2.7 L/day, respectively. However, this includes total water from all beverages such as coffee, tea, juices, soda and water, as well as moisture from foods\textsuperscript{37}. An Adequate Intake (AI) of 3.0 L/day for men and 2.2 L/day for women (~104 fl oz and 72 fl oz) of total beverages, including water, was also recommended. These guidelines recommend that individuals be attentive to thirst cues and consume beverages with meals to maintain adequate hydration status, but do not make specific recommendations pertaining to beverage consumption and weight management. Thus, epidemiological and acute meal studies suggests a beneficial role for water consumption in reducing energy intake and promoting weight management, yet there is insufficient data from intervention studies to make conclusive evidence-based intake recommendations for water consumption.

\textbf{Other Energy-Free Beverages}

\textit{Energy-free, Artificially Sweetened Beverages.}

Approximately one fifth of US adults consume energy-free, artificially sweetened beverages, such as diet soft drinks and other artificially sweetened beverages\textsuperscript{24}. These
beverages provide a source of water and sweetness in the diet without additional energy.\textsuperscript{34}

Concern about a negative effect of diet soft drink consumption on energy intake arose from animal studies reporting an increased food intake and weight gain following prolonged exposure to saccharin-sweetened yogurt.\textsuperscript{38} This suggested that artificial sweeteners may “uncouple” a relationship between sweet taste and energy content, which may have prompted rodents to consume more food and gain weight.\textsuperscript{38} Yet, in humans there are conflicting data on artificial sweetener intake and weight status and most available data are correlational; few intervention studies have investigated the influence of energy-free artificially-sweetened beverages on energy intake regulation and body weight. Specifically, habitual intake of artificially sweetened beverages is associated with self-reported BMI, and high consumers of artificially sweetened beverages (>28 fl oz/d) were more likely to report body weight concerns such as restrained eating and body dissatisfaction.\textsuperscript{39} A dose-response relationship between artificially sweetened beverage consumption and BMI change over time has also been reported; odds of becoming overweight/obese for individuals consuming >22 artificially sweetened drinks per week was almost twice that of individuals consuming no artificially sweetened beverages.\textsuperscript{40} However, those consuming artificially sweetened beverages were more likely to be female, dieting, and overweight/obese at baseline.

In contrast, epidemiological investigations have reported that women who increased diet soft drink consumption gained less weight over a four-year period than women who decreased diet soft drink consumption.\textsuperscript{41} In addition, replacing energy-containing beverages with artificially sweetened beverages was associated with greater weight loss (~1.6 kg) over 12 months, which is slightly less than that reported with water.\textsuperscript{30}
In ad libitum meal studies, artificially sweetened beverage preloads (i.e. prior to the ingestion of a meal) do not appear to stimulate appetite or affect subsequent food intake\textsuperscript{9,12,42}, and short term intervention studies incorporating artificially sweetened beverages into the usual diet have demonstrated weight loss in both overweight\textsuperscript{43} and normal weight adults\textsuperscript{44}. Thus, although epidemiological data in this area are conflicting, existing experimental/intervention trials do not suggest that energy-free artificially sweetened beverages increase food intake or body weight. These beverages could be used as an alternative to water as a substitution for energy-containing beverages, particularly for interventions targeting weight management.

\textit{Coffee and Tea}

Coffee and tea in their unaltered form contribute fluid to the diet without contributing energy. Increased coffee and tea consumption is associated with less weight gain over time in men and women; this observation is not attributed to beverage caffeine content\textsuperscript{45}. Adults who routinely (i.e., \textgeq 1 time per week) consumed green, oolong or black tea for >10 years have lower body fat percentages and smaller waist circumferences than nonconsumers\textsuperscript{46}, and research has suggested that green tea in particular may play a role in weight loss and weight maintenance. Green tea contains catechins, particularly epigallocatechin gallate (EGCG), which in concentrated supplement form has been shown to increase fat oxidation\textsuperscript{47-49}, reduce body fat\textsuperscript{50}, and increase weight loss\textsuperscript{47}. However, several cups of tea must be consumed to achieve the benefits of the catechin levels found in concentrated forms. In contrast, daily energy intake among high consumers of popular energy-containing coffee and tea drinks (i.e. lattes, espressos, café mochas, cappuccinos) is 206 kcal higher than nonconsumers\textsuperscript{51}. Thus, while there may be some benefits to consuming coffee and tea in their energy-free form, consumption of energy-containing coffee and tea drinks may increase total energy intake.
Energy-containing Beverages

Soft Drinks

Regular (sweetened) soft drinks are the greatest contributor of energy in the American diet. A recent meta-analysis reported a clear association between soft drink consumption and increased energy intake, and previous reviews have concluded that a strong association exists between sweetened soft drink consumption and risk of overweight/obesity. However, others suggest that dietary behaviors (i.e., food choices, dietary restraint, energy intake, beverage type and usage) and economics (i.e., poverty, food and beverage costs) contribute to obesity more than sugar-sweetened beverages. Increased intake of soft drinks is associated with BMI, weight gain and the risk of type 2 diabetes, and risk factors for the metabolic syndrome.

Soft drink consumers (>4 servings/wk) have higher total energy intakes and engage in less physical activity than low soft drink consumers (<3 servings/wk). Longitudinal studies report that women who decrease their intake of soft drinks over a four-year period gain less weight than those who maintain or increase their soft drink intake. Intervention studies indicate that consuming soft drinks for 3 weeks increases usual energy intake and body weight, and although data are conflicting, some acute meal studies suggest an increase in total meal energy intake (i.e., beverage + meal) when sugar-sweetened soft drinks are consumed (see Table 1). Methodological differences may contribute to conflicting study outcomes in this area.

High fructose corn syrup (HFCS) is a primary ingredient in soft drinks, mainly because of its sweet taste, low cost and wide availability. Its potential role in the obesity epidemic has been suggested, but an expert panel assembled by The Center for Food, Nutrition, and Agricultural Policy conducted a review and concluded that HFCS consumption is not “uniquely” responsible for increasing rates of obesity. Individual sweeteners (i.e., sucrose, HFCS) appear
to have similar effects on intake-related hormones and energy intake. Although controversy remains, most research in this area suggests that energy-containing soft drink intake should be limited, regardless of sweetener type.

**Juice and Juice Drinks**

Fruit juices (100% juice) contain important nutrients, and are a contributor to total fruit intake. However, fruit juices contain little or no fiber, and because beverages are less satiating than solid foods, whole fruit is preferable for weight management. Increased consumption of fruit juice (juice or juice drinks) compared with decreased consumption over four years is associated with weight gain, as is fruit drink intake (i.e., fruit punch, sweetened fruit-flavored drinks). Due to their minimal nutritional value and energy content, juice drink intake should be minimized, and whole fruit should be encouraged rather than fruit juice due to its greater satiating ability.

**Milk and Soy Beverages**

Fluid milk is a major source of energy and calcium in the US diet. In recent years, a great deal of attention has focused upon the role of dietary calcium in weight loss. Interest in calcium arose from its role in the regulation of energy metabolism, specifically related to hormones influencing lipolysis and fatty acid synthesis. Studies have associated a higher milk intake with less weight gain over time, which suggests that milk consumption may be beneficial for weight management. Research has demonstrated that consumption of calcium-containing beverages promotes weight loss, however conflicting evidence also exists.

Milk is rich in nutrients, however high milk consumption could increase dietary fat, cholesterol, and energy intake, and contribute to weight gain. Satiety and fullness are greater after consumption of a skim milk beverage as compared to a sugar-sweetened beverage,
however meal energy intake with the two beverages is not different\textsuperscript{11,69}. Intervention studies\textsuperscript{67} have demonstrated that increasing skim or 1% milk consumption by three servings per day without other intentional dietary changes leads to weight gain among adults aged 55-85 yrs, although less than would be expected based upon the additional energy provided in the milk.

Most research in this area has focused on dairy products; however, soy milk may be comparable to skim milk at facilitating weight loss (see Table 1). Individuals on a hypocaloric diet supplemented either with soy or skim milk lost equal amounts of weight and had similar nutrient intakes\textsuperscript{66}. Thus, consumption of either dairy or soy milk may be beneficial as part of a hypocaloric diet. Due to their energy and fat content, low-fat or non-fat options may be recommended, and appropriate reductions in other sources of energy should be encouraged to compensate for the energy content of the dairy or soy beverages.

\textit{Alcohol}

Beer is among the top ten sources of energy in the US diet\textsuperscript{25}. Although possibly controversial, the Beverage Guidance Panel\textsuperscript{34} categorized alcohol as an energy-containing beverage with some nutrients. Alcohol drinkers experience health benefits not seen in abstainers including smaller waist circumference\textsuperscript{70} and a lower prevalence of metabolic syndrome\textsuperscript{71,72}. Others have associated a high alcohol intake (>81 g/wk) with abdominal obesity; however, after accounting for alcoholic beverage type (beer, wine, liquor), only liquor consumption was associated with abdominal obesity\textsuperscript{73}. Similarly, a linear relationship between intake of spirits and BMI has been reported (see Table 1)\textsuperscript{74}. Associations have also been found between a heavy alcohol intake (>30 g/day; a glass of wine represented \~10g alcohol), weight gain and obesity, but not light-moderate alcohol intake\textsuperscript{75}. This appears consistent with studies reporting a J-shaped relationship between total alcohol consumption and waist-to-hip ratio and BMI\textsuperscript{74}.
Conflicting results may be due to confounding factors related to alcohol intake and weight status, such as smoking, physical activity, educational level, and economic status, as well as to alcoholic beverage type \(^{72}\).

Clinical studies investigating alcohol consumption and meal energy intake have found that ad libitum alcoholic beverage consumption increased total meal energy intake as compared to soft drink consumption \(^{76}\), and that daily energy intake was greater after consuming a 5% alcohol beer as compared to a nonalcoholic beer or cola \(^{22}\). Overconsumption of alcoholic beverages at a meal may be related to increased thirst due to their diuretic effect \(^{76}\), although others report that moderate alcohol consumption does not exert a diuretic effect \(^{77}\). A high plasma alcohol concentration may reduce dietary cognitive restraint and promote energy overconsumption \(^{76}\).

Moderate alcohol consumption may have health benefits \(^{78}\), including less weight gain with time \(^{75}\) and a lower risk of abdominal obesity \(^{70-72}\). Some evidence suggests more benefits of wine and beer consumption \(^{71}\) as opposed to consumption of liquor/spirits \(^{74}\). However, as with other energy-containing beverages that appear to be additive to meal/daily energy intake, energy intake may acutely increase with alcohol ingestion. Thus, as with other energy-containing beverages that appear to be additive to meal/daily energy intake, portion control and moderation should be encouraged.

**Conclusions**

In the US, energy intake from beverages has increased dramatically in recent decades \(^{79}\). Americans are consuming more energy from soft drinks \(^{25}\) which may be replacing water and nutrient-containing beverages such as milk. Because energy-containing beverages do not promote satiety \(^{22}\), intake of energy-containing beverages may be an important dietary factor
contributing to weight gain. In contrast, water consumption may reduce hunger and energy intake\textsuperscript{27-30}. These benefits, as well as its low cost and wide availability, suggests that increased water consumption (\textgreater{}1 L/day; \textgreater{}33.8 fl oz) and a reduced intake of energy-containing beverages\textsuperscript{30} may facilitate weight management. However, this has not been directly addressed beyond the acute meal setting.

A limited amount of research suggests that other energy-free beverages (i.e., diet soft drinks, coffee/tea) may facilitate weight management, particularly if substituted for energy-containing beverages\textsuperscript{30}. While there may be health benefits to consuming milk, 100% fruit juice, and in moderation, alcoholic beverages, additional energy provided by these beverages must be compensated for by reducing food intake. A summary of literature investigating beverage consumption (by category), acute energy intake and body weight is provided in Figure 1. However, due to the lack of long-term intervention studies, further research is warranted to determine if specific patterns of beverage consumption improves health and weight status.

There are a number of limitations to existing research which should be acknowledged. First, a conflict of interest may exist between financial sponsors of beverage research and researchers. Industry-sponsored research may be less likely to report unfavorable results compared to studies with no industry support\textsuperscript{80}. Differences in effect sizes between industry-funded and non-funded research studies have also been reported\textsuperscript{52}. Therefore, financial disclosures should be considered when evaluating this literature. A second limitation, as mentioned previously, is the lack of randomized controlled trials (RCT). Available literature largely consists of epidemiological studies, which provide evidence of associations of beverage intake and weight status but not causal relationships, and from short-term feeding studies. Other limitations include possible confounding lifestyle behaviors by categories of beverage consumers
and aging, which may independently influence gastric emptying and energy intake regulation.

Weight management practitioners may consider the recently proposed beverage intake guidelines, and existing recommendations. To maintain hydration, an AI of 3.0 L/day for men and 2.2 L/day for women (~104 fl oz and 72 fl oz, respectively) of total beverages is recommended, but no specific recommendations for water intake and weight management exist. An increase in the total beverage volume consumed is associated with greater weight loss during a hypocaloric diet; therefore, water (>1 L/day; >33.8 fl oz) and other energy-free beverages should be consumed to satisfy thirst and promote optimal hydration status, without increasing total energy intake. Solid fruits should be emphasized to meet fruit intake recommendations, and low-fat/non-fat dairy or soy products may be recommended to provide micronutrients while minimizing saturated fat and energy intake. Alcoholic beverages should be consumed in moderation, for those who wish to consume alcohol. Other energy-containing beverages (ie, soft drinks, fruit drinks and whole milk) are not recommended for frequent consumption due to their energy content and low satiating ability, as energy provided by beverages appears additive to total energy intake. As highlighted in a recent commentary, additional research addressing the role of beverage consumption in adult weight management is clearly needed.
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Table 1. *Studies Investigating Energy-free and Energy-containing Beverage Consumption: Weight, Energy Intake, and Weight-Related Outcomes*

