

**Research and Professional Briefs**

# Impact of Portion Size and Energy Density on Snack Intake in Preschool-Aged Children

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## ABSTRACT

The influence of dietary environmental factors on child weight status may be important in the battle against childhood obesity. Portion size and energy density are factors shown to impact entrée energy intake in children. However, the influence of these factors on child snack energy intake has not been studied. Thus, the aim of this study was to investigate the impact of portion size on intake of a lower energy-dense and higher energy-dense snack in preschool-aged children. A 2×2 crossover design (within-subject factors of portion size and energy density) was conducted on Wednesdays in a preschool setting on the University of Tennessee campus from October 2008 to November 2008. Seventeen children had complete data (age 3.8±0.6 years; 10 of 17 were female; 14 of 17 were white). Foods were applesauce (lower energy dense=0.43 kcal/g) and chocolate pudding (higher energy dense=1.19 kcal/g), and portion sizes were 150 g (small) and 300 g (large). Measures included anthropometrics, hunger, liking of foods, and caretakers' child-feeding practices using validated instruments. Mixed factorial analyses of covariance, with order controlled, analyzed gram and energy snack intake across conditions. There was no significant main effect of energy density on snack intake, but the main effect of portion size on snack intake (small portion size 84.2±30.8 kcal, large portion size 99.0±52.5 kcal;  $P<0.05$ ) was significant. Results indicate increased energy intake when snacks are offered in larger portion size, regardless of energy density. Snack portion size may be an environmental strategy that can reduce excessive energy intake in children.

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To prevent childhood obesity, a greater understanding of dietary environmental factors that influence energy intake are needed. Two dietary environmental factors shown to influence entrée energy intake in pre-

school-aged children are portion size and energy density, with greater portion size and energy density of served entrées producing greater energy intake (1-7). For example, Fisher (1) found larger entrée portion size increased gram and energy intake in children as young as 2 years of age in a laboratory setting. When entrées of higher energy density, calculated as kilocalories per gram, were served to children 2 to 6 years, greater energy intake occurred, but gram consumption was not substantially affected (4,5,7).

As both portion size and energy density independently influence energy intake, when combined these dietary environmental factors may have additive effects. However, Fischer and colleagues (6) examined the effects of portion size and energy density on food and energy intake in children aged 5 to 6 years in a laboratory setting and found that energy intake was 15% greater when the larger portioned entrée was served and total meal energy was 18% higher when served the high-energy-density entrée than when served the lower-energy-density entrée, but no interaction of the two variables occurred. Leahy and colleagues (7) found energy intake to be substantially affected by energy density, but not portion size of the entrée, and no interaction between energy density and portion size in children aged 2 to 5 years in a university preschool setting.

Young children consume a substantial amount of energy from snacks (8-10). Although previous studies examining portion size and energy density on energy intake have tested this within a meal and manipulated these variables in entrée items (11), little research has examined the influence of these variables on energy intake in snacks. Therefore, this study investigated the impact of portion size and energy density on intake, both grams and kilocalories, of snacks in preschool-aged children. It was hypothesized a greater intake (grams and energy) would occur with a larger portion size snack, and a greater intake of energy, but not grams, would occur with a higher energy density snack.

## METHODS

### Study Design

This study was a 2×2 cross-over design with the within-subject factors of portion size (small vs large) and energy density (applesauce [lower energy dense] vs pudding [higher energy dense]). Four sessions lasting no longer than 30 minutes took place in a preschool setting on Wednesday afternoons, every other week from October 2008 to November 2008. Two classrooms participated and foods were presented in differing orders between the classrooms to control for order effects. Order one received the higher-energy-dense snack (small then large portion

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size for the first two sessions) subsequently followed by the lower-energy-dense snack (small then large portion size for the last two sessions), and order two received the lower-energy-dense food and large portion size first. Dependent variables were grams and energy of snack consumed.

### Participants

Families with children (aged 2 to 5 years) attending full-day preschool ( $n=32$ ) at the Early Learning Center on the University of Tennessee Knoxville campus were informed about the study by letters. Interested families received two parental consent forms and questionnaires to take home and complete. Children were ineligible to participate if they did not receive parental consent, their caretaker reported that they were unable to use a spoon, were lactose-intolerant, or were allergic to and/or disliked foods used in the study. Of the children in the two classrooms, five caretakers did not provide consent and two disliked the snack foods and were ineligible for the study. In addition, four children were absent at least 1 data-collection day. Although 21 children completed all sessions of the study, 4 children were excluded from the analyses because they consumed  $<5$  kcal in at least one session. This study was approved by the Institutional Review Board at the University of Tennessee Knoxville.

