

Modifying Eating Behavior: Novel Approaches for Reducing Body Weight, Preventing Weight Regain, and Reducing Chronic Disease Risk^{1–3}

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ABSTRACT

This article is a summary of the symposium “Modifying Eating Behavior: Novel Approaches for Reducing Body Weight, Preventing Weight Regain, and Reducing Chronic Disease Risk” held 29 April 2014 at the ASN Scientific Sessions and Annual Meeting at Experimental Biology 2014 in San Diego, CA. In this symposium, novel approaches to modifying eating behavior were highlighted, including 1) alteration of meal timing and macronutrient composition and 2) retraining and provision of feedback about eating behavior. Dr. Ciampolini discussed a method for teaching individuals to recognize a decrease in blood glucose concentration, and therefore the need for energy, by learning the associated physical sensations (signifying hunger). Dr. Madar and Sigal Sofer presented their work on reducing hunger during energy reduction by feeding carbohydrate only in the evening. Dr. Hamilton-Shield reviewed studies on the Mandometer (Mikrodidakt), a device for training individuals to slow eating rate. Finally, Dr. Sazonov presented information on a wearable device, the Automatic Ingestion Monitor, which senses jaw motion and/or hand-to-mouth gestures to detect and characterize food intake. His goal is to use the instrument to prevent overeating by providing feedback to the user to stop ingestion at a predetermined limit. *Adv Nutr* 2014;5:789–791.

The burden of excess weight and accompanying chronic disease risk continues to be a problem of epidemic proportions in the United States and around the world. Sustained weight loss is difficult to achieve in formal treatment programs, with multiple factors being associated with weight regain, including high hunger, unrealistic weight-loss goals, and high intakes of calories, fats, and sugars. Recently, a number of additional factors were shown to improve long-term weight loss. In addition, there is now better understanding of the neuroendocrinological pathways that regulate hunger and satiety in response to metabolic fuel availability and energy balance. For example, the hormone ghrelin is orexigenic and stimulates appetite, whereas the hormones leptin, cholecystokinin, peptide YY, glucagon-like peptide 1, and some others are anorexigenic and promote cessation of eating

during a meal. However, it is well known that ingestive behavior is influenced by not only physiologic but also by emotional and cultural factors (1). An emerging principle of ingestive behavior is that overeating results when individuals eat in response to external cues rather than internal ones (2). An approach to combat overeating in response to external cues is to promote strategies to assist individuals to be more attentive to internal physiologic signals of hunger and satiety; these strategies have been shown to be promising regarding weight control (2). In this symposium, novel approaches to modifying eating behavior were highlighted, including 1) alteration of meal timing and macronutrient composition and 2) retraining and provision of feedback about eating behavior. Each of these may affect hunger and/or improve adherence to specific dietary regimens, which could benefit long-term weight-loss success. Most of these relatively new approaches are supported by data from randomized controlled trials lasting ≥ 5 mo, which are summarized below.

Dr. Mario Ciampolini from the Unit of Preventive Gastroenterology, Department of Pediatrics at the University of Florence, opened by describing a training strategy that would help individuals to better recognize physiologic signs of hunger. After tracking glucose and insulin responses after

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² The organizer has indicated that related reviews of this symposium will be submitted for publication in an upcoming issue of *Advances in Nutrition*.

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a meal, Ciampolini hypothesized that a low blood glucose concentration indicates utilization of the previous meal and are an indicator of low energy availability to the body. He termed this physiologic condition a state of “initial hunger” and has developed a training protocol designed to teach individuals to recognize the dip in blood glucose concentration by learning the physical sensations associated with it. The training protocol took ~2 wk and started with a prolonged fast (up to 48 h). At the point during the fast when individuals felt a physical sensation of hunger, the individuals measured and took note of their own blood glucose concentration. After consuming a small meal (300 kcal), they waited for the sensation of initial hunger again and remeasured their blood glucose. After 2 wk of repeating this procedure of eating a small meal, waiting for the initial hunger sensation, and confirming this sensation by measuring glucose, individuals were able to accurately recognize physiologic hunger. In a randomized controlled intervention (3), Ciampolini tested his “initial hunger” training method in a weight-reduction intervention in 39 overweight individuals. After the 5-mo trial, participants who had used the initial hunger approach lost more weight than did participants in the control group. The effectiveness and durability of the initial hunger training in a large clinical trial remains to be determined. The initial hunger approach may be challenging if it is not well tolerated or convenient to follow by individuals with demanding lifestyles. Anecdotally, however, Ciampolini found that over a 10-y period, 14 of 17 individuals using the method maintained a weight decrease of 5 kg.