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<td>Canty and Chan, 1991</td>
<td>n= 2; M* n= 18; F* normal weight</td>
<td>Experimental study, within-subjects, repeated measures; 200 ml preload (water, ASP*, SUC*, or SAC* sweetened beverage), <em>ad libitum</em> test meal.</td>
<td>No difference between preloads on meal EI*. Rating of desire to eat was higher 45 minutes after water preload compared to SUC preload.</td>
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<tr>
<td>Davy et al., 2008</td>
<td>n = 7; M n= 17; F overweight</td>
<td>Experimental study, within-subjects, repeated measures; 500 ml water preload or no beverage, <em>ad libitum</em> test meal</td>
<td>Test meal EI was 74 kcals less after the water preload compared to the no preload condition.</td>
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<tr>
<td>Study</td>
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<td>Description</td>
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</tr>
<tr>
<td>DellaValle et al., 2005 ¹⁰</td>
<td>n= 44; F</td>
<td>Experimental study, within-subjects, repeated measures; 360 ml beverages (regular cola, orange juice, 1% milk, ASP cola, tap water) or no beverage consumed with an <em>ad libitum</em> meal.</td>
<td>Meal EI was not different in water preload vs. no beverage conditions.</td>
</tr>
<tr>
<td></td>
<td>normal weight, overweight and obese</td>
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</tr>
<tr>
<td>Duffey and Popkin, 2006 ²⁴</td>
<td>n= 9,491; M, F</td>
<td>Cross sectional analysis, NHANES* 1999-2002</td>
<td>Water consumers ingest less energy from energy-containing beverages than soft drink consumers (10.7% vs. 24.0%); those who avoid high fat, fast foods are more likely to consume water.</td>
</tr>
<tr>
<td>Holt et al., 2000 ¹²</td>
<td>n= 11; M</td>
<td>Experimental study, within-subjects, repeated measures; 375 ml preload (sugar-rich cola, ASP cola, water) before <em>ad libitum</em> consumption of a snack (chips) and lunch.</td>
<td>Total EI was similar across conditions.</td>
</tr>
<tr>
<td></td>
<td>normal weight</td>
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<tr>
<td>Lappalainen</td>
<td>n= 8; F</td>
<td>Experimental study, within-subjects,</td>
<td>Drinking water increased feelings of satiety and</td>
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<tr>
<td>Study</td>
<td>Design</td>
<td>Sample Characteristics</td>
<td>Methods</td>
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</tr>
<tr>
<td>et al., 1993</td>
<td>normal weight</td>
<td>repeated measures; 400 ml water given during fixed-intake meal</td>
<td>diminished hunger; effect was not maintained after the meal.</td>
</tr>
<tr>
<td>Murakami et al., 2008</td>
<td>n= 1,136; F</td>
<td>Cross-sectional survey; diet-history questionnaire (150 food and beverage items)</td>
<td>Water intake from foods (all foods except beverages), but not beverages (sum of energy-containing beverages and energy-free beverages) was associated with lower BMI and WC.</td>
</tr>
<tr>
<td>Popkin et al., 2005</td>
<td>n= 4,755; M, F</td>
<td>Cross-sectional analysis; NHANES 1999-2001</td>
<td>Total daily EI was 194 kcals less for water consumers vs. nonconsumers; water consumers also ingest fewer energy-containing beverages.</td>
</tr>
<tr>
<td>Rodin, 1990</td>
<td>n= 12; M</td>
<td>Experimental study, within-subjects, repeated measures; 500ml preload (fructose, glucose, ASP, or plain water), <em>ad libitum</em> meal.</td>
<td>The water preload yielded similar meal EI to that of ASP.</td>
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<tr>
<td></td>
<td>n= 12; F</td>
<td>overweight and normal weight</td>
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</tr>
<tr>
<td>Rolls et al., 1990</td>
<td>n= 42; M</td>
<td>Experimental study, within-subjects, repeated measures; 240 ml or 480 ml preloads (ASP, SUC or water), <em>ad libitum</em> meal.</td>
<td>No difference in meal EI between preloads.</td>
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<tr>
<td></td>
<td>normal weight</td>
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<tr>
<td>Study</td>
<td>Sample Characteristics</td>
<td>Study Design</td>
<td>Analysis Methods</td>
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<tr>
<td>Stookey et al., 2007&lt;sup&gt;29&lt;/sup&gt;</td>
<td>n= 311; F overweight and obese</td>
<td>Experimental study, 24 hr recalls; Fixed effect model used for analysis</td>
<td>During a 12-month hypocaloric diet intervention, replacing energy-containing beverages with water was associated with decreased self-reported EI (~200 kcal/d); impact on body weight was not reported.</td>
</tr>
<tr>
<td>Stookey et al., 2008&lt;sup&gt;30&lt;/sup&gt;</td>
<td>n= 173; F overweight</td>
<td>Experimental study, 24 hr recalls; Mixed models used for analysis (secondary analysis of above study)</td>
<td>Drinking ≥1 L water/day (by self-report) was associated with greater weight loss (2 kg) vs. water intake of &lt;1 L/d, over 12 months.</td>
</tr>
<tr>
<td>Van Walleghen et al., 2007&lt;sup&gt;27&lt;/sup&gt;</td>
<td>n= 25; M normal weight</td>
<td>Experimental study, within-subjects, repeated measures; 500 ml water preload or no beverage, <em>ad libitum</em> test meal.</td>
<td>Test meal EI was 60 kcals lower in the water preload vs. no preload condition among older adults (60-80 yrs). No differences in meal EI between conditions among younger adults (21-35 yrs).</td>
</tr>
</tbody>
</table>

**Energy-free Artificially Sweetened Beverages**

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample Characteristics</th>
<th>Study Design</th>
<th>Analysis Methods</th>
<th>Findings</th>
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<tbody>
<tr>
<td>Appleton and</td>
<td>n= 20; F</td>
<td>Experimental study, within-subjects,</td>
<td>Low consumers of AS beverages (0 ml/d) had</td>
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<tr>
<td>Study Authors and Year</td>
<td>Sample Characteristics</td>
<td>Design and Procedures</td>
<td>Findings</td>
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<tr>
<td>Blundell, 2007</td>
<td>normal weight</td>
<td>repeated measures; 330 ml preload (water, energy containing, or AS* beverages), <em>ad-libitum</em> test meal.</td>
<td>higher intakes following a sweetened preload compared to the high consumers (&gt;825 ml/day).</td>
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</tr>
<tr>
<td>Binkley and Golub, 2007</td>
<td>n= 1,574; M,F</td>
<td>Cross-sectional; comparison of grocery purchase patterns of regular vs. diet soft drink consumers.</td>
<td>Diet soda consumers spend more on items deemed “nutritious” than regular soda consumers; use of diet soft drinks is not associated with increased purchase of high energy-dense foods.</td>
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<tr>
<td>Canty and Chan, 1991</td>
<td>n= 2; M</td>
<td>Experimental study, within-subjects, repeated measures; 200ml preload (water, ASP, SUC, or SAC sweetened beverage), <em>ad libitum</em> test meal.</td>
<td>No effect of sweetener type on meal EI.</td>
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</tr>
<tr>
<td>DellaValle et al., 2005</td>
<td>n= 44; F normal weight, overweight and obese</td>
<td>Experimental study, within-subjects, repeated measures; 360 ml beverages (regular cola, orange juice, 1% milk, ASP cola, tap water) or no beverage consumed with an <em>ad libitum</em> meal.</td>
<td>Meal EI was not different in noncaloric (water, ASP cola) vs. no beverage conditions.</td>
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<tr>
<td>Fowler et al., 2008</td>
<td>n=3,682; M, F</td>
<td>Prospective cohort, 8-yr follow-up, ~65% Mexican American</td>
<td>Among San Antonio Heart Study participants, self-reported consumption of AS beverages (diet soft drinks, artificially sweetened coffee and tea) at baseline was associated with increased risk of weight gain at follow-up compared with non-consumers.</td>
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<tr>
<td>Holt et al., 2000</td>
<td>n= 11; M normal weight</td>
<td>Experimental study, within-subjects, repeated measures; 375 ml preload (sugar-rich cola, ASP cola, water) before ad libitum consumption of a snack (chips) and lunch.</td>
<td>The ASP drink did not stimulate a greater appetite when compared to plain water; total EI was similar across conditions.</td>
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<tr>
<td>Monsivais et al., 2007</td>
<td>n= 19; M n= 18; F normal and overweight</td>
<td>Experimental study, within-subjects, repeated measures; preloads (cola sweetened with SUC, HFCS*-42 (42% fructose), HFCS-55 (55% fructose), ASP, and 1% milk), ad</td>
<td>Meal EI not different in AS cola vs. no beverage condition.</td>
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<tr>
<td>Study</td>
<td>Sample Size</td>
<td>Design Type</td>
<td>Intervention</td>
<td>Findings</td>
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<tr>
<td>Raben et al., 2002 [43]</td>
<td>n= 6; M n= 35; F overweight</td>
<td>Experimental study, parallel; given food and beverages sweetened with SUC (n=21) or AS (ASP, ACE-K*, cyclamate, SAC; n=20) for 10 weeks.</td>
<td>No changes in EI, BW*, or FM* observed among those receiving AS.</td>
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<tr>
<td>Rodin, 1990 [42]</td>
<td>n= 12; M n= 12; F overweight and normal weight</td>
<td>Experimental study, within-subjects, repeated measures; 500ml preload (fructose, glucose, ASP, or plain water), <em>ad libitum</em> meal.</td>
<td>The ASP drink yielded similar meal EI to that of water.</td>
<td></td>
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<tr>
<td>Schulze et al., 2004 [41]</td>
<td>n= 51,603; F overweight</td>
<td>Prospective cohort, association of sweetened beverage consumption with weight gain over a four-year period</td>
<td>Less weight gain among F who increased AS soft drink consumption from ≤ 1 per week to 1 ≥ per day than those decreasing AS drink consumption.</td>
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<tr>
<td>Stookey et al., 2008 [50]</td>
<td>n= 173; F overweight</td>
<td>Experimental study, 24 hr recalls; Mixed models used for analysis</td>
<td>Replacement of energy-containing beverages with nonwater energy-free beverages (“diet drinks”) was associated with less weight loss than increasing water consumption, over 12 months (determined by...</td>
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</table>
### Energy-containing Beverages

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample Size</th>
<th>Design/Description</th>
<th>Findings</th>
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</thead>
<tbody>
<tr>
<td>Tordoff and Alleva, 1990</td>
<td>n= 21; M n= 9; F normal weight</td>
<td>Experimental study, within-subjects, repeated measures; supplemented usual diet covertly with 1150 g/day of soda sweetened with ASP, HFCS, or no drink for 3 weeks each.</td>
<td>Lower EI and BW in ASP condition in M.</td>
</tr>
<tr>
<td><strong>Coffee/Tea</strong></td>
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<tr>
<td>Lopez-Garcia et al., 2006</td>
<td>n= 1,847; M n= 39,740; F</td>
<td>12-yr prospective study; participants were classified into quintiles based on levels of change in caffeine, coffee and tea consumption.</td>
<td>Increases in tea and coffee consumption were inversely associated with weight gain independent of caffeine intake.</td>
</tr>
<tr>
<td>Wu et al., 2003</td>
<td>n= 569; M n= 641; F</td>
<td>Cross sectional study on habitual tea consumption</td>
<td>Habitual tea drinkers (≥1 drink/wk regularly) for &gt;10 yrs had lower BF%<em>, WHR</em> than nonhabitual tea drinkers.</td>
</tr>
</tbody>
</table>
### Soft-drinks

<table>
<thead>
<tr>
<th>Study</th>
<th>n</th>
<th>Gender</th>
<th>Study Design</th>
<th>Description</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buemann et al., 2002</td>
<td>22</td>
<td>M, normal weight</td>
<td>Experimental study, within-subjects, repeated measures; red wine, lager beer, or carbonated SSB* were served with an <em>ad libitum</em> meal. Beverages were supplied <em>ad libitum</em> in first condition and fixed in second.</td>
<td>No significant difference across beverage conditions in total EI when beverage intake was fixed. Total meal EI was lower in the soft drink and beer condition in the <em>ad libitum</em> beverage condition.</td>
<td></td>
</tr>
<tr>
<td>Canty and Chan, 1991</td>
<td>2; 18; F</td>
<td>normal weight</td>
<td>Experimental study, within-subjects, repeated measures; 200ml preload (water, ASP, SUC, or SAC sweetened beverage), <em>ad libitum</em> test meal.</td>
<td>No effect of sweetener type on meal EI.</td>
<td></td>
</tr>
<tr>
<td>DellaValle et al., 2005</td>
<td>44; normal weight, overweight and</td>
<td>Experimental study, within-subjects, repeated measures; 360 ml beverages (regular cola, orange juice, 1% milk, Energy-containing beverages (cola, OJ, milk) add to total meal EI. No difference in total meal EI across energy-containing beverage conditions; total</td>
<td></td>
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<tr>
<td>Study</td>
<td>Sample Size</td>
<td>Design</td>
<td>Preload</td>
<td>Results</td>
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<tr>
<td>Dhingra et al., 2007 56</td>
<td>n= 2,569; M n= 3,470; F</td>
<td>Prospective, 4 yrs</td>
<td>ASP cola, tap water) or no beverage consumed with an <em>ad libitum</em> meal.</td>
<td>Meal EI ~104 kcal higher in energy-containing vs. energy-free conditions due to added beverage kcals. In middle aged adults (mean age=53 yrs), consuming &gt;1 soft drink (diet or regular) per day increased odds of developing obesity (OR 1.31, 95% CI) as compared to those consuming &lt;1 drink/day. Not differentiated between regular and diet soft drinks for BMI*.</td>
<td></td>
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<tr>
<td>Harper et al., 2007 11</td>
<td>n= 22; M normal weight</td>
<td>Experimental study, within-subjects, repeated measures; 500 ml preload (cola or chocolate milk), <em>ad libitum</em> lunch.</td>
<td>No difference between beverages on meal EI.</td>
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<tr>
<td>Holt et al., 2000 12</td>
<td>n= 11; M normal weight</td>
<td>Experimental study, within-subjects, repeated measures; 375 ml preload (sugar-rich cola, ASP cola, water) mornings before <em>ad libitum</em></td>
<td>Total EI from the snack and lunch did not differ between preloads; total daily EI was also similar across conditions.</td>
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<tr>
<td>Study</td>
<td>Sample Size</td>
<td>Study Design</td>
<td>Findings</td>
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<tr>
<td>Kvaavik et al., 2005</td>
<td>n= 207; M n= 215; F</td>
<td>Longitudinal, 18-20 yr follow-up</td>
<td>Long-term, high consumption (&gt;3-4/wk) of sweetened soft drinks was associated with increased EI, smoking, and decreased PA*, but not self reported BW.</td>
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<tr>
<td>Lin et al., 2004</td>
<td>n= 2,914; F</td>
<td>Cross-sectional</td>
<td>Soft drinks correlated positively with BMI in high-income samples (&gt;185% poverty guidelines).</td>
<td></td>
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</tr>
<tr>
<td>Mattes, 1996</td>
<td>n= 8; M n= 8; F</td>
<td>Experimental study, within-subjects, repeated measures; 1.08L beverage (5% ethanol beer, 2.9% ethanol light beer, 0.1% ethanol no-alcohol beer, cola, carbonated water) provided with crackers and cheese; daily EI assessed with 24-hr food records</td>
<td>EI was greater on days energy-containing beverage (cola) were consumed as compared to water.</td>
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<tr>
<td>Melanson et</td>
<td>n= 30; F</td>
<td>2 day experimental study, within-</td>
<td>No differences in plasma glucose, insulin, leptin,</td>
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</table>

consumption of a snack (chips) and lunch.
<table>
<thead>
<tr>
<th>Reference</th>
<th>Study Design</th>
<th>Subjects</th>
<th>Methods</th>
<th>Findings</th>
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</thead>
<tbody>
<tr>
<td>al., 2007</td>
<td>normal weight</td>
<td>subjects, repeated measures; day 1 given HFCS-55 or SUC beverage, day 2</td>
<td>ad libitum EI assessed; compared effects of sweetener on EI and related hormones.</td>
<td>and ghrelin between conditions; No differences in EI on day 2. No “control” comparison condition.</td>
</tr>
<tr>
<td>Monsivais et al., 2007</td>
<td>n= 19; M, n=18; F</td>
<td>Experimental study, within-subjects, repeated measures; 215 kcal preloads</td>
<td>(cola sweetened with SUC, HFCS-42 (42% fructose), HFCS-55 (55% fructose), ASP, and 1% milk), ad libitum meal.</td>
<td>No differences between SUC and HFCS sweetened colas on meal EI, hunger, or satiety; meal EI higher in all energy-containing beverage conditions than no beverage and ASP beverage.</td>
</tr>
<tr>
<td>Raben et al., 2002</td>
<td>n = 6; M, n= 35; F</td>
<td>Experimental study, parallel; given food and beverages sweetened with SUC (n=21) or AS (ASP, ACE-K, cyclamate, SAC; n=20) for 10 weeks.</td>
<td>SUC group had increases in EI, BW, and FM.</td>
<td></td>
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<tr>
<td>Rodin, 1990</td>
<td>n= 12; M</td>
<td>Experimental study, within-subjects;</td>
<td>Lower meal EI after fructose preload vs. other</td>
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<tr>
<td>Reference</td>
<td>n</td>
<td>Gender</td>
<td>Preload Details</td>
<td>Results</td>
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<tr>
<td>St. Onge et al., 2004</td>
<td>12</td>
<td>F</td>
<td>500ml preload (fructose, glucose, ASP, or plain water), <em>ad libitum</em> meal.</td>
<td>Preloads. Reduced thermogenesis with the SSB beverage vs. mixed nutrient beverage; higher satiety/fullness ratings (AUC*) with the mixed nutrient beverage as compared to the SSB following consumption.</td>
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<tr>
<td></td>
<td>11</td>
<td>M</td>
<td>n= 8; F normal weight and overweight</td>
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<td></td>
<td>Experimental study, within-subjects repeated measures; two isocaloric (600 kcal) isovolumetric conditions: SSB* or mixed nutrient (17% Protein, 67% Carbohydrate, 16% Fat) beverages followed by energy expenditure thermic response for 7 hrs measured via indirect calorimetry.</td>
<td></td>
</tr>
<tr>
<td>Tordoff and Alleva, 1990</td>
<td>21</td>
<td>M</td>
<td>n= 9; F normal weight</td>
<td>Higher EI and BW in HFCS conditions among M &amp; F.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Experimental study, within-subjects repeated measures; supplemented usual diet covertly with 1150 g/day of soda sweetened with ASP, HFCS, or no drink for 3 weeks each.</td>
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</table>
## Other energy-containing beverages