### Foods

Foods that were part of the Early Learning Center menu (each offered monthly), amorphous, and consumed with spoons—unsweetened applesauce (lower-energy-dense food, 0.43 kcal/g) and chocolate pudding, made with 2% milk (higher-energy-dense food, 1.19 kcal/g)—were used in this study. Small portion size was 150 g (lower-energy-dense=64.5 kcal; higher-energy-dense=178.5 kcal) and large portion size was 300 g (lower-energy-dense=129 kcal; higher-energy-dense=357 kcal). The small portion size used (150 g $\approx$ 5.3 oz) is similar to the preportioned (4 oz) applesauce and pudding found in grocery stores. The amount provided to children was similar to that used in a study by Leahy and colleagues (7). Water was available to children *ad libitum*, which is standard practice during snack time at the Early Learning Center. Intake of water was not measured.

### Procedures

For each session, children were provided a standard lunch, (family style) from the Early Learning Center. The same lunch menu was used for all intervention days. Three hours after lunch, children completed measures of hunger and liking of the foods with the help of research assistants before receiving their snack. Preportioned snacks, as typically served at the Early Learning Center, were passed out and children were asked not to share their snack and to eat as much or as little of their snack as desired. Children sat at the table with a classroom attendant, which was standard procedures at the Early Learning Center, and a research assistant while they consumed their snack until reported being done. Children had a maximum of 30 minutes to consume the snack, but could leave the table during the 30 minutes when done

with their snack. Once all data were collected, all families with children that completed all measures were entered in a drawing for a prize (\$50.00 gift certificate).

### Measures

**Anthropometrics.** In the first session, anthropometrics of children were measured by the research team. Children removed shoes and any excess clothing before being measured. Weight was measured to one-tenth of a pound using a calibrated portable digital scale (Healthometer Professional, Sunbeam Product Inc, Boca Raton, FL). The height of each child was measured twice to the nearest eighth of an inch using a portable stadiometer (SECA, ITIN Scale Company, Brooklyn, NY). Body mass index (BMI) was calculated as  $\text{kg}/\text{m}^2$ . The research team calculated children's BMI  $z$  score by standardizing the BMI value in relation to the population mean and standard deviation for children's age and sex (12,13). Children's BMI was also compared to the Centers for Disease Control and Prevention's BMI percentile charts to determine overweight/obese status (12,13).

**Consumption.** Snacks were measured by the research team before and after consumption to the nearest tenth of a gram using a calibrated food scale (Denver Instruments SI-8001, Fisher Scientific, Arvada, CO). Amount of snack consumed was determined by subtracting post-snack weight from pre-snack weight. Snack energy intake was determined using Nutrition Data System for Research software (developed by the Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN, version 2008, 2008). If spillage occurred during consumption, the research team collected the spilled food and returned it to the bowl.

**Liking of Foods.** Liking of each food was assessed with the aid of a trained research assistant before each snack was served at each session, using a three-point Likert-type scale (1=like; 2=neutral; 3=dislike) anchored with faces showing an expression of like (smile face), neutrality, and dislike (frown face) similar to those used previously (6,14). Lower values represented greater liking.

**Hunger.** The hunger of children was assessed with the aid of trained research assistants before each snack was served at each session with a tool developed by Birch (14) and used in previous studies (1,2,6). A series of three cartoon drawings of an individual was presented, similar to a 3-point Likert-type scale (1=very hungry; 2=neutral; 3=not hungry). The first cartoon drawing had a stomach with no shading to represent "very hungry" and the shading increased to the last stomach being fully shaded representing "not hungry." Lower values represented greater hunger.

### Caretaker Questionnaires

Caretakers completed three questionnaires at home: a demographic questionnaire, the Child Feeding Questionnaire (CFQ) (15), and the Three Factor Eating Questionnaire (TFEQ) (16,17). The CFQ assesses seven factors: perceived responsibility, perceived parent weight, perceived child weight, concern about child weight, restriction, pressure to eat, and monitoring (15). Higher numbers represent greater values on each factor. The TFEQ

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