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# Reductions in entrée energy density increase children's vegetable intake and reduce energy intake

— Kathleen E. Leahy, Leann L. Birch, and Barbara J. Rolls —

Department of Nutritional Sciences, The Pennsylvania State University, University Park, Pennsylvania (KEL and BJR)  
Department of Human Development and Family Studies, The Pennsylvania State University, University Park, Pennsylvania (LLB)  
Center for Childhood Obesity Research, The Pennsylvania State University, University Park, Pennsylvania (LLB)

To prevent childhood overweight, major health organizations recommend changes in eating behavior such as limiting the consumption of energy-dense foods<sup>1</sup> and consuming diets with recommended amounts of fruits and vegetables<sup>2</sup>. These recommendations are supported by studies in adults, which have demonstrated that consumption of a diet low in energy density (ED; kcal/g) can moderate energy intake<sup>3</sup> and improve diet quality<sup>4</sup>. It is not clear however, that these dietary changes have a similar impact on children. We will review recent studies that have tested the effect of reducing the energy density of foods on preschool children's energy intake.

Several studies have demonstrated that reducing the energy density of food can be an effective approach to moderate children's energy intake<sup>5, 6</sup> because, like adults, children tend to consume a consistent weight of a food even when it is reduced in energy density<sup>5</sup>. In these studies, the energy density of a main dish was reduced by decreasing the proportion of fat in the recipe. Another way to reduce the energy density of a recipe is to increase the proportion of water-rich ingredients, such as vegetables. Increasing the proportion of vegetables in a dish has been shown to reduce energy intake in adults<sup>7</sup>. The aim of our recent study<sup>8</sup> was to determine the effect on preschool children's energy intake of decreasing the energy density of a main dish by reducing the proportion of fat and incorporating extra vegetables. Another aim of our study was to assess whether vegetable intake would be influenced by the vegetable content of the dish.

## ***Reducing dietary energy density decreased energy intake and increased vegetable intake***

Preschool children (30 boys, 31 girls) were served a standard breakfast and a test lunch one day per week for four weeks. The lunch consisted of applesauce, carrots, milk, and a pasta dish with a vegetable-based tomato sauce. Two versions of the pasta dish were formulated to be similar in taste and appearance while differing in energy density: the higher-ED dish had 1.6 kcal/g and the lower-ED dish was reduced in energy density by 25% (1.2 kcal/g). The reduction in the energy density of the pasta was achieved by decreasing the amount of cheese and substituting low-fat cheeses (thus decreasing fat content) and increasing the amount of puréed broccoli and cauliflower (thus increasing water content). Children's taste ratings for both versions of the pasta were assessed at the end of the study.

The results showed that children consumed a consistent weight of food

and milk across experimental conditions, and therefore, the energy density of the pasta had significant effects on children's energy intake from the dish and from the meal. Decreasing the energy density of the pasta by 25% led to a 25% reduction in children's energy intake of the dish and a 17% decrease in their energy intake at lunch.

Because the lower-ED version of the pasta had a higher vegetable content (three times the amount of broccoli and cauliflower), children consumed significantly more puréed broccoli and cauliflower when served this dish than when served the higher-ED version. The mean increase in intake of broccoli and cauliflower was more than half a serving of vegetables, where an age-appropriate serving is equivalent to 3 tablespoons<sup>9</sup>. A majority of children (79%) rated the taste of the lower-ED version of the pasta as the same or better than that of the higher-ED version of the dish.

## ***Implications***

This study extends the current literature on the effects of dietary energy density in children. It shows that the addition of vegetables to a food in order to lower the energy density could provide an effective strategy to both increase vegetable intake and decrease energy intake. Adding puréed vegetables to a pasta sauce did not affect acceptability, but when combined with a modest reduction in fat content, it significantly reduced energy intake. This effect is similar to the results of studies in which fat reduction alone was used to reduce the energy density of a dish/recipe<sup>5, 6</sup>. Although the studies that we have described focus on the effects of energy density at a single meal, we have found that reductions in energy density can have persistent effects on energy intake in young children. In a recent study, reducing energy density using a combination of strategies led to a decrease in energy intake over the two days of the intervention<sup>10</sup>.

In addition to providing an approach to reducing the energy density of children's diets, increasing the vegetable content of foods could improve young children's vegetable intake. Increasing vegetable intake is vital considering many children are not meeting dietary recommendations<sup>11</sup>. In the present study, vegetable intake increased by half of a serving of vegetables, but larger increases in vegetable intake may be possible if greater amounts of vegetables are incorporated into dishes or if multiple recipes are adjusted using this approach. While it is important for children to be offered vegetables in a variety of forms, incorporating vegetables into foods is a strategy that can be used to increase children's vegetable intake and to moderate energy intake.

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