<table>
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<tr>
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<th>Sample Size</th>
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<th>Objective</th>
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</thead>
<tbody>
<tr>
<td>DellaValle et al., 2005</td>
<td>n= 44; F normal weight, overweight and obese</td>
<td>Experimental study, within-subjects, repeated measures; 360 ml beverages (regular cola, orange juice, 1% milk, ASP cola, tap water) or no beverage consumed with an <em>ad libitum</em> meal.</td>
<td>Orange juice added to total meal EI. Beverage intake has no effect on satiety; no difference in total meal EI across energy-containing beverage conditions; total meal EI ~104 kcal higher in energy-containing vs. energy-free conditions due to added beverage kcals.</td>
<td></td>
</tr>
<tr>
<td>Lin et al., 2004</td>
<td>n= 2,914; F</td>
<td>Cross-sectional</td>
<td>Juice drinks correlated positively with BMI in high-income samples (&gt;185% poverty guidelines).</td>
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</tr>
<tr>
<td>Schulze et al., 2004</td>
<td>n= 51,603; F</td>
<td>Prospective cohort, association of SSB consumption with weight gain</td>
<td>4-yr weight gain was highest in women who increased SSB consumption from &lt;1 per week to 1≥ per day, and lowest in woman who decreased consumption. Increased fruit punch and fruit juice consumption was also associated with greater weight gain vs. decreased consumption.</td>
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<tr>
<td>Study</td>
<td>Sample Size</td>
<td>Design</td>
<td>Description</td>
<td>Results/Findings</td>
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<tr>
<td>Soenen and Westerterp-Plantenga, 2007 69</td>
<td>n= 15; M</td>
<td>Experimental study, within subjects, repeated measures; 800 ml preloads (0 kcal or 358 kcal SUC, HFCS, 1.5% milk), <em>ad libitum</em> meal.</td>
<td>Total EI (preload + meal) was higher with all energy-containing preloads as compared to the 0 kcal beverage preload. No effect on satiety.</td>
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<td></td>
<td>n= 15; F</td>
<td>normal weight</td>
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<tr>
<td>Sun and Empie, 2007 86</td>
<td>n= 38,409; M, F</td>
<td>Cross-sectional; association of SSB (energy-containing soft drinks, colas, sugar sweetened fruit beverages) with BMI.</td>
<td>No relationship was found between obesity and SSB consumption among SSB consumers and non-consumers.</td>
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<tr>
<td>Milk</td>
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<tr>
<td>Barr et al., 2000 67</td>
<td>n= 71; M</td>
<td>Randomized; 12 weeks, two groups: skim or 1% milk supplement (three 8 oz. servings/day) or control (no supplement). Both groups maintained usual diets.</td>
<td>Weight gain in the milk group was 0.6 kg more than the control group.</td>
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<tr>
<td></td>
<td>n= 129; F</td>
<td>normal weight and overweight, aged 55-85 yrs</td>
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<tr>
<td>Della Valle et</td>
<td>n= 44; F</td>
<td>Experimental study, within-subjects,</td>
<td>Milk added to total meal EI. Beverage intake has</td>
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<tr>
<td>Study</td>
<td>Participants</td>
<td>Study Design</td>
<td>Details</td>
<td>Findings</td>
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<tr>
<td>al., 2005 10</td>
<td>normal weight, overweight and obese</td>
<td>repeated measures; 360 ml beverages (regular cola, orange juice, 1% milk, ASP cola, tap water) or no beverage consumed with an <em>ad libitum</em> meal.</td>
<td>no effect on satiety; no difference in total meal EI across energy-containing beverage conditions; total meal EI ~104 kcal higher in energy-containing vs. energy-free conditions due to added beverage kcals.</td>
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<tr>
<td>Harper et al., 2007 11</td>
<td>n= 22; M normal weight</td>
<td>Experimental study, within-subjects, repeated measures; 500 ml preload (cola or skim chocolate milk), <em>ad libitum</em> lunch.</td>
<td>Satiety and fullness were greater with milk preload compared to cola; no difference between conditions on meal EI.</td>
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<tr>
<td>Hollis and Mattes, 2007 68</td>
<td>n= 28, M n=30, F overweight and obese</td>
<td>Experimental study, crossover; 7 day low dairy (1 portion 2% milk, 1% chocolate milk, yogurt or cheese), 7 day washout, 7 day high dairy (3 total; 1 portion each milk, yogurt and cheese)</td>
<td>EI was 209 kcal/day higher in high vs. low dairy period. Increased dairy consumption may lead to weight gain.</td>
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<tr>
<td>Lukaszuk et al., 2007 66</td>
<td>n= 14; F overweight and</td>
<td>Randomized control trial; 720 ml/day soy milk or skim milk on a</td>
<td>No differences in weight, %BF, WC*, and FFM* between soy and skim milk groups.</td>
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<tr>
<td>Study</td>
<td>Sample Characteristics</td>
<td>Methodology</td>
<td>Data Description</td>
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</table>
| Monsivais et al., 2007 [84] | n= 19; M
n=18; F
normal and overweight | Experimental study, within-subjects, repeated measures; 215 kcal preloads (cola sweetened with SUC, HFCS-42 (42% fructose), HFCS-55 (55% fructose), ASP, and 1% milk), ad libitum meal. | Reduced meal EI following milk beverage as compared to SUC and HFCS beverage; total (meal + beverage) EI greater in milk condition than no beverage and ASP condition. |
| Rosell et al., 2006 [65] | n=19,352; F | Longitudinal, weight change over 9 yrs, association with frequencies of dairy consumption | Consistent intake of >1 serving per day of whole milk, sour milk and cheese was inversely associated with weight gain. |
| Soenen and Westerterp-Plantenga, 2007 [69] | n= 15; M
n= 15; F
normal weight | Experimental study, within subjects, repeated measures; 800 ml preloads (0 kcal or 358 kcal SUC, HFCS, 1.5% milk), ad libitum meal. | Total EI (preload + meal) was higher after the milk preload compared to the 0 kcal preload. |
<p>| Alcohol | | | |</p>
<table>
<thead>
<tr>
<th>Study</th>
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<th>Gender</th>
<th>Study Design</th>
<th>Description</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buemann et al., 2002</td>
<td>22</td>
<td>M</td>
<td>Experimental study, within-subjects, repeated measures; red wine, lager beer, or carbonated SSB were served with an <em>ad libitum</em> meal. Beverages were supplied <em>ad libitum</em> in first condition and fixed in second.</td>
<td>Total meal EI was higher with wine than with beer in the <em>ad libitum</em> beverage condition. No significant meal EI difference when beverage intakes were fixed.</td>
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</tr>
<tr>
<td>Freiberg et al., 2004</td>
<td>3,951 M, 4,174 F</td>
<td>Cross-sectional; alcohol consumption and metabolic syndrome prevalence</td>
<td>Mild to moderate alcohol consumption (&gt;20 beverages/month), particularly wine and beer, is associated with lower WC and metabolic syndrome prevalence compared with non-consumers; strongest association with beer and wine drinkers.</td>
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</tr>
<tr>
<td>Lukasiewicz et al., 2005</td>
<td>1,481 F, 1,210 M</td>
<td>Cross-sectional; alcohol intake was assessed with 24-hr dietary recalls; association of total alcohol and specific beverages (beer, wine, spirits) with BMI and WHR.</td>
<td>J-shaped relationship for WHR and total alcohol consumption; BMI was positively associated with total alcohol consumption and wine in M only. Positive linear association with spirits and BMI in M &amp; F. No relationships found with beer.</td>
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<tr>
<td>Study</td>
<td>Sample Size</td>
<td>Design</td>
<td>Description</td>
<td>Findings</td>
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<tr>
<td>Mattes, 1996</td>
<td>n= 8; M n= 8; F</td>
<td>Experimental study, within-subjects, repeated measures; 1.08L beverage (5% ethanol beer, 2.9% ethanol light beer, 0.1% ethanol no-alcohol beer, cola, carbonated water) provided with crackers and cheese; daily EI assessed with 24-hr food records</td>
<td>Daily EI was greater on days energy-containing beverages (beer, light beer, no-alcohol beer) were consumed as compared to water. Daily EI was also higher when the 5% beer was consumed as compared to 0.1% beer or water.</td>
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<tr>
<td>Riserus and Ingelsson, 2007</td>
<td>n= 807; M</td>
<td>Cross-sectional; association of self-reported alcohol intake with insulin sensitivity and abdominal obesity.</td>
<td>High alcohol intake (&gt;81g/wk) was associated with abdominal obesity; alcohol intake associated with WC but not BMI.</td>
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<tr>
<td>Rossell et al., 2003</td>
<td>n= 1,730; M n= 1,974; F</td>
<td>Cross-sectional; alcohol consumption and metabolic syndrome prevalence.</td>
<td>Nondrinkers had higher WHR than drinkers. In F, metabolic syndrome was more common in non-drinkers than drinkers. No relationship between alcohol intake and metabolic syndrome in M.</td>
<td></td>
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<tr>
<td>Tolstrup et al., 2008</td>
<td>n= 20,472; M n= 23,071; F</td>
<td>Prospective cohort, 5 yrs; association of drinking frequency with changes in</td>
<td>Drinking frequency was inversely associated with changes in WC in women but not men.</td>
<td></td>
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</tr>
<tr>
<td>Wannamethee and Shaper, 2003</td>
<td>n= 7,608; M</td>
<td>Prospective study, 5 yrs; self reported alcohol consumption and BMI.</td>
<td>BMI increased significantly from the light-moderate (≤30g/d) to very heavy alcohol (&gt;30g/d) intake group in a dose-response manner. Heavy drinking was associated with weight gain over time, but not light-moderate drinking.</td>
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</table>

Nondrinkers and rare drinkers had highest odds of major increases in WC.

* Acesulfame K, ACE-k; Area under the curve, AUC; Artificially sweetened, AS; Aspartame, ASP; Body Fat, BF; Body mass index, BMI; Body weight, BW; Energy Intake, EI; Fat-free mass, FFM; Female, F; High Fructose corn syrup, HFCS; Male, M; National Health and Nutrition Examination Survey, NHANES; Physical Activity, PA; Saccharin, SAC; Sucrose, SUC; Sugar sweetened beverages, SSB; Waist circumference, WC; Waist-to-Hip Ratio; WHR.
Figure Legend

Figure 1. Summary: Influence of beverage consumption on acute energy intake and body weight. (pg 50)
Figure 1.

<table>
<thead>
<tr>
<th>Beverage Type</th>
<th>Acute Energy Intake (i.e., Meal, Day)</th>
<th>Body Weight</th>
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</thead>
<tbody>
<tr>
<td>Water</td>
<td>[△,a]</td>
<td>?</td>
</tr>
<tr>
<td>Artificially-Sweetened Beverages</td>
<td>[△a]</td>
<td>?</td>
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<tr>
<td>(energy-free)</td>
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<tr>
<td>Coffee, Tea</td>
<td>?</td>
<td>?</td>
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<tr>
<td>Soft Drinks (energy-containing)</td>
<td>[△]</td>
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<tr>
<td>Juices, Juice Drinks</td>
<td>[△]</td>
<td>?</td>
</tr>
<tr>
<td>Milk, Soy Beverages</td>
<td>[△a]</td>
<td>?</td>
</tr>
<tr>
<td>Alcohol</td>
<td>[△]</td>
<td></td>
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</tbody>
</table>

**Increase; Decrease; No change; ? Unknown.**

*among middle aged and older adults.*

*among young adults.*

50
CHAPTER 3

Water Consumption Increases Weight Loss During a Hypocaloric Diet Intervention in Middle-Aged and Older Adults

Abstract

Water consumption acutely reduces meal energy intake (EI) among middle-aged and older adults. Our objectives were to determine if pre-meal water consumption facilitates weight loss among overweight/obese middle-aged and older adults, and to determine if the ability of pre-meal water consumption to reduce meal EI is sustained after a 12-week period of increased water consumption. Adults (n=48; 55-75 yrs, BMI 25-40 kg/m²) were assigned to one of two groups: 1) hypocaloric diet + 500 ml water prior to each daily meal (water group), or 2) hypocaloric diet alone (non-water group). At baseline and wk 12, each participant underwent two ad libitum test meals: 1) No preload (NP), and 2) 500 ml water preload (WP). Meal EI was assessed at each test meal and body weight was assessed weekly for 12 weeks. Weight loss was ~2 kg greater in the water group than in the non-water group, and the water group (b = -0.87, P< 0.001) showed a 44% greater decline in weight over the 12 weeks than the non-water group (b=-0.60, P< 0.001). Test meal EI was lower in the WP than NP condition at baseline, but not at week 12 (baseline: WP 498±25 kcal, NP 541±27 kcal, P=0.009; 12-wk: WP 480±25 kcal, NP 506±25 kcal, P=0.069). Thus, when combined with a hypocaloric diet, consuming 500 ml water prior to each main meal leads to greater weight loss than a hypocaloric diet alone in middle-aged and older adults. This may be due in part to an acute reduction in meal EI following water ingestion.
Key Words: Water, Weight Loss, Obesity, Dietary Strategies, Older Adults
Introduction

If recent trends continue, 86% of US adults will be overweight or obese by the year 2030\(^1\). Middle-aged and older adults (aged ≥40 yrs) are at increased risk for obesity and approximately 70% in this segment of the population are currently overweight or obese\(^2\). Age-related weight gain may be attributed to several factors including a reduction in energy expenditure, a reduction in energy requirements, and an increased susceptibility to energy overconsumption\(^3-6\). Obesity among older adults is associated with impaired physical function, increased morbidity and mortality, and greater health care costs\(^7-9\). Thus, identifying successful weight management strategies for middle-aged and older adults has significant public health implications.

Increasing daily water consumption is widely recognized as a weight loss strategy in the general public, yet there is surprisingly little data supporting this practice. Epidemiological studies suggest that energy intake (EI) is significantly lower (~9%, or 194 kcals/d) in water drinkers compared with non-water drinkers\(^10\), and that sweetened beverage consumption is associated with weight gain and obesity\(^11\). Recently, investigators reported that substituting water for energy-containing beverages decreases self-reported EI\(^12\), and that increasing self-reported daily water consumption by ≥1 L in overweight women is associated with increased weight loss of ~2 kg over a 12-month diet intervention compared with women who consumed < 1L water daily\(^13\). Laboratory-based test meal studies have demonstrated that water consumed with a meal reduces ratings of hunger and increases rating of satiety\(^14,15\), though no differences in meal EI were observed when compared to a no beverage condition\(^14\). We\(^16,17\) have recently demonstrated that both normal-weight and overweight/obese middle-aged and older
adults ingest less energy at an ad libitum meal when given a water preload (500 ml, ~16 fl oz) 30 minutes prior to the meal compared with a no-preload meal condition. However, a reduction in meal EI following water ingestion has not been observed in studies of young adults\textsuperscript{16, 18}, suggesting there may be age-related differences in the ability of water to acutely reduce EI. Others studies reporting no effect of water ingestion on EI in young adults\textsuperscript{19-21} have used water as a control condition; a no-preload condition is not available for comparison. It is unknown if increased water consumption facilitates weight loss over time.

We tested the hypothesis that pre-meal water consumption would lead to greater weight loss in older overweight and obese individuals consuming a hypocaloric diet. Given previous findings\textsuperscript{16, 17}, a secondary objective was to determine if the ability of pre-meal water consumption to reduce ad libitum EI is sustained after a 12-week period of increased water consumption in older overweight and obese adults.

