



U.S. Department  
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# Dietary Energy Density and Body Weight: A Review of the Evidence

## Nutrition Insight 50

### BACKGROUND

Energy density (ED) is the amount of energy per weight of food or beverage (kiloJoules/gram [kJ/g] or kilocalories/gram[k/g]). Foods high in water and/or fiber are lower in ED, while foods high in fat are higher in ED. Dietary ED can be based on calculations using food only (excluding all beverages), food and caloric beverages (excluding noncaloric beverages), or all food and beverages. Short-term feeding studies suggest that lower ED food choices can result in lower calorie intakes, indicating that lower ED diets may improve body weight management.

The 2005 Dietary Guidelines Advisory Committee (DGAC) found insufficient evidence to determine the impact of ED on body weight in adults. Since that time, new research on ED and body weight has been published, so the 2010 DGAC considered the relationship between dietary ED and body weight in both adults, and children and adolescents.

This *Nutrition Insight* provides an overview of the systematic reviews on the relationship between dietary energy density and body weight in adults, children, and adolescents, conducted by the 2010 Dietary Guidelines Advisory Committee (DGAC) and the USDA Nutrition Evidence Library (NEL) to support the development of the *Dietary Guidelines for Americans, 2010*. The 2010 DGAC review was updated in 2011.

### REVIEW OF THE EVIDENCE

The 2010 DGAC conducted systematic reviews examining the relationship between ED and body weight in adults, children, and adolescents using the USDA Nutrition Evidence Library's (NEL) methodology, which is designed to be rigorous, transparent, and reproducible and to minimize bias (Spahn, Lyon, Altman et al., 2011). The DGAC 2010 report (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2010) can be accessed at [www.dietaryguidelines.gov](http://www.dietaryguidelines.gov), and information on the literature search, evidence abstraction and analysis, and criteria for study quality can be accessed at [www.NEL.gov](http://www.NEL.gov). In 2011, the DGAC members who led the 2010 DGAC's systematic reviews on energy density worked with the NEL to update the original DGAC review.

#### USDA NUTRITION EVIDENCE LIBRARY

The USDA Nutrition Evidence Library (NEL) specializes in conducting systematic reviews to inform Federal nutrition policy and programs. The Library is a key resource for making food and nutrition research accessible to all Americans.

[www.NEL.gov](http://www.NEL.gov)

#### Energy Density and Body Weight

Two NEL systematic reviews were conducted to assess the relationship between energy density and body weight: one in adults and one in children and adolescents. Both reviews included studies published between 1980 and 2011.

*Adults.* The review in adults identified 17 studies; 7 randomized controlled trials (RCTs) and 1 non-RCT examined the relationship between ED and weight loss, and 9 cohort studies examined the relationship between ED and weight status or weight maintenance. Fifteen studies received a positive quality rating, and two were rated neutral. Studies were conducted in the United States, Brazil, France, Germany, the Netherlands, Denmark, and South Korea. Sample sizes of interventional and observational studies ranged from 23 to 89,432 subjects.

Fifteen of 17 studies found a relationship between lower ED diets and improved weight loss or weight maintenance. Four RCTs and one non-RCT found that lowering ED was linked with significantly greater weight loss. However, one RCT found that consuming a high ED snack led to weight gain, but a low ED snack had no effect. In these studies, average weight loss ranged from 0.05 kg to 7.9 kg. Two RCTs found no differences in weight following consumption of low versus high ED diets. Lastly, all nine cohort studies found associations between lower ED and improved weight, body mass index (BMI), waist circumference, or weight maintenance.

*Children.* The review in children and adolescents identified six studies. They were all prospective studies that examined the association between dietary ED (kJ/g or kcal/g) and adiposity among youth. Five of the studies received a positive quality rating, and one was rated neutral.

Four of six cohort studies found a positive association between dietary ED and adiposity. One cohort study found no association between ED and adiposity. Another cohort study found an inverse association between ED and adiposity.

### Calculating Energy Density

While there is no agreed-upon method by which to calculate ED, researchers suggest that considering the ED calculation method, and in particular whether or not beverages are included in the calculations, is important when interpreting data on the relationship between ED and weight. Beverages tend to be lower in ED than solid foods due to high water content, and questions have been raised about possible differential effects of beverages compared to solid foods on hunger, satiety, and weight.

In the review examining the relationship between ED and body weight of adults, six of the trials and eight of the cohort studies calculated ED using foods only, excluding all beverages. Two RCTs did not specify whether ED was determined using foods only or foods and beverages combined, and one cohort study calculated ED based on all foods and beverages consumed. Among these studies, the results were similar regardless of how ED was calculated, with subjects exhibiting the largest increases in ED gaining more weight than those who decreased ED. Therefore, in adults, it appears that results did not differ systematically based on ED calculation method.

In the review examining the relationship between ED and body weight of children and adolescents, three of the studies on children calculated ED using foods only, excluding all beverages. One study calculated ED using all foods and beverages, both caloric and noncaloric. One study calculated ED using all foods and caloric beverages only. The final study used five different methods in order to compare findings by method of calculation. It is noteworthy that the four cohort studies described above that found positive associations of dietary ED with adiposity calculated energy density by methods that excluded all or most beverages.

More research is needed to understand ( a) the beverage patterns associated with lower ED diets and (b) if and how satiety mechanisms differ between solid foods and beverages.

## CONCLUSIONS AND FUTURE RESEARCH

The 2010 DGAC concluded that strong and consistent evidence in adults indicates that dietary patterns that are relatively low in ED improve weight loss and weight maintenance. In addition, they concluded that there was moderately strong evidence from methodologically rigorous longitudinal cohort studies in children and adolescents to suggest that there is a positive association between dietary ED and increased adiposity.

The 2010 DGAC noted that well-controlled studies are needed to test interventions that are likely to improve energy balance, including dietary approaches that reduce energy density.

## FROM RESEARCH TO RECOMMENDATIONS

The *Dietary Guidelines for Americans, 2010* encourages consumption of an eating pattern low in ED. An eating pattern low in ED is characterized by a relatively high intake of vegetables, fruit, and dietary fiber and a relatively low intake of total fat, saturated fat, and added sugars. The 2010 DGA noted that consuming an eating pattern low in ED may help to reduce calorie intake and improve body weight outcomes. The 2010 DGA also noted that eating patterns low in ED may be associated with improved overall health, including a lower risk of type 2 diabetes in adults.

## REFERENCES

Spahn, J.M., Lyon, J.M.G., Altman, J.M., et al. (2011). The systematic review methodology used to support the 2010 Dietary Guidelines Advisory Committee. *J Am Diet Assoc.* 111(4):520-523.

U.S. Department of Agriculture and U.S. Department of Health and Human Services. (2010). *Dietary Guidelines for Americans, 2010* (7<sup>th</sup> Ed.). Washington, DC: U.S. Government Printing Office.

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