Dr. Julian Hamilton-Shield from the Bristol Royal Hospital for Children presented research relating the speed of eating and obesity in children and adolescents. Gut hormones are secreted after food reaches the small intestine, so there is a lag period between volume of food ingested and corresponding sensations of satiety. The premise that follows is that if individuals eat too quickly, they may not experience fullness until after ingesting more than is desired. Therefore, Shield hypothesized that eating more slowly would allow the individual to develop awareness of satiety during the meal, which would, in turn, decrease the consumption of food. He used a Mandometer, a commercially available computerized device (now called the Mandolean; Mikrodidakt), to track the rate of decrease in the weight of food remaining on the plate as it was being consumed. Thus, this approach uses biofeedback to provide information and advice regarding eating rate. In a 12-mo randomized controlled trial in children and adolescents who were obese, those trained to eat using the Mandometer had more favorable eating outcomes in terms of decreased food intake and increased satiety, which translated to greater weight loss compared with the control group (4). Data presented suggested that training with a Mandometer decreased eating speed and changes in the hormones ghrelin and peptide YY consistent with increased satiety. Current mechanistic studies from this group are being conducted to explore the impact of Mandometer training on neurobiological measures using fMRI.

In another presentation, Dr. Edward Sazonov from the Department of Electrical and Computer Engineering at the University of Alabama, Tuscaloosa, highlighted another approach that relies on biofeedback to modify food intake behavior. The approach involves a wearable device, called the Automatic Ingestion Monitor (AIM), which senses jaw motion and/or hand-to-mouth gestures to detect and characterize food intake. The AIM is not yet commercially available, but initial validation studies have shown that it is highly accurate as an objective measurement of food intake (5). Sazonov demonstrated that the AIM is able to detect ingestive behaviors that were missed by a food record, a reference method of dietary assessment that relies on individuals’ self-report. Thus, the AIM has the potential to provide improvement in assessment of dietary intake over many current methods. Sazonov’s group also seeks to use the instrument to prevent overeating by providing feedback that signals the user to stop ingestion at a predetermined limit. This approach is promising because even small decrements in daily caloric intake have been shown to induce weight loss. The next steps will involve intervention studies in free-living individuals to assess effectiveness for weight reduction, as well as other measures including feasibility and compliance.

Dr. Zecharia Madar and PhD student Sigal Sofer from the Institute of Biochemistry and Food Science at the Hebrew University of Jerusalem presented their work on a dietary strategy that can be used to modify neuroendocrine mediators of food intake and improve metabolic variables. Their hypotheses were derived from observations of the circadian rhythmicity of hunger, with a zenith around 2000 h in the evening and a nadir at 0800 h ~12 h later. The biologic explanation for this phenomenon is the need to consume a larger meal before sleep to support a 12-h fast—and to prevent disruption of sleep due to hunger. However, in some studies, a greater energy intake in the evening compared with morning has been associated with obesity. Madar proposed strategies that would theoretically alter the circadian rhythm of peripheral tissues so that individuals would have low hunger during waking hours, thus conferring benefit for weight management. To support his hypothesis, Madar presented data that suggest that circadian rhythms of secretion of leptin and ghrelin, hormones involved in the regulation of satiety and hunger, respectively, could be altered by changing the timing of dietary intake. He hypothesized that altering the timing of carbohydrate intake could shift the secretion profile of insulin to the evening, and this would have an impact on the secretion of leptin and ghrelin to promote less hunger during daylight hours. Because a negative correlation between insulin and adiponectin concentrations is well established and the experimental diet allowed no carbohydrate consumption during the daytime, Madar also expected to detect increased daytime adiponectin concentrations and improved variables associated with the metabolic syndrome.

In a 6-mo randomized controlled intervention in 78 obese men and women, Madar tested the hypothesis that

during energy intake reduction, compared with a standard diet with no control of the timing of macronutrient intake, a diet characterized by carbohydrates eaten only in the evening would enhance daytime satiety, thus promoting greater weight loss (6). In accordance with his hypothesis, switching to an evening pattern of carbohydrate consumption resulted in more weight loss in the experimental group, which was associated with more favorable responses of hunger and satiety and leptin and ghrelin secretion profiles. In addition, elevated adiponectin concentrations resulted in improved biochemical and inflammatory status. The innovative studies by Madar's group are exciting and hold promise as a strategy for obesity and metabolic syndrome treatment and prevention. However, the early results regarding mechanisms do not clarify whether the observed changes in hormones including adiponectin, leptin, and ghrelin are upstream or a consequence of energy restriction and weight loss. Also, future work in a larger study should be conducted to determine the subgroups of obese individuals for whom this dietary regimen may be most suitable.

The novel strategies described for reducing body weight were each based on established theories for neuroendocrinological regulation of ingestive behavior. Three of the strategies—initial hunger, the Mandometer, and the AIM—provide biofeedback to promote healthier eating behaviors. The initial hunger approach and Mandometer device enable the user to better sense the intrinsic cues of hunger and satiety, whereas the AIM has the potential to also be used in this way, so that each of these novel strategies may help translate biologic phenomena to behavioral outcomes more effectively. For example, blood glucose concentration is a marker of energy status but the use of blood glucose monitoring to train individuals to better sense their hunger

status is novel. Also innovative are the approaches to manipulate the secretion of hormones through carbohydrate consumption patterns or speed of eating. Advantages of the strategies are that they are individual-centered and take into account factors that have been shown to lead to successful weight loss, including self-monitoring and reducing hunger. Further work will be needed to determine whether these approaches improve adherence to dietary regimens and are effective as well as cost-effective at the population level in order to help combat the obesity epidemic.

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