**Methods and Procedures**

**Subject Characteristics**

Overweight or obese (BMI 25-40 kg/m\textsuperscript{2}) men and women between the ages of 55-75 yrs were recruited from the local community though newspaper advertisements. For inclusion in the study, individuals were required to be weight stable (+2 kg, >1 year) and nonsmokers. Individuals were excluded if they reported a history of depression, eating disorders, diabetes, uncontrolled hypertension (>159/99 mm Hg), heart, lung, kidney disease; cancer, food allergies/intolerances to items used in the laboratory test meals; or current use of medications known to alter food intake or body weight. Individuals were blinded to the specific purpose of the study, and were informed that the study involved
examination of dietary factors believed to influence weight loss. The study protocol was approved by the Institutional Review Board of Virginia Polytechnic Institute and State University. All participants provided written informed consent prior to study enrollment.

Protocol

Initial Screening Procedures and Baseline Assessments

An overview of the study protocol is depicted in Figure 1. Individuals meeting initial enrollment criteria completed baseline laboratory assessments over a series of four visits. Height was measured in meters without shoes using a wall-mounted stadiometer, and body weight was measured to the nearest 0.1 kg using a digital scale with participants wearing light street clothing and no shoes (Scale-Tronix model 5002, Wheaton, IL). Percentage body fat, absolute fat mass, fat-free mass and total body bone mineral content were measured using dual energy x-ray absorptiometry (DXA) (GE Lunar Prodigy; GE Healthcare, Madison, WI). Waist circumference was measured to the nearest 0.5 cm at the umbilicus, using a Gulick tape measure (Gulick, Country Technology, Inc, Gays Mill, WI). Resting blood pressure was measured in the seated position using a mercury sphygmomanometer after a 15-minute period of rest; the average of three measurements ±6 mmHg was used. To assess habitual dietary intake and beverage consumption, participants were instructed in proper methods to record their food and beverage intake (including water consumption) for four consecutive days, which included three weekdays and one weekend day, and provided with food models to assist in portion size determination. Records were reviewed for completeness upon their return, and analyzed using diet analysis software (NDS-R 4.05, University of Minnesota, Minneapolis, MN). A second trained technician reviewed all diet analyses for data entry errors. To assess
habitual beverage consumption, baseline and week 12 food intake records were manually reviewed to calculate mean daily amounts (kcal, g) of water and other beverages consumed. Dietary energy density (ED; kcal/g) was calculated from the food and beverage intake records and was expressed in four ways: total ED including all foods and beverages consumed; beverage ED including water; beverage ED excluding water; and ED from food only, excluding all beverages. When comparing ED (food + beverages) between individuals or over time, excluding water from the calculation could lead to higher ED values among water consumers or those increasing water intake, compared to those consuming energy-free beverages (diet sodas, coffee and tea). Thus, multiple ED calculations were performed. Participants collected urine for one 24-hour period for assessment of total urine volume, and specific gravity was determined using a refractometer (Fisher UriSystem, Fisher Scientific). Blood was sampled from an antecubital vein for assessment of lipid and lipoprotein concentrations, which were performed using a SynchronLX20 (Beckman Coulter, Inc., Fullerton, CA). Total cholesterol and triglyceride concentrations were determined using the timed endpoint method, high-density lipoprotein cholesterol (HDL-C) was determined by homogenous assay, and low-density cholesterol (LDL-C) was determined by calculation. Habitual physical activity (steps/day) was measured using GT1M activity monitors for a four-day period (ActiGraph, Pensacola, FL).

Following initial assessments, each participant underwent two laboratory test meal conditions within a two week period, separated by a minimum of two days, in a random order as follows: 1) 30-minute waiting period (no preload) followed by an ad libitum breakfast meal, and 2) preload consisting of 500 ml (~16 fl oz) chilled bottled
water followed within 30 minutes by an ad-lib meal. Condition 1 served as the “baseline” EI for comparison. A 30-minute time interval between the preload and ad libitum meal is the most effective time interval to study EI compensation using preloads. Subjects were instructed not to eat or drink for at least 12 hours prior to arriving for the test meal. The meal consisted of typical breakfast items (cinnamon raisin bagel, cream cheese, margarine, jelly, vanilla yogurt, banana, mozzarella cheese stick, cereal bar, orange juice, coffee, cream and sugar) provided in excess of what would normally be consumed, from which the participants were allowed to self-select during a 20-minute meal period. All foods used in the breakfast meals were evaluated for palatability prior to study initiation. Foods were presented on a meal tray and arranged in the same manner (i.e. location on tray, temperature) on both testing days, and meals were served in individuals cubicles under standardized laboratory conditions (i.e., quiet, temperature controlled). All foods were covertly weighed (±0.1g) before being served and again after the completion of the meal to determine the amount consumed. Meal energy and nutrient intake were calculated using diet analysis software (NDS-R, University of Minnesota, Minneapolis, MN). Participants completed visual analog scales (VAS) during the test meal procedure at times 0, 30, 60, 90, 120, and 150 minutes to subjectively rate their feelings of hunger, satiety (fullness) and thirst. Time 0 represented arrival for the meal, and time 30 represented the time immediately prior to receiving the meal.

**Intervention Period**

Following completion of all baseline assessments (Figure 1), participants were randomly assigned to one of two diet groups for 12 weeks: 1) hypocaloric diet + 16 fl oz (500 ml) bottled water prior to each of the three daily meals (“water group”), or 2)
hypocaloric diet alone (“non-water group”). Individuals assigned to the water group were provided with cases of bottled water (Aquafina, Pepsico, Inc.), and were instructed to consume one bottle prior to each meal (3x16 fl oz bottles/day). Water group participants were provided with a daily tracking form to record their premeal water consumption (Appendix I), which was returned to the study personnel at weekly visits for calculation of weekly water consumption (%) compliance. Non-water group participants were offered bottled water, but were not given instructions or recommendations on water consumption. Both groups were provided with a variety of additional foods consistent with their meal plans, in order to keep participants blinded to the study purpose.

Consumption of these items was not mandatory. Participants received one “provided” food per week in addition to the bottled water, and all participants received the same food item during that week (e.g., seven red delicious apples, 55 kcal each; seven navel oranges, 62 kcal each; one box of microwave popcorn, Orville Redenbacher’s Smart Pop 94% Fat-Free, four Butter-Flavored 100-calorie packs, ConAgra Foods, Inc, Omaha, NE). Both groups received individualized instruction by a registered dietitian on a hypocaloric diet (women: 1200 kcals, men: 1500 kcals), which was developed using USDA food guide pyramid guidelines. Consumption of fruits, vegetables, lean sources of protein, lowfat/nonfat dairy products, and whole grains was emphasized; both groups were instructed to moderate their consumption of high-fat snack foods, sweetened energy-containing beverages, and alcohol. Meal plan booklets with sample menus were also provided (Appendix H). Average energy and macronutrient content (% energy from fat/carbohydrate/protein, ED) of the 1200 and 1500 kcal sample menus, not including optional energy-free beverages (e.g., water, diet soft drinks) were as follows: 1191 kcal
(30/52/21, 1.28 kcal/g); 1425 kcal (28/53/22, 0.93 kcal/g). Participants were instructed to maintain their current level of physical activity throughout the intervention.

Participants returned weekly to the laboratory for body weight measurement and dietary counseling (Appendix J), and dietary intake records were repeated at weeks 4 and 8 to encourage compliance.

Post-Testing

Following the 12-week intervention, participants repeated all baseline measurements (body weight and composition, four-day dietary intake record and activity monitoring, fasting blood draw, resting blood pressure, 24-hr urine collection, two ad libitum laboratory test meal studies), completed an exit survey, and were compensated $50.

Statistical Analyses

Power calculations ($\alpha=0.05$, power=0.8) were performed based upon expected differences in weight loss between hypocaloric diets groups (2.0±2.5 kg) to determine the targeted final sample size (n=40). Baseline group demographic characteristics were assessed using independent samples t-test and Pearson’s chi-square ($\chi^2$) tests (SPSS v. 12.0 for windows). To assess group difference in weight loss over 12 weeks, a random coefficients (mixed) model (i.e., growth curve analysis) was used, which includes all available data from an individual, corrects for unreliability of measurement and emphasizes individual growth trajectories rather than average values at each occasion $^{28, 29}$. The growth curve model was fitted using STATA 9.1 xtmixed function. Full-information maximum likelihood estimation, which uses all available data (i.e., weekly body weight measurements) on the 48 participants enrolled into the intervention, was
used to address partially observed data. To capture potential variations in the effect of increased water consumption on weight loss over the 12-week intervention, a quadratic effect of time (week-squared) was included in the model as a covariate. The intercept was specified at the first occasion of measurement (i.e., week=0). Follow-up occasions occurred weekly for 12 weeks, and time was coded as 0 to 12. All main effects and their interactions with the linear and quadratic effects remained in the model regardless of the significance of the effect.

For secondary outcome variables, repeated measures analysis of variance (ANOVA) was used to assess group and time differences for subjects completing the 12-week intervention; analysis of covariance was used to adjust for baseline differences when present. When significant interactions were detected, t-tests were used for post hoc analyses. Group differences in pre-to-post change values (Δ) were analyzed using independent samples t-test. The trapezoidal model was used to calculate area under the curve (AUC) for each VAS variable, and differences in VAS ratings during the test meal period were assessed using repeated measures ANOVA. Associations among variables were assessed by simple correlational analyses (Pearson’s r). The alpha level was set a priori at P<0.05. Data are expressed as mean±SEM.

Results

Baseline Characteristics

Forty eight individuals were enrolled in the study and randomized, and 41 completed the 12-week intervention and all post-testing measurements (Figure 1). Baseline group demographic characteristics are shown in Table 1. Most participants were white (~92%), and remaining participants were African American (n=2), and “other” (n=2). There were
no group differences at baseline in age, body weight, BMI, body composition, urinary specific gravity, systolic blood pressure (BP), total cholesterol and triglyceride concentration, or physical activity level; however, 24-hour urine volume and HDL-C concentration was lower and diastolic BP and LDL-C concentration was higher in the water group at baseline (Table 2). There were no baseline group differences in mean daily intake of water, total beverage volume, or beverage energy content (Table 3).

**Intervention**

As depicted in Figure 2, weight declined significantly over the 12 weeks for both groups (b=-0.27, P< 0.01), although the water group (b = -0.87, P< 0.001) showed a 44% greater decline (i.e., greater rate of weight loss) over the 12 weeks than the non-water group (b=-0.60, P< 0.001). There was also a significant quadratic trend in weight loss (b= 0.01, P < 0.05), indicating that the linear decline in weight leveled off toward the end of the study period. This abatement was greater for the water group (b = 0.03, P < 0.001) than for the non-water group (b = 0.02, P< 0.001).

Body composition and other clinical outcome variables at baseline and post-intervention are presented in Table 2. Decline in total fat mass was greater in the water than non-water group (water: Δ-5.4±0.6 kg; non-water: Δ-3.3±0.5 kg; P=0.01), however per cent of initial body weight lost (7.8±0.7% vs. 6.5±0.7%, water vs. non-water, respectively; P=0.17) and reduction in per cent body fat (water: Δ-3.4±0.5%; non-water: Δ-2.1±0.6%; P=0.08) were not different between groups. Reductions in BMI, waist circumference, systolic and diastolic BP, total cholesterol, LDL-C, and triglyceride concentrations were observed over the 12-week intervention, but there were no group differences in changes in these outcomes (Table 2). There was no change over time or
between groups in bone mineral content during the 12-week intervention. The reduction in HDL-C concentration was smaller in the water group compared with the non-water group following the 12-week intervention (water: Δ-0.6±0.9 mg/dl; non-water: Δ-3.9±0.9 mg/dl; P=0.01).

Average weekly water intake compliance among water group participants was reported to be 90±2%, and an objective indicator of compliance, urinary specific gravity, declined over time in the water group as compared to the non-water group (Table 2). The increase in urine volume over time was not different between groups.

Due to an unintended greater random allocation of males to the water group than non-water group (Table 1), additional analyses were performed to determine if weight loss outcomes differed between males and females in two groups. Total weight loss was not different (all P>0.05) among males and females in each diet group (water: M -7.7 kg, F -7.0 kg, both ~8% of initial weight lost; non-water: M -6.7 kg, F -5.0 kg, both ~6% of initial weight lost) or in the pooled sample (M -7.3 kg, F -5.7 kg, ~7% of initial weight).

Dietary intake and physical activity outcomes over the 12-week intervention are presented in Table 3. There were no baseline group differences in mean daily EI or dietary ED, but several differences were detected in dietary outcomes at baseline compared to week 12. Mean daily EI declined similarly in both groups. Total dietary ED (food + all beverages, including water) declined more in the water group as compared to the non-water group. After 12 weeks, both groups had significantly reduced EI from beverages to ~10% of total EI, and water group participants demonstrated greater increases in water and total fluid consumption than the non-water group participants. Beverage ED, both including and excluding water, declined in both groups but no group
differences in beverage ED were detected. Similarly, energy and ED from food alone decreased in both groups, but no group differences were found. Dietary changes associated with reductions in body weight included changes in water intake ($r=0.35$, $P=0.03$), and absolute and relative fat intake (fat grams: $r=-0.36$, $P=0.03$; percent energy from fat: $r=-0.44$, $P=0.005$). No other significant associations of dietary intake variables with weight changes were found. Physical activity level did not change during the 12-week intervention.

Of the 31 participants completing the exit survey, 11 (water group, $n=8$; non-water group, $n=3$) believed that water was involved some aspect of the study, and of those, eight (water group, $n=7$; nonwater group, $n=1$) accurately identified the purpose of the study.

**Ad Libitum Test Meals**

In the pooled sample, mean ad libitum breakfast meal EI was lower in the water preload (WP) condition as compared to the no-preload (NP) condition at baseline (WP $498\pm25$ kcal, NP $541\pm27$ kcal, $P=0.009$) but not at week 12 (WP $480\pm25$ kcal, NP $506\pm25$ kcal, $P=0.069$). No significant group by condition differences were found in breakfast meal EI, when expressed in either in absolute (kcal) or relative (% change) terms.

Subjective ratings of hunger, fullness, and thirst during the two test meal conditions at baseline and at 12-weeks are shown in Figures 3 and 4, respectively. Hunger AUC ratings did not differ significantly between groups, conditions, or over time. Fullness AUC ratings were higher in the WP compared to NP condition ($8975\pm258$ vs $8296\pm275$ mm min, respectively; $P=0.002$), but there were no differences between groups
or over time. As would be expected, thirst AUC ratings were lower in the WP compared to NP condition (4090±342 vs 7297 mm min, respectively; P<0.001), and no differences were noted between groups or over time. Hunger and thirst AUC values were correlated in the WP condition (r=0.496, P<0.001) but not the NP condition (r=0.149, P=0.312).

**Discussion**

To our knowledge, this is the first randomized control trial investigating the influence of increased water consumption on weight loss. Our results indicate that when combined with a hypocaloric diet, consuming 500 ml (~16 fl oz) of water prior to each of the three main daily meals (1.5 L/d) leads to ~2 kg greater weight loss over 12 weeks as compared to a hypocaloric diet alone (Figure 2), among middle-aged and older adults. This difference was attributed to a 44% greater rate of weight loss among water group participants compared to non-water participants over the 12-week period. This effect may be due in part to an acute reduction in meal EI following water ingestion, which we observed at the baseline laboratory test meal studies. A reduction in meal EI following water consumption is accompanied by increased sensations of fullness, which may facilitate a lower meal EI following water ingestion. However, it is not clear from our findings how long this effect is sustained, as we did not observe significant differences between meal conditions after the 12-week weight loss intervention.

Our data are consistent with prior reports. In a secondary analysis of a trial comparing several weight loss diets, Stookey et al\textsuperscript{31} found that overweight women who reported drinking \(\geq 1\) L/d of water over a 12-month period increased weight loss by ~2 kg compared to those who did not increase water consumption. However, increased water consumption was not manipulated, and water consumption data was self-reported.
Nonetheless, our data are in agreement with these findings in that they support a beneficial role of increasing water consumption while consuming a hypocaloric diet.

Though the exact mechanism responsible for the greater weight loss with increased water consumption is presently unknown, consuming water *before* a meal or *with* a meal reduces sensations of hunger, and increases satiety \(^{15-17}\). First, changes in subjective sensations of hunger and satiety are associated with an acute reduction in meal EI \(^{16,17}\), but prior to our study it was unknown if this acute reduction in meal EI could facilitate weight loss while consuming a hypocaloric diet. Advancing age is also associated with delayed gastric emptying \(^{32}\) which may play a role in reducing meal EI following a water preload in middle aged and older adults; this possibility warrants further investigation. We did not detect group differences in self-reported EI over the 12-week intervention, possibly due to the limitations associated with utilizing self-reported dietary intake measures \(^{33}\). Studies including objective measures of daily EI, such as those conducted on an in-patient metabolic research unit, are needed to more accurately quantify the potential daily reduction in EI associated with increased water ingestion.

Second, replacing energy-containing beverages in the diet with water may lead to a reduction in overall EI, as epidemiological data suggests that total beverage energy contributes > 400 kcals to daily EI \(^{34}\). In our sample, beverage EI declined by ~100 kcal over the 12-week intervention, but did not differ between groups and is thus unlikely to explain our findings. Since both groups were instructed to moderate their consumption of sweetened energy-containing beverages and alcohol, the lack of a group difference in beverage EI and non-water beverage consumption is not unexpected. However, in the entire sample, a greater increase in water intake was positively associated with weight
loss. In addition, overall dietary ED (food + beverages, including water) decreased significantly more in the water group than the non-water group which may be attributed to an increased water intake among water group participants; reducing dietary ED is thought to be an effective weight loss strategy.

Finally, it is possible that daily self-monitoring of water intake contributed to a greater weight loss in our water group participants, as others have demonstrated benefits of daily self-monitoring behaviors associated with weight management (i.e., daily self-weighing). Further research is warranted to determine the relative contributions of each of these possible physiological and behavioral mechanisms related to water consumption promoting weight loss.

There are some limitations that should be acknowledged. First, the sample size was small. However, this sample size provided sufficient power to detect physiologically and statistically significant effects in many outcome variables which were consistent with our hypothesis. Second, no standardized laboratory test is available to objectively assess compliance with the water intervention. We utilized urinary specific gravity, 24-hour urine collections, self-reported daily compliance logs, and food intake records. These procedures provided reasonable indicators of compliance when comparing the two groups over time and there was consistency among most of these measures. Finally, these results may not apply to the general population, in that our study only included primarily white, middle-aged and older adults. Rolls et al did not observe a difference in meal EI in young, normal weight men who were given 8 and 16 oz of water 30 minutes prior to a meal as compared to no beverage. This observation is consistent with our findings in young adults. Future studies examining premeal water intake in younger populations
could address methodological changes such as increasing the quantity of the water preload, or reducing the time between the preload ingestion and the ad libitum meal.

These findings may have clinical implications. Our prior work\textsuperscript{16,17} led us to hypothesize that premeal water consumption could reduce daily EI by \textasciitilde225 kcals, and over a 12-week period, could produce an energy deficit of \textasciitilde18,900 kcal and lead to \textasciitilde2.5 kg weight loss. Although we recognize this is an extrapolation, it is consistent with our findings. Dietitians and other weight management practitioners often advise individuals desiring weight loss to increase their water consumption, and this strategy is often recommended in popular weight loss programs\textsuperscript{37-39}. These findings provide an evidence-basis for this strategy among middle-aged and older adults. In addition, increasing water consumption is a simple, inexpensive behavioral change which can be recommended as a component of a hypocaloric diet to possibly enhance weight loss outcomes. Another potential health benefit of this strategy is improved hydration status, as habitual fluid intake among our population (Table 2) was well below current guidelines\textsuperscript{40}. Thus, our findings suggest benefits of increasing water consumption for weight management and health among middle-aged and older adults.

We conclude that for overweight or obese middle-aged and older adults, consuming \textasciitilde2 cups of water prior to each of the three main daily meals may increase weight loss when combined with a hypocaloric diet, as compared to a hypocaloric diet alone. This strategy may aid in increasing fullness, thereby promoting a reduction in meal EI. Future studies, with larger sample sizes, are needed to confirm our findings as well as to determine how long the acute reduction in meal EI following water ingestion is
sustained; if this increased weight loss with water consumption is maintained over time; and if increased water consumption facilitates long-term weight loss maintenance.

Acknowledgments

Funding for this investigation was provided by a research grant from the Institute for Public Health and Water Research.

References


71
Table 1. Baseline group demographic characteristics: hypocaloric diet with increased daily water consumption (“water group”) and hypocaloric diet alone (“nonwater group”)

<table>
<thead>
<tr>
<th></th>
<th>Water Group</th>
<th>Non-water Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male/Female, n</td>
<td>12/11</td>
<td>6/19*</td>
</tr>
<tr>
<td>Race, white/nonwhite, n</td>
<td>21/2</td>
<td>23/2</td>
</tr>
<tr>
<td>Age, years</td>
<td>62.6 ± 1.2</td>
<td>62.2 ± 1.0</td>
</tr>
<tr>
<td>Height, m</td>
<td>1.69 ± 0.02</td>
<td>1.65 ± 0.02</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>93.2 ± 2.8</td>
<td>89.9 ± 3.4</td>
</tr>
<tr>
<td>BMI, kg/m²</td>
<td>32.6 ± 0.8</td>
<td>32.9 ± 1.3</td>
</tr>
</tbody>
</table>

Data are presented as mean ± s.e.m.

* Group difference, p<0.05
Table 2. *Body composition and other clinical characteristics in the water and nonwater groups before and after the 12-week intervention*  

<table>
<thead>
<tr>
<th></th>
<th>Water Group</th>
<th>Non-water Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>Week 12</td>
</tr>
<tr>
<td><strong>BMI, kg/m²</strong> ^1</td>
<td>32.1±1.1</td>
<td>29.5±1.1</td>
</tr>
<tr>
<td><strong>% Body Fat</strong> ^1</td>
<td>39.9±1.8</td>
<td>36.5±2.0</td>
</tr>
<tr>
<td><strong>Total Fat Mass, kg</strong> ^2</td>
<td>35.1±2.2</td>
<td>29.7±2.3</td>
</tr>
<tr>
<td><strong>Total Fat-free Mass, kg</strong></td>
<td>52.4±2.6</td>
<td>51.2±2.5</td>
</tr>
<tr>
<td><strong>Total Bone Mineral Content, kg</strong></td>
<td>3.1±0.1</td>
<td>3.1±0.1</td>
</tr>
<tr>
<td><strong>Systolic Blood Pressure, mmHg</strong> ^1</td>
<td>126±2</td>
<td>118±2</td>
</tr>
<tr>
<td><strong>Diastolic Blood Pressure, mmHg</strong> ^1,3</td>
<td>80±1</td>
<td>73±1</td>
</tr>
<tr>
<td><strong>Total Cholesterol, mg/dl</strong> ^1</td>
<td>221±8.7</td>
<td>201±7.9</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>----------------------</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>HDL-C, mg/dl</td>
<td>42±2.7</td>
<td>42±2.6</td>
</tr>
<tr>
<td>LDL-C, mg/dl</td>
<td>153±7.4</td>
<td>139±6.6</td>
</tr>
<tr>
<td>Triglycerides, mg/dl</td>
<td>132±15.4</td>
<td>101±15.3</td>
</tr>
<tr>
<td>Waist Circumference, cm</td>
<td>105.5±2.7</td>
<td>99.4±2.8</td>
</tr>
<tr>
<td>Urine Volume, ml</td>
<td>1,594±171</td>
<td>2,233±168</td>
</tr>
<tr>
<td>Specific gravity, UG</td>
<td>1.015±0.001</td>
<td>1.009±0.001</td>
</tr>
</tbody>
</table>

Data are presented as mean ± s.e.m.

1Significant main effect of time, P < 0.01.

2Significant group by time interaction, P < 0.05.

3Group difference at baseline, P < 0.05

4Significant main effect of time, P< 0.05.
Table 3. *Self-Reported Dietary Intake and Physical Activity in Water and Non-water Groups Before and After the 12-week Intervention*

<table>
<thead>
<tr>
<th></th>
<th>Water Group</th>
<th>Non-water Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>Week 12</td>
</tr>
<tr>
<td><strong>Total Diet:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy, kcal/d$^1$</td>
<td>1991±114</td>
<td>1454±96</td>
</tr>
<tr>
<td>Weight, g/d$^2$</td>
<td>2616±149</td>
<td>3226±180</td>
</tr>
<tr>
<td>Carbohydrate (% energy)</td>
<td>48.5±1.9</td>
<td>51.1±2.8</td>
</tr>
<tr>
<td>Protein (% energy)$^1$</td>
<td>16.1±0.7</td>
<td>18.0±0.5</td>
</tr>
<tr>
<td>Fat (% energy)</td>
<td>35.2±1.6</td>
<td>31.5±2.1</td>
</tr>
<tr>
<td>Energy Density, kcal/g</td>
<td>0.78±0.04</td>
<td>0.48±0.04</td>
</tr>
<tr>
<td><strong>Beverages Only:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy, kcal/d$^1$</td>
<td>235±23</td>
<td>148±16</td>
</tr>
<tr>
<td>Total Beverage weight, g/d$^2$</td>
<td>1588±122</td>
<td>2287±160</td>
</tr>
<tr>
<td>Water consumption, g/d$^2$</td>
<td>306±65</td>
<td>1291±122</td>
</tr>
<tr>
<td>Beverage weight, excluding water, g/d$^1$</td>
<td>1283±111</td>
<td>996±111</td>
</tr>
<tr>
<td>Beverage Energy</td>
<td>0.15±0.01</td>
<td>0.07±0.01</td>
</tr>
<tr>
<td>Density, including water, kcal/g&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>Beverage Energy</strong></td>
<td>0.20±0.02</td>
<td>0.17±0.02</td>
</tr>
<tr>
<td>Density, excluding water, kcal/g&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Food Only:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy, kcal/d&lt;sup&gt;1&lt;/sup&gt;</td>
<td>1756±107</td>
<td>1306±88</td>
</tr>
<tr>
<td>Weight, g/d</td>
<td>1027±67</td>
<td>939±66</td>
</tr>
<tr>
<td>Energy Density, kcal/g&lt;sup&gt;1&lt;/sup&gt;</td>
<td>1.74±0.07</td>
<td>1.44±0.08</td>
</tr>
<tr>
<td><strong>Physical activity, steps/d</strong></td>
<td>7073±662</td>
<td>7349±589</td>
</tr>
</tbody>
</table>

Data are presented as mean ± s.e.m.

<sup>1</sup>Significant main effect of time, P < 0.01.

<sup>2</sup>Significant group by time interaction, P < 0.05.

<sup>3</sup>Significant group by time interaction, P < 0.01

<sup>4</sup>Calculated with all foods and beverages, including water.
Figure Legends:

**Figure 1.** Study Design (pg 79)

**Figure 2.** Weight loss among Water and Non-water group participants over the 12-week intervention. (pg 80)

**Figure 3.** (multi-panel): Visual analog scale (VAS) ratings of Hunger (3A), Fullness (3B), and Thirst (3C) among Water and Non-water group participants at baseline in the water preload and no preload ad libitum meal conditions. Following completion of the 0 min VAS scale, the water preload was provided (water preload condition) (a); subjects completed the next VAS scale at 30 min, and were immediately provided with the ad libitum meal (b). VAS scales were completed following the ad libitum meal at 60 min (c), and at subsequent 30 min intervals until the completion of the 150-min testing period. *Significant difference between preload conditions, P<0.05. (pg 81)

**Figure 4.** (multi-panel): Visual analog scale (VAS) ratings of Hunger (4A), Fullness (4B), and Thirst (4C) among Water and Non-water group participants following the 12-week intervention in the water preload and no preload ad libitum meal conditions. Following completion of the 0 min VAS scale, the water preload was provided (water preload condition) (a); subjects completed the next VAS scale at 30 min, and were immediately provided with the ad libitum meal (b). VAS scales were completed following the ad libitum meal at 60 min (c), and at subsequent 30 min intervals until the completion of the 150-min testing period. *Significant difference between preload conditions, P<0.05. (pg 82)
Figure 1.

**Initial Screening Tests**
Visit 1: Medical History, Eating Habits and Depression Questionnaires, 4-Day Food Record, 4-Day Activity Monitor
Visit 2: Fasting blood draw, Body Composition, Blood pressure
Visit 3: Laboratory ad libitum Test Meal 1
Visit 4: Laboratory ad libitum Test Meal 2

- Excluded (n=17)
  - Did not meet inclusion criteria (n=8)
  - Refused to participate (n=9)

**Randomized (n=48)**

**Hypocaloric Diet + Increased water consumption (n=23)**
- “Water Group”
  - Discontinued intervention (n=2)
    - Time Constraints

**Hypocaloric diet alone (n=25)**
- “Non-water Group”
  - Discontinued intervention (n=4)
    - Lost Interest (n=3)
    - Transportation problems (n=1)

**12-Week Intervention**
- Weekly body weight checks, diet counseling
- Urine collection and food records at weeks 4, 8

**12-Week Post-Testing**
Visit 17: Fasting blood draw, Body Composition, 4 day food record, 24-hr urine collection, 4 day physical activity monitor, exit surveys
Visit 18: Laboratory ad libitum Test Meal 3
Visit 19: Laboratory ad libitum Test Meal 4

**Included in analysis (n=20)**
**Incomplete post data (n=1)**

**Follow-Up**

**Analysis**

Included in analysis (n=21)
Figure 2

The graph illustrates the weight loss (Kg) over time for two groups: Non-Water Group and Water Group. The 95% CI Weight Loss is shown over various weeks, indicating a gradual decrease in weight loss for both groups. The Water Group shows a more pronounced decrease in weight loss compared to the Non-Water Group.
Chapter 4
Conclusions

If recent trends continue, all American adults will be overweight by 2048. Older Americans are at an increased risk for obesity; thus, obesity prevention and treatment strategies targeting older adults are clearly needed. The previous investigations were conducted to examine the influence of beverage intake on adult weight management, and to determine the effectiveness of increased water consumption as a weight loss strategy. Through our literature review, we determined that consumption of energy-containing beverages may increase body weight gain, and contribute to the rising prevalence of obesity among this population. In addition, substituting water or energy-free beverages for energy-containing beverages may reduce energy intake, and lead to weight loss overtime. From our intervention study, we determined that when combined with a hypocaloric diet, increasing premeal water consumption, approximately 2 cups prior to each meal, appears to be an effective weight loss strategy for older adults as compared to a hypocaloric diet alone. Weight loss was 2 kg greater in the water group as compared to the nonwater group. Increasing water intake reduces feelings of hunger and increases satiety, which may increase adherence to a hypocaloric diet. Because water is commonly accessible at little or no cost, these findings demonstrate a practical obesity prevention and treatment strategy.

There are several future studies that can be suggested based upon these findings. Our intervention was a short-term (i.e., 12-week) weight loss study, and the long-term effects of increased water consumption on weight loss and weight loss maintenance are
unknown. Future studies are needed to determine whether increased water intake contributes to weight maintenance following weight loss.

In addition, the exact mechanism responsible for weight loss with increased water consumption has not been identified. Given that changes in gastric emptying have been noted with advancing age\(^4\), there are relatively few studies examining the effect of water intake on gastric distension in older adults. Antral area is believed to play a key role in promoting fullness and terminating a meal, and aging is associated with a more rapid filling of the antrum\(^4\). This is one possible explanation for the observed differences in energy intake between older and younger adults when consuming water prior to a meal. Furthermore, we found that premeal water consumption reduces feelings of hunger and increases satiety; however, we did not find differences in self-reported energy intake between groups over time. This could be a result of limitations in self-reported dietary intake assessment methods. Future studies should include objective measures of food intake to determine if increased water consumption reduces energy intake or if there are other metabolic factors contributing to weight loss such as increased thermogenesis\(^5\).

Previous research has shown that consuming water prior to a meal did not appear to have an impact on meal energy intake in younger adults\(^6,7\). These studies utilized a 30 minute interval between the given preload and the test meal. It is unknown whether reducing the amount of time between a water preload and the meal could impact subsequent meal energy intake in this population. Flood-Obbagy and Rolls\(^8\) served a test meal 15 minutes following an energy-containing beverage preload (apple juice) to younger adults. Test meal intake was significantly lower following the preload as compared to a no-preload condition; yet after considering the energy intakes from the
preload and the meal, there was no difference in energy intake. Decreasing the time between the preload and the meal may be an effective strategy for reducing intake at a meal in younger adults, and future studies should determine the influence of water as a preload in this situation.

Finally, future studies could examine whether smaller or larger doses of water consumption would have a similar effect on weight loss. Our intervention utilized a water dose of 16 fluid ounces of water prior to each meal; however, it is unknown whether smaller amounts can be consumed to produce similar weight loss in this population. Additionally, it is unknown whether doses larger than 16 fluid ounces of water would have a greater impact reducing energy intake, possibly resulting in greater weight loss. Future studies could examine the effects of varying volumes of premeal water consumption on energy intake and weight loss in the older adult population.

There are additional benefits to increasing habitual water consumption other than weight loss. Dehydration results from inadequate water and fluid intake, which can lead to cognitive impairment and impair exercise performance and blood pressure regulation. Because of limited data and individual variability, there is currently no recommended dietary allowance (RDA) for water intake; however, an adequate intake (AI) for total water intake, drinking water and additional water from food and beverages, was established from the Third National Health and Nutrition Examination Survey 1988-1994 (NHANES III). Habitual water and beverage consumption appears to be lower in the older adult population; therefore, increasing habitual water intake may prevent dehydration in this population without increasing energy intake.
In conclusion, increasing premeal water consumption in combination with a hypocaloric diet appears to be an effective weight loss strategy in older adults. Given the high prevalence of obesity within this population, these findings provide a simple, feasible and effective dietary strategy for weight management.

References


DATE: July 20, 2006

MEMORANDUM

TO: Brenda M. Davy
    Kevin P. Davy
    Janet W. Rankin

FROM: David M. Moore

SUBJECT: IRB Full IRB Approval: “Weight Loss In Older Adults”, IRB # 06-372

The above referenced protocol was submitted for full review and approval by the IRB at the July 17, 2006 meeting. The board had voted approval of this proposal contingent upon receipt of responses to questions raised during its deliberation. Following receipt and review of your responses, I, as Chair of the Virginia Tech Institutional Review Board, have, at the direction of the IRB, granted approval for this study for a period of 12 months, effective July 17, 2006.

Approval of your research by the IRB provides the appropriate review as required by federal and state laws regarding human subject research. As an investigator of human subjects, your responsibilities include the following:

1. Report promptly proposed changes in previously approved human subject research activities to the IRB, including changes to your study forms, procedures and investigators, regardless of how minor. The proposed changes must not be initiated without IRB review and approval, except where necessary to eliminate apparent immediate hazards to the subjects.

2. Report promptly to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

3. Report promptly to the IRB of the study’s closing (i.e., data collecting and data analysis complete at Virginia Tech). If the study is to continue past the expiration date (listed above), investigators must submit a request for continuing review prior to the continuing review due date (listed above). It is the researcher’s responsibility to obtain re-approval from the IRB before the study’s expiration date.

4. If re-approval is not obtained (unless the study has been reported to the IRB as closed) prior to the expiration date, all activities involving human subjects and data analysis must cease immediately, except where necessary to eliminate apparent immediate hazards to the subjects.

Important:
If you are conducting federally funded non-exempt research, this approval letter must state that the IRB has compared the OSP grant application and IRB application and found the documents to be consistent. Otherwise, this approval letter is invalid for OSP to release funds. Visit our website at http://www.irb.vt.edu/pages/newstudy.htm#OSP for further information.

cc: File
DATE: September 22, 2006

MEMORANDUM

TO: Brenda M. Davy
    Kevin P. Davy
    Janet W. Rankin

FROM: David M. Moore

SUBJECT: IRB Amendment 1 Approval: “Weight Loss In Older Adults”, IRB # 06-372

This memo is regarding the above referenced protocol which was previously granted approval by the IRB on July 17, 2006. You subsequently requested permission to amend your IRB application. Since the requested amendment is nonsubstantive in nature, I, as Chair of the Virginia Tech Institutional Review Board, have granted approval for requested protocol amendment, effective as of September 21, 2006. The anniversary date will remain the same as the original approval date.

As an investigator of human subjects, your responsibilities include the following:

1. Report promptly proposed changes in previously approved human subject research activities to the IRB, including changes to your study forms, procedures and investigators, regardless of how minor. The proposed changes must not be initiated without IRB review and approval, except where necessary to eliminate apparent immediate hazards to the subjects.

2. Report promptly to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

3. Report promptly to the IRB of the study’s closing (i.e., data collecting and data analysis complete at Virginia Tech). If the study is to continue past the expiration date (listed above), investigators must submit a request for continuing review prior to the continuing review due date (listed above). It is the researcher’s responsibility to obtained re-approval from the IRB before the study’s expiration date.

4. If re-approval is not obtained (unless the study has been reported to the IRB as closed) prior to the expiration date, all activities involving human subjects and data analysis must cease immediately, except where necessary to eliminate apparent immediate hazards to the subjects.

cc: File
INSTITUTIONAL REVIEW BOARD AMENDMENT 2 APPROVAL (WEIGHT LOSS IN OLDER ADULTS)

DATE: November 1, 2006

MEMORANDUM

TO: Brenda M. Davy
   Kevin P. Davy
   Janet W. Rankin

FROM: David M. Moore

SUBJECT: IRB Amendment 2 Approval: "Weight Loss In Older Adults", IRB # 06-372

This memo is regarding the above referenced protocol which was previously granted approval by the IRB on July 17, 2006. You subsequently requested permission to amend your IRB application. Since the requested amendment is nonsubstantive in nature, I, as Chair of the Virginia Tech Institutional Review Board, have granted approval for requested protocol amendment, effective as of November 1, 2006. The anniversary date will remain the same as the original approval date.

As an investigator of human subjects, your responsibilities include the following:

1. Report promptly proposed changes in previously approved human subject research activities to the IRB, including changes to your study forms, procedures and investigators, regardless of how minor. The proposed changes must not be initiated without IRB review and approval, except where necessary to eliminate apparent immediate hazards to the subjects.
2. Report promptly to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.
3. Report promptly to the IRB of the study’s closing (i.e., data collecting and data analysis complete at Virginia Tech). If the study is to continue past the expiration date (listed above), investigators must submit a request for continuing review prior to the continuing review due date (listed above). It is the researcher’s responsibility to obtained re-approval from the IRB before the study’s expiration date.
4. If re-approval is not obtained (unless the study has been reported to the IRB as closed) prior to the expiration date, all activities involving human subjects and data analysis must cease immediately, except where necessary to eliminate apparent immediate hazards to the subjects.

Approval date: 7/17/2006
Continuing Review Due Date: 6/25/2007
Expiration Date: 7/16/2007

cc: File
DATE: May 21, 2007

MEMORANDUM

TO: Brenda M. Davy
    Kevin P. Davy
    Janet W. Rankin

FROM: David M. Moore

SUBJECT: IRB Amendment 3 Approval: "Weight Loss In Older Adults", IRB # 06-372

This memo is regarding the above referenced protocol which was previously granted approval by the IRB on July 17, 2006. You subsequently requested permission to amend your IRB application. Since the requested amendment is nonsubstantive in nature, I, as Chair of the Virginia Tech Institutional Review Board, have granted approval for requested protocol amendment, effective as of May 21, 2007. The anniversary date will remain the same as the original approval date.

As an investigator of human subjects, your responsibilities include the following:

1. Report promptly proposed changes in previously approved human subject research activities to the IRB, including changes to your study forms, procedures and investigators, regardless of how minor. The proposed changes must not be initiated without IRB review and approval, except where necessary to eliminate apparent immediate hazards to the subjects.
2. Report promptly to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.
3. Report promptly to the IRB of the study’s closing (i.e., data collecting and data analysis complete at Virginia Tech). If the study is to continue past the expiration date (listed above), investigators must submit a request for continuing review prior to the continuing review due date (listed above). It is the researcher’s responsibility to obtained re-approval from the IRB before the study’s expiration date.
4. If re-approval is not obtained (unless the study has been reported to the IRB as closed) prior to the expiration date, all activities involving human subjects and data analysis must cease immediately, except where necessary to eliminate apparent immediate hazards to the subjects.

cc: File
DATE:    July 20, 2007

MEMORANDUM

TO:    Brenda M. Davy
        Kevin P. Davy
        Janet W. Rankin

FROM:    David M. Moore

SUBJECT:    IRB Full Review Continuation 1:  “Weight Loss In Older Adults”, IRB # 06-372

This memo is regarding the above referenced protocol which was previously granted approval by the IRB. The proposed research, having been previously approved at a convened IRB meeting, required full IRB review prior to granting an extension of approval, according to the specifications authorized by 45 CFR 46.110 and 21 CFR 56.110. The above referenced protocol was submitted for full review continuation and approval by the IRB at its most recent meeting. Pursuant to your request, I, as Chair of the Virginia Tech Institutional Review Board, have, at the direction of the IRB, granted approval for this study for a period of 12 months, effective July 17, 2007.

Approval of your research by the IRB provides the appropriate review as required by federal and state laws regarding human subject research. As an investigator of human subjects, your responsibilities include the following:

1. Report promptly proposed changes in previously approved human subject research activities to the IRB, including changes to your study forms, procedures and investigators, regardless of how minor. The proposed changes must not be initiated without IRB review and approval, except where necessary to eliminate apparent immediate hazards to the subjects.

2. Report promptly to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

3. Report promptly to the IRB of the study’s closing (i.e., data collecting and data analysis complete at Virginia Tech). If the study is to continue past the expiration date (listed above), investigators must submit a request for continuing review prior to the continuing review due date (listed above). It is the researcher’s responsibility to obtained re-approval from the IRB before the study’s expiration date.

4. If re-approval is not obtained (unless the study has been reported to the IRB as closed) prior to the expiration date, all activities involving human subjects and data analysis must cease immediately, except where necessary to eliminate apparent immediate hazards to the subjects.

cc: File
DATE: July 17, 2008

MEMORANDUM

TO: Brenda M. Davy
    Kevin P. Davy
    Janet W. Rankin

FROM: David M. Moore

SUBJECT: IRB Full Review Continuation 2: "Weight Loss In Older Adults", OSP #455929, 455467, IRB # 06-372

This memo is regarding the above referenced protocol which was previously granted approval by the IRB. The proposed research, having been previously approved at a convened IRB meeting, required full IRB review prior to granting an extension of approval, according to the specifications authorized by 45 CFR 46.110 and 21 CFR 56.110. The above referenced protocol was submitted for full review continuation and approval by the IRB at a recent meeting. Pursuant to your request, I, as Chair of the Virginia Tech Institutional Review Board, have, at the direction of the IRB, granted approval for this study for a period of 12 months, effective July 17, 2008.

Approval of your research by the IRB provides the appropriate review as required by federal and state laws regarding human subject research. As an investigator of human subjects, your responsibilities include the following:

1. Report promptly proposed changes in previously approved human subject research activities to the IRB, including changes to your study forms, procedures and investigators, regardless of how minor. The proposed changes must not be initiated without IRB review and approval, except where necessary to eliminate apparent immediate hazards to the subjects.

2. Report promptly to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

3. Report promptly to the IRB of the study’s closing (i.e., data collecting and data analysis complete at Virginia Tech). If the study is to continue past the expiration date (listed above), investigators must submit a request for continuing review prior to the continuing review due date (listed above). It is the researcher’s responsibility to obtain re-approval from the IRB before the study’s expiration date.

4. If re-approval is not obtained (unless the study has been reported to the IRB as closed) prior to the expiration date, all activities involving human subjects and data analysis must cease immediately, except where necessary to eliminate apparent immediate hazards to the subjects.

cc: File
    OSP
DATE: July 13, 2009

MEMORANDUM

TO: Brenda M. Davy
   Kevin P. Davy
   Janet W. Rankin

FROM: David M. Moore

SUBJECT: IRB Full Review Continuation 3: “Weight Loss In Older Adults”, OSP #455929, 455467, IRB # 06-372

This memo is regarding the above referenced protocol which was previously granted approval by the IRB. The proposed research, having been previously approved at a convened IRB meeting, required full IRB review prior to granting an extension of approval, according to the specifications authorized by 45 CFR 46.110 and 21 CFR 56.110. The above referenced protocol was submitted for full review continuation and approval by the IRB at a recent meeting. Pursuant to your request, I, as Chair of the Virginia Tech Institutional Review Board, have, at the direction of the IRB, granted approval for this study for a period of 12 months, effective July 17, 2009.

Approval of your research by the IRB provides the appropriate review as required by federal and state laws regarding human subject research. As an investigator of human subjects, your responsibilities include the following:

1. Report promptly proposed changes in previously approved human subject research activities to the IRB, including changes to your study forms, procedures and investigators, regardless of how minor. The proposed changes must not be initiated without IRB review and approval, except where necessary to eliminate apparent immediate hazards to the subjects.

2. Report promptly to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

3. Report promptly to the IRB of the study’s closing (i.e., data collecting and data analysis complete at Virginia Tech). If the study is to continue past the expiration date (listed above), investigators must submit a request for continuing review prior to the continuing review due date (listed above). It is the researcher’s responsibility to obtain re-approval from the IRB before the study’s expiration date.

4. If re-approval is not obtained (unless the study has been reported to the IRB as closed) prior to the expiration date, all activities involving human subjects and data analysis must cease immediately, except where necessary to eliminate apparent immediate hazards to the subjects.

cc: File
OSP
Food Groups: Daily Calorie Levels:

<table>
<thead>
<tr>
<th></th>
<th>1200 kcals</th>
<th>1500 kcals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruits</td>
<td>1 c*</td>
<td>1.5 c</td>
</tr>
<tr>
<td>Vegetables</td>
<td>1.5 c</td>
<td>2 c</td>
</tr>
<tr>
<td>Grains</td>
<td>4 oz eq</td>
<td>5 oz eq</td>
</tr>
<tr>
<td>Meat/Beans</td>
<td>3 oz eq</td>
<td>4 oz eq</td>
</tr>
<tr>
<td>Milk</td>
<td>2 c</td>
<td>3 c</td>
</tr>
<tr>
<td>Oils</td>
<td>4 tsp</td>
<td>5 tsp</td>
</tr>
<tr>
<td>Discretionary calories</td>
<td>171 kcals</td>
<td>182 kcals</td>
</tr>
</tbody>
</table>

*Abbreviations: c, cup; oz eq, ounce equivalent; tsp, teaspoon; kcals, kilocalories

Serving Examples

**Fruits:**
- Includes fresh, frozen, canned, and dried fruit and fruit juices.
- 1 cup of fruit or 100% fruit juice, ½ cup dried fruit equals 1 cup from the fruit group.

**Vegetables:**
- Includes fresh, frozen, canned, and dried vegetables and vegetable juices.
- 1 cup of raw or cooked vegetables or vegetable juice, or 2 cups of raw leafy greens equals 1 cup from the vegetable group.

**Grains:**
- Includes foods made from wheat, rice, oats, cornmeal, barley.
- 1 slice of bread, 1 cup ready to eat cereal, ½ cup cooked rice, pasta or cooked cereal can be considered a 1 ounce equivalent from the grains group. At least half of these should be whole grains.

**Meat and Beans:**
- 1 ounce of cooked lean meat, poultry, or fish, 1 egg, 1 Tbsp. reduced fat peanut butter, ¼ cup cooked dry beans, or ½ ounces nuts and seeds can be considered a 1 ounce equivalent from the meat and beans group.

**Milk:**
- Any product derived from milk that retains the calcium content. Low fat (1%) or fat-free options are recommended.
- 1 cup of milk or yogurt, 1 ½ ounces reduced fat natural cheese, or 2 ounces of processed cheese are 1 cup servings from the milk group.

**Oil group:**
- Fats from different plants that are liquid at room temperature such as canola, corn, olive, soybean and sunflower oil.
- Foods naturally high in oils: nuts, olives, some fish and avocados.
-Processed foods containing oils: margarine, mayonnaise and salad dressings.

**Discretionary calories:** The remaining amount of calories after accounting for the recommendations of the food guide pyramid. (Extra calories)

*http://www.mypyramid.gov/downloads/MyPyramid_Food_Intake_Patterns.pdf*
### Sample Daily Meal Plan Distribution (1200 calories)

<table>
<thead>
<tr>
<th>Time</th>
<th>Meal</th>
<th>Details</th>
</tr>
</thead>
</table>
| **BREAKFAST** |                       | 1 c FRUIT  
1 oz GRAINS  
1 c MILK  
1 TSP OIL |
| **LUNCH**      |                       | 2 oz GRAINS  
1 oz MEAT/BEANS  
½ c VEGETABLES  
2 TSP OIL |
| **SNACK**      |                       | 1 c FRUIT |
| **DINNER**     |                       | 1 oz GRAINS  
2 oz MEAT/BEANS  
1 c MILK  
1 c VEGETABLES  
1 TSP OIL |

### Sample Daily Meal Plan Distribution (1500 calories)

<table>
<thead>
<tr>
<th>Time</th>
<th>Meal</th>
<th>Details</th>
</tr>
</thead>
</table>
| **BREAKFAST** |                       | ½ c FRUIT  
2 oz GRAINS  
1 c MILK  
2 TSP OIL |
| **LUNCH**      |                       | 2 oz GRAINS  
2 oz MEAT/BEANS  
1 c VEGETABLES  
2 TSP OIL |
| **SNACK**      |                       | 1 c MILK  
1 c FRUIT |
| **DINNER**     |                       | 1 oz GRAINS  
2 oz MEAT/BEANS  
1 c MILK  
1 c VEGETABLES  
1 TSP OIL |
Additional Weight Loss Tips:

☑ Set goals for yourself
  • Creating realistic weight loss goals will help you reach your target weight
  • Aim to eat a variety of nutrient-dense foods which are high in vitamins, minerals and even fiber by exploring new healthier food options at meal times
  • Limit foods high in cholesterol, saturated and trans fats, and refined, processed foods that have many calories but fewer nutrients

☑ Plan meals and snacks ahead of time
  • Plan daily meals in advance to avoid splurging on high calorie foods and overeating.
  • Keep healthy snacks in plain view such as fresh fruits, washed and sliced veggies at work and at home.
  • Go grocery shopping at least once per week so you have plenty of healthy foods handy. Focus on the perimeter of the grocery store where the freshest foods tend to be.
  • Allow yourself enough time to sit down and enjoy your meals. Skipping meals often leads to overeating later in the day!

☑ Monitor yourself!
  • Track what you eat by counting calories or keeping food records.
  • Weigh yourself regularly, 1-2 times per week.
  • Read food labels to develop an awareness of the calorie content of foods. Be wary of foods that claim to be Low-Fat or Reduced Fat. It doesn’t always mean reduced calorie.
  • Watch out for portion sizes. Divide big bags of snacks into ready to eat single-size portions that you can grab on the go to avoid overeating.
  • Learn to recognize and manage the triggers that cause you to eat even when you’re not hungry. Stress, boredom and even tiredness can lead to overeating. Try calling a friend, reading a book, or taking a short nap instead of eating.

☑ Reward yourself when goals have been met!
  • Buy new clothes or shoes
  • Arrange a manicure or pedicure
  • Schedule a full body massage at a local salon
  • Avoid using food as a reward! Organize fun times with friends and family and other activities that don’t revolve around eating.
**Tips for Eating Out**

**Restaurant meals are often higher in fat.** Fat is an inexpensive and easy way to make foods taste better. Be sure to ask questions about preparation and don't be afraid to ask for substitutions.

**Portion sizes are much larger.** Try ordering two appetizers as an entrée, or request a To-Go Box and divide the entree into two servings. Enjoy one at the restaurant and the second as the following day's lunch. You could also try sharing an entrée with a friend.

*Look for some of these words throughout the menu to gauge the calorie contents of the items.*

**Lots of fat:**

- Alfredo
- Basted
- Batter-dipped
- Breaded
- Buttery
- Creamy
- Crispy and crunchy
- Deep-fried
- Marinated
- Pan-Fried
- Rich
- Sautéed

**Opt for instead:**

- Grilled
- Baked
- Broiled
- Steamed
- Dressing and sauces on the side

**Indicators of huge portion sizes:**

- Combo
- Jumbo
- Feast
- King Size
- Grande
- Supreme

**Try these alternatives:**

- Appetizer
- Kiddie
- Luncheon
- Petite
- Regular
- Salad size

*Adapted from *Dieting For Dummies* by Jane Kirby, RD; 1998.
Free Foods:
These are foods that are very low in calories. If you feel hungry, you may try these foods to help stay on your weight loss diet:

• Diet Sodas
• Carbonated water/mineral water
• Club soda
• Unsweetened tea
• Black coffee, unsweetened
• Raw broccoli, cauliflower
• Sugar-free gelatin

• Cucumber
• Onions
• Radishes
• Salad greens
• Celery
• Cherry tomatoes
• Sugar-free hard candies or chewing gum

Seasonings/spices
These can be added to sandwiches or meals to increase flavor without adding many extra calories.

• Hot sauce
• Vinegar
• Mustard
• Horseradish
• Garlic/Onion

• Mrs. Dash (sodium free)
• Lemon
• Pepper
• Cilantro and other fresh or dried herbs

Low calorie suggested dressings:

• Salsa
• Newman’s Own Light Balsamic Vinaigrette
• Hidden Valley Fat-Free dressings
• Kroger Lite Ranch
• Kraft Free Italian Dressing

Margarines:

• Brummel and Brown
• I Can’t Believe It’s Not Butter Fat Free margarine spread
# 1200 kcal Sample Menu: Day 1

<table>
<thead>
<tr>
<th>Time</th>
<th>Meal</th>
<th>Food Items</th>
</tr>
</thead>
</table>
| BREAKFAST|                               | ½ C FRESH BERRIES  
|          |                               | ½ C OATMEAL WITH CINNAMON AND 1 TSP MARGARINE  
|          |                               | 1 C SKIM MILK  
|          |                               | WATER, TEA, COFFEE |

| LUNCH    |                               | 2 SLICES WHOLE WHEAT BREAD  
|          |                               | 3 OZ SLICED TURKEY  
|          |                               | 1 ½ SLICES LOW-FAT CHEESE (1 ½ OZ)  
|          |                               | LETTUCE, TOMATO, SPROUTS  
|          |                               | 1 TSP MAYONNAISE  
|          |                               | ½ C RAW CARROTS  
|          |                               | 2 TSP LOW FAT DRESSING  
|          |                               | DIET SODA, WATER, TEA |

| SNACK    |                               | LOW-FAT GRANOLA BAR  
|          |                               | 1 SMALL APPLE |

| DINNER   |                               | ½ C BROWN RICE  
|          |                               | 3 OZ GRILLED BARBEQUE CHICKEN  
|          |                               | 1 C STEAMED GREEN BEANS  
|          |                               | 1 TSP MARGARINE  
|          |                               | DIET SODA, WATER, TEA |

---

If you are following the 1500 calorie diet:

**BREAKFAST:** Add a slice of whole wheat toast and 1 tsp margarine

**LUNCH:** Add 1 ounce of turkey and ½ cup celery

**SNACK:** Add ½ cup fruit and 1 cup of milk

---

**Quick Tip:**

Try to choose whole wheat breads with at least 3 grams of fiber per serving. Fiber helps satisfy you so you stay fuller longer, and can be found in whole wheat products, fruits and vegetables.

**Suggested low fat granola bars:**

- Quaker Low-fat Chewy Granola Bars
- Special K Bars, blueberry or strawberry
- Kashi TLC Bars
# 1200 kcal Sample Menu: Day 2

<table>
<thead>
<tr>
<th><strong>BREAKFAST</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 MEDIUM BANANA</td>
<td>1 C CORNFLAKES</td>
</tr>
<tr>
<td>1 C SKIM MILK</td>
<td>COFFEE/ UNSWEETENED TEA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>LUNCH</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 C PASTA SALAD WITH 2 TSP LIGHT ITALIAN DRESSING AND VEGETABLES</td>
<td>1 C GREEN LEAFY LETTUCE</td>
</tr>
<tr>
<td>1 C LOW-FAT YOGURT</td>
<td>WATER/UNSWEETENED TEA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>SNACK</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 OZ ROASTED ALMONDS</td>
<td>1 MEDIUM APPLE</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>DINNER</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3 INCH SQUARE CORNBREAD</td>
<td>1 C VEGETABLE SOUP WITH BEANS</td>
</tr>
<tr>
<td>1 TSP MARGARINE</td>
<td>1 C SKIM MILK</td>
</tr>
<tr>
<td>DIET SODA, WATER, TEA</td>
<td></td>
</tr>
</tbody>
</table>

**IF YOU ARE FOLLOWING THE 1500 CALORIE DIET:**

**BREAKFAST:** Add 1 CUP OJ  
**LUNCH:** Add 1 CUP LEAFY GREENS, 2 TSP DRESSING  
**SNACK:** Add ½ OZ ALMONDS  
**DINNER:** Add ½ CUP SOUP

![Quick Tip:](true)  

**Quick Tip:**  
Try to choose dark leafy greens and colorful vegetables to optimize nutrient content. Vegetables, along with fruits and whole grains, are a nutrient dense food, meaning they have few calories but many vitamins, minerals, and fiber. Incorporating a variety of these foods into your diet also helps to prevent boredom.
# 1200 kcal sample menu: Day 3

<table>
<thead>
<tr>
<th>Time</th>
<th>Meal Description</th>
</tr>
</thead>
</table>
| **BREAKFAST** | 1 SLICE WHOLE WHEAT TOAST  
1 TSP MARGARINE  
1 C LOW FAT YOGURT  
COFFEE/ UNSWEETENED TEA |
| **LUNCH** | 2 SLICES WHOLE WHEAT BREAD  
CHICKEN SALAD (2 OZ CHICKEN, 1 TSP MAYO, CELERY)  
½ C VEGETABLE SOUP  
½ C GRAPES  
WATER/UNSWEETENED TEA |
| **SNACK** | MEDIUM ORANGE  
1 LOW-FAT GRANOLA BAR |
| **DINNER** | 2 OZ EXTRA LEAN GROUND BEEF  
1 SLICE OF CHEESE  
WHOLE WHEAT HAMBURGER BUN  
KETCHUP, MUSTARD  
1 MEDIUM BAKED SWEET POTATO  
1 TSP MARGARINE  
1 TSP BROWN SUGAR  
DIET SODA, WATER, TEA |

**IF YOU ARE FOLLOWING THE 1500 CALORIE DIET:**

**BREAKFAST:** ADD A SLICE OF TOAST AND 1 TSP MARGARINE  
**LUNCH:** ADD 1 OUNCE CHICKEN, 1 TSP MAYO  
**DINNER:** ADD 1 OZ BEEF  

**Quick Tip:**

Choose extra lean ground beef. The label should say at least “90% lean”. You may even be able to find ground beef that is 93% or 95% lean. Ground turkey is another low-fat option that can be used to make patties, but it should specify 90% lean or better on the label!
# 1200 kcal sample menu: Day 4

## Breakfast
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 MEDIUM BAGEL</td>
<td></td>
</tr>
<tr>
<td>2 TSP LOW-FAT CREAM CHEESE</td>
<td></td>
</tr>
<tr>
<td>1 C SKIM MILK</td>
<td></td>
</tr>
<tr>
<td>COFFEE/ UNSWEETENED TEA</td>
<td></td>
</tr>
</tbody>
</table>

## Lunch
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 8” FLAVORED TORTILLA</td>
<td></td>
</tr>
<tr>
<td>2 OZ TURKEY</td>
<td></td>
</tr>
<tr>
<td>1½ OZ LOW-FAT CHEESE</td>
<td></td>
</tr>
<tr>
<td>LETTUCE, TOMATO, SPROUTS</td>
<td></td>
</tr>
<tr>
<td>MUSTARD</td>
<td></td>
</tr>
<tr>
<td>1 C LIGHT POPCORN</td>
<td></td>
</tr>
<tr>
<td>WATER/UNSWEETENED TEA</td>
<td></td>
</tr>
</tbody>
</table>

## Snack
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 C LOW-FAT YOGURT</td>
<td></td>
</tr>
<tr>
<td>½ C GRAPES</td>
<td></td>
</tr>
</tbody>
</table>

## Dinner
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 C PASTA</td>
<td></td>
</tr>
<tr>
<td>½ C MARINARA WITH GROUND TURKEY</td>
<td></td>
</tr>
<tr>
<td>2 C LEAFY GREENS</td>
<td></td>
</tr>
<tr>
<td>2 TSP LOW-FAT DRESSING</td>
<td></td>
</tr>
<tr>
<td>1 SLICE GARLIC BREAD</td>
<td></td>
</tr>
<tr>
<td>DIET SODA, WATER, TEA</td>
<td></td>
</tr>
</tbody>
</table>

### If you are following the 1500 calorie diet:

**Breakfast:** Add 1 tsp jelly

**Lunch:** Add 1 ounce of turkey and ½ cup popcorn

**Snack:** Add ½ cup fruit

### Quick Tip:

**Be aware of bagel sizes. A medium bagel is considered about 3 ½ - 4 ounces. Many New York style bagels can count for up to 6 servings of grains! Many brands such as Thomas’ have mini bagels that are smaller and also provide whole wheat options.**

**Suggested light popcorn:**

- Orville Redenbacher’s Smart Pop (94% fat free)
- Act II 94% fat free popcorn
**1200 kcal sample menu: Day 5**

<table>
<thead>
<tr>
<th>BREAKFAST</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 BOILED EGG</td>
<td></td>
</tr>
<tr>
<td>2 SLICES TURKEY BACON</td>
<td></td>
</tr>
<tr>
<td>1 ENGLISH MUFFIN</td>
<td></td>
</tr>
<tr>
<td>1 TSP MARGARINE</td>
<td></td>
</tr>
<tr>
<td>COFFEE/TEA</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LUNCH</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 APPLE</td>
<td></td>
</tr>
<tr>
<td>1 C YOGURT</td>
<td></td>
</tr>
<tr>
<td>2 C LEAFY GREENS</td>
<td></td>
</tr>
<tr>
<td>2 TSP LOW-FAT DRESSING</td>
<td></td>
</tr>
<tr>
<td>1 OZ ROASTED ALMONDS</td>
<td></td>
</tr>
<tr>
<td>COFFEE/UNSWEETENED TEA/WATER</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SNACK</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ½ OZ CHEESE</td>
<td></td>
</tr>
<tr>
<td>5 WHOLE WHEAT CRACKERS</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DINNER</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>½ C BROWN RICE</td>
<td></td>
</tr>
<tr>
<td>¼ C COOKED BLACK BEANS WITH SALSA</td>
<td></td>
</tr>
<tr>
<td>½ C STEAMED BROCCOLI WITH 2 TSP MARGARINE</td>
<td></td>
</tr>
<tr>
<td>COFFEE/UNSWEETENED TEA/WATER</td>
<td></td>
</tr>
</tbody>
</table>

**IF YOU ARE FOLLOWING THE 1500 CALORIE DIET**

**LUNCH:** ADD 2 OZ CHICKEN  
**DINNER:** ADD 1/2 CUP BROCCOLI AND 1 CUP SKIM MILK

**Quick Tip:**

LOOK FOR LOW FAT DAIRY OPTIONS WHEN CHOOSING CHEESE AND YOGURT. LOW-FAT OR FAT-FREE CUPS OF YOGURT HAVE EQUAL AMOUNTS OF CALCIUM BUT FEWER CALORIES THAN FULL FAT YOGURT OPTIONS.

**Suggested Low-Fat Dairy Foods:**

- Kroger Light Yogurt or Yoplait Light Yogurt  
- Kraft Light Naturals Reduced Fat Cheese  
- Breakstone’s Fat Free or 2% Milkfat Cottage Cheese
### 1200 kcal sample menu: Day 6

| **BREAKFAST**   | 1 CUP CHEERIOS  
|                 | ½ CUP BERRIES  
|                 | 1 CUP SKIM MILK  
|                 | COFFEE/ UNSWEETENED TEA  |

| **LUNCH**       | 1 SLIMFAST OPTIMA SHAKE OR BAR  
|                 | ½ CUP FRUIT COCKTAIL  
|                 | 1 OZ ROASTED ALMONDS  
|                 | WATER/UNSWEETENED TEA  |

| **SNACK**       | LOW-FAT YOGURT  |

| **DINNER**      | WENDY’S JUNIOR HAMBURGER  
|                 | KETCHUP, MUSTARD, ONIONS, PICKLES  
|                 | BAKED LAYS POTATO CHIPS  
|                 | DIET SODA, WATER, TEA  |

---

**IF YOU ARE FOLLOWING THE 1500 CALORIE DIET:**

**LUNCH:** ADD 1 CUP CARROTS AND CELERY WITH 2 TSP LOW-FAT DRESSING, AND ½ CUP FRUIT COCKTAIL.  
**DINNER:** ADD SIDE SALAD WITH LOW-FAT DRESSING

---

**Quick Tip:**

*WHEN CHOOSING FAST FOOD OPTIONS, TRY TO MODERATE CALORIES CONSUMED DURING THE DAY. MANY FAST FOOD CHAINS NOW OFFER HEALTHIER MAIN MENU AND SIDE MENU ITEMS AS WELL. AVOID DEEP FRIED CHOICES AND OPT FOR GRILLED OR BAKED ITEMS.*

---

**Suggestions**

*WENDY’S CHILI; LARGE - 330 KCALS, 9 G FAT; SMALL - 220 KCALS, 6 G FAT*  
*WENDY’S GRILLED CHICKEN SANDWICH; 370 KCALS, 8 G FAT*  
*TACO BELL BEAN BURRITO; 370 KCALS, 10 G FAT*  
*TACO BELL CHICKEN RANCHERO SOFT TACOS; 270 KCALS, 14 G FAT*  
*MCDONALD’S HAMBURGER; 260 KCALS, 9 G FAT*  
*MCDONALD’S ASIAN SALAD WITH GRILLED CHICKEN; 290 KCALS, 10 G FAT*
**1200 kcal sample menu: Day 7**

| **BREAKFAST**       | 1 SLICE WHOLE WHEAT TOAST  
|                     | 1 TSP MARGARINE  
|                     | 1 C LOW FAT YOGURT  
|                     | COFFEE/ UNSWEETENED TEA  |
| **LUNCH**           | WENDY’S BAKED POTATO WITH CHIVES AND SOUR CREAM  
|                     | WENDY’S SMALL CHILI  
|                     | WATER/UNSWEETENED TEA  |
| **SNACK**           | APPLE  |
| **DINNER**          | 2 C LEAFY GREENS  
|                     | 2 TSP FAT-FREE DRESSING  
|                     | 3 OZ BAKED CHICKEN WITH LEMON AND PEPPER  
|                     | 1 C STEAMED MIXED VEGGIES  
|                     | ½ C BROWN RICE  
|                     | DIET SODA, WATER, TEA  |

**IF YOU ARE FOLLOWING THE 1500 CALORIE DIET:**

**BREAKFAST:** ADD 1 SLICE OF WHEAT TOAST AND 1 TSP MARGARINE  
**SNACK:** ADD 1 OZ ROASTED ALMONDS

**Quick Tip:**

**Fresh herbs are a great way to season meats and vegetables without adding extra sodium or many calories.**

**Other Suggested Seasonings:**

**Chicken:** basil, garlic, barbeque sauce, dijon mustard  
**Fish:** lemon, pepper, salsa  
**Beef:** pepper, garlic  
**Pork:** applesauce, orange slices, low-sodium teriyaki sauce
# 1200 kcal sample menu: Day 8

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<thead>
<tr>
<th><strong>BREAKFAST</strong></th>
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<tbody>
<tr>
<td>McDonald’s Egg McMuffin</td>
<td>1 C Orange Juice</td>
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<td></td>
<td>Coffee/Unsweetened Tea</td>
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<table>
<thead>
<tr>
<th><strong>LUNCH</strong></th>
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<tbody>
<tr>
<td>2 Slices Whole Wheat Bread</td>
<td>2 oz Sliced Turkey</td>
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<tr>
<td>1 ½ oz Low-Fat Cheese</td>
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<tr>
<td>Lettuce, Tomato, Sprouts, Mustard</td>
<td>½ C Cantaloupe</td>
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<td></td>
<td>Water/Unsweetened Tea</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>SNACK</strong></th>
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<tbody>
<tr>
<td>1 C Skim Milk</td>
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<tr>
<td>½ C Fruit Cocktail</td>
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<thead>
<tr>
<th><strong>DINNER</strong></th>
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<tr>
<td>3 oz Pork Tenderloin</td>
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<tr>
<td>½ C Roasted Carrots</td>
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<tr>
<td>1 Medium Whole Wheat Roll</td>
<td>1 tsp Low-Fat Margarine</td>
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<tr>
<td>1 C Skim Milk</td>
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<tr>
<td>Diet Soda, Water, Tea</td>
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</table>

**If you are following the 1500 calorie diet:**

**Lunch:** Add 1 ounce of turkey and ½ cup carrots
**Snack:** Add 1 LF Granola bar

☑️ **Quick Tip:**

**Broil, Grill, or Roast Meat, Poultry, or Fish instead of Frying. Trim away the visible fat portions of meats, and remove the skin of poultry before cooking to reduce the fat content.**
### 1200 kcal sample menu: Day 9

**Breakfast**

1 boiled egg  
1 banana  
1 slice wheat toast with low-fat margarine  
Coffee/unsweetened tea

**Lunch**

Wendy’s grilled chicken sandwich  
Lettuce, tomato  
Side salad with fat free dressing  
Water/unsweetened tea

**Snack**

½ c low-fat cottage cheese  
½ c fruit cocktail

**Dinner**

Vegetable quesadilla:  
1 6 inch tortilla, assorted mixed vegetables, 1  
½ oz shredded low-fat cheese  
1 c vegetable soup  
Diet soda, water, tea

---

**If you are following the 1500 calorie diet:**

**Breakfast:** Add 1 slice toast, 1 tsp margarine, and 1 egg  
**Snack:** Add 1/2 cup fruit cocktail

---

☑️ Quick Tip:

Be careful with the high sodium content in canned soups. Opt for lower sodium options, or when preparing your own homemade soups, limit the amount of salt added. Gradually decrease the amount of sodium consumed in your diet because it takes about 2 weeks before your taste for salty foods will change.
### 1200 kcal Sample Menu: Day 10

<table>
<thead>
<tr>
<th>Time</th>
<th>Meal</th>
<th>Serving Size</th>
<th>Ingredients</th>
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</thead>
<tbody>
<tr>
<td></td>
<td><strong>Breakfast</strong></td>
<td></td>
<td>½ C Oatmeal, 1 TSP Margarine, 1 C Milk, Coffee/Unsweetened Tea</td>
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<tr>
<td></td>
<td><strong>Lunch</strong></td>
<td></td>
<td>2 OZ Chicken Salad, 1 C Leafy Greens, ½ C Pasta Salad, Water/Unsweetened Tea</td>
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<td><strong>Snack</strong></td>
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<td>¼ C Trail Mix: Mixed Nuts, Raisins, Chocolate Pieces, ½ C Grapes</td>
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<td><strong>Dinner</strong></td>
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<td>Grilled Cheese (2 slices whole wheat bread, 1 ½ oz cheese, 1 TSP margarine), 1 C Tomato Soup, Diet Soda, Water, Tea</td>
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</table>

**If you are following the 1500 calorie diet:**

- **Breakfast:** Add ½ cup oatmeal and 1 medium orange
- **Lunch:** Add ½ cup pasta salad and 1 cup leafy greens

**Quick Tip:**

Try making chicken salad with low fat vanilla or plain yogurt instead of mayonnaise. Flavor the yogurt with one or two teaspoons of orange juice and add chopped grapes, apples and walnuts. Scoop onto leafy greens as a salad.
### 1200 kcal sample menu: Day 11

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<thead>
<tr>
<th><strong>BREAKFAST</strong></th>
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<tbody>
<tr>
<td></td>
<td>2 LOW-FAT WAFFLES</td>
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<td></td>
<td>1 TBSP LIGHT SYRUP</td>
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<td></td>
<td>1 C ORANGE JUICE</td>
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<td></td>
<td>COFFEE/ UNSWEETENED TEA</td>
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<tr>
<td><strong>LUNCH</strong></td>
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<td>3 OZ GRILLED SALMON</td>
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<td></td>
<td>2 C LEAFY GREENS</td>
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<td></td>
<td>2 TSP LIGHT DRESSING</td>
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<td></td>
<td>1 C SKIM MILK</td>
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<td></td>
<td>WATER/UNSWEETENED TEA</td>
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<tr>
<td><strong>SNACK</strong></td>
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<tr>
<td></td>
<td>1 C GRAPES</td>
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<tr>
<td></td>
<td>1 C LOW-FAT YOGURT</td>
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<tr>
<td><strong>DINNER</strong></td>
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<tr>
<td></td>
<td>CHICKEN WRAP:</td>
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<td></td>
<td>1 FLAVORED TORTILLA (6 INCH)</td>
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<td></td>
<td>2 OZ SLICED GRILLED CHICKEN</td>
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<td>½ C RICE</td>
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<td>1/2 C BLACK BEAN, CORN AND TOMATO SALSA</td>
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<td>DIET SODA, WATER, TEA</td>
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</tbody>
</table>

If you are following the 1500 calorie diet:

**BREAKFAST:** ADD 1 MEDIUM BANANA  
**DINNER:** ADD 1 OZ CHICKEN AND 1 CUP SKIM MILK

✅ Quick Tip:

Create your own salsa with beans, corn and tomatoes. Add varieties of peppers depending on your tolerance for spicy foods and some onions. You can store leftovers in the refrigerator to eat with baked tortilla chips as a snack.
### 1200 kcal sample menu: Day 12

<table>
<thead>
<tr>
<th></th>
<th>Breakfast</th>
<th>Lunch</th>
<th>Snack</th>
<th>Dinner</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Breakfast</strong></td>
<td>1 lean pocket, bacon egg and cheese</td>
<td>Tuna salad pita:</td>
<td>1 c fat-free yogurt</td>
<td>Medium baked potato with 1/2 cup low-fat</td>
</tr>
<tr>
<td></td>
<td>1 c orange juice</td>
<td>1 6 inch pita</td>
<td></td>
<td>vegetarian chili</td>
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<tr>
<td></td>
<td>coffee/ unsweetened tea</td>
<td>2 oz drained canned tuna, 1 tsp mayo, celery lettuce, tomato, sprouts</td>
<td></td>
<td>1 c steamed broccoli</td>
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<tr>
<td></td>
<td></td>
<td>1 ½ oz low-fat cheese</td>
<td></td>
<td>1 c skim milk</td>
</tr>
<tr>
<td></td>
<td></td>
<td>medium orange</td>
<td></td>
<td>diet soda, water, tea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 c carrots and celery</td>
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<tr>
<td><strong>Snack</strong></td>
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<td><strong>Dinner</strong></td>
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**If you are following the 1500 calorie diet:**

**Breakfast:** Add 1 cup skim milk  
**Lunch:** Add 1 oz tuna  
**Dinner:** Add ½ cup vegetarian chili

**Quick Tip:**

Adding shredded vegetables to your sandwiches helps to increase the fiber content without contributing many calories. Try sliced cucumbers, alfalfa sprouts, carrots, green and red peppers to also add some color and variety.
# 1200 kcal Sample Menu: Day 13

| **Breakfast** | Vegetable Egg White Omelet:  
3 Egg Whites, 1 ½ oz Low-Fat Cheese, ½ C Mushrooms, Peppers, Onions  
1 Slice Whole Wheat Toast  
1 C Orange Juice  
1 Tsp Low-Fat Margarine  
Coffee/Unsweetened Tea |
| **Lunch** | Vegetable Pita:  
6" Whole Wheat Pita, ¼ C Hummus, Lettuce, Tomato, Sprouts, Shredded Carrots, Cucumber  
1 C Fat-Free Yogurt  
Water/Unsweetened Tea |
| **Snack** | ½ C Low-Fat Frozen Yogurt  
½ C Berries |
| **Dinner** | Vegetable-Beef Stir Fry:  
2 Oz Lean Beef, Sliced  
1 C Mixed Vegetables (Peppers, Onions, Mushrooms, Broccoli, Carrots)  
2 Tsp Olive Oil  
½ C Brown Rice  
Diet Soda, Water, Tea |

**If you are following the 1500 Calorie Diet:**

**Breakfast:** Add 1 slice wheat toast and 1 tsp margarine  
**Dinner:** Add 1 oz beef

**Quick Tip:**

The leanest beef cuts include round steaks and roasts (round eye, top round, bottom round, round tip), top loin, top sirloin, and chuck shoulder and arm roasts.
1200 kcal sample menu: Day 14

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<tbody>
<tr>
<td><strong>BREAKFAST</strong></td>
<td>1 C CHEERIOS</td>
<td>1 MEDIUM BANANA</td>
</tr>
<tr>
<td></td>
<td>1 C SKIM MILK</td>
<td>COFFEE/ UNSWEETENED TEA</td>
</tr>
<tr>
<td><strong>LUNCH</strong></td>
<td>1 LEAN POCKET, CHICKEN FAJITA</td>
<td>1 C CARROTS AND CELERY</td>
</tr>
<tr>
<td></td>
<td>2 TSP FAT FREE DRESSING</td>
<td>WATER/UNSWEETENED TEA</td>
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<tr>
<td><strong>SNACK</strong></td>
<td>1 MEDIUM APPLE</td>
<td>2 TBSP LOW-FAT PEANUT BUTTER</td>
</tr>
<tr>
<td><strong>DINNER</strong></td>
<td>OPEN FACED TUNA MELT:</td>
<td>1 SLICE WHEAT BREAD</td>
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<td></td>
<td>3 OZ TUNA</td>
<td>1 TBSP PICKLE RELISH</td>
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<tr>
<td></td>
<td>TOMATO SLICES</td>
<td>1 ½ OZ LF CHEESE</td>
</tr>
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<td>1 C VEGETABLE SOUP</td>
<td>DIET SODA, WATER, TEA</td>
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**IF YOU ARE FOLLOWING THE 1500 CALORIE DIET:**

**BREAKFAST:** 1 CUP ORANGE JUICE  
**LUNCH:** ADD 1 CUP GRAPES AND 1 GLASS SKIM MILK  
**DINNER:** ADD 5 WHOLE WHEAT CRACKERS

**Quick Tip:**

LEAN POCKETS BRAND OFFERS A WIDE VARIETY OF FLAVORS THAT HAVE FEWER CALORIES AND FAT THAN NORMAL HOT POCKETS. THESE ARE ALSO VERY CONVENIENT AND ONLY TAKE ABOUT 2 MINUTES TO COOK IN THE MICROWAVE. ALSO TRY LEAN CUISINE AND HEALTHY CHOICE FROZEN ENTREES FOR QUICK AND EASY LUNCHES OR DINNERS.
Appendix I

Weight Loss Group 1 Instruction Sheet

Instructions:
Drink 1 bottle of Aquafina, 30 minutes prior to each meal. Please check off the box corresponding to breakfast, lunch, and dinner after you have finished drinking the bottle of water. We understand that you may miss a meal occasionally so we ask that you be honest when recording water consumption prior to the meal.

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<th>Week of ______</th>
<th>Monday</th>
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Appendix J

Weekly Progress Tracking Sheet

Baseline weight ______ lbs

Weight Loss Goals:

1. What is your weight loss goal for this study?

In 12 weeks, I would like to lose ________ lbs.

2. How will you try to achieve these goals?

- For best results, we recommend a 0.5 pound to a maximum of a 2 pound weight loss per week. Research has shown that rapid weight loss, i.e. more than 2 pounds per week may have a negative effect on long term maintenance of weight loss and even your health. Studies have also shown that even just a 5 -10% decrease in total body weight can be beneficial for your health.

- A pound of fat is equal to 3500 calories. This would be comparable to eating 500 fewer calories per day to lose one pound per week.