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Research review

Effects of snacks on energy intake: An evolutionary perspective

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Abstract

The question addressed in this paper is whether the consumption of snacks contributes to higher energy intake and body weight in humans. Currently available snacks have a higher energy density than most of the foods that were available in Paleolithic diets. Humans have a weak defense against overeating, which is a functional trait from an evolutionary perspective. Various studies found that people do not compensate their energy intake after the consumption of snacks. This is particularly true for energy-containing drinks, which provide calories in liquid form. It is concluded that snack consumption may contribute to a positive energy balance.

Keywords: Evolution; Meals; Snacks; Energy intake

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Introduction

In the popular press it is often noted that the number of snacks that are eaten during the day has increased in the last decades and will further increase in the near future. The alleged increase in snack consumption is often assumed to be one of the changes in the dietary pattern that has contributed to the increase in the prevalence of obesity (Jahns, Siega-Riz & Popkin, 2001; Zizza, Siega-Riz & Popkin, 2001). The objective of the present paper is to evaluate the effects of snack consumption on energy intake and long-term energy balance (i.e., body weight and obesity) from an evolutionary perspective.

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Meals and snacks from an evolutionary perspective

People eat in episodes, and not continuously. The number, size, and composition of eating moments or eating episodes per day vary in time, history, and culture (Meiselman, 2002). In the modern industrialized societies, we distinguish between meals and snacks. The term 'meal' usually refers to the three main eating moments of the day, including breakfast (in the morning), lunch (at the beginning of the afternoon), and dinner (at the beginning at the evening). The term 'snack' refers to other eating episodes, and includes all foods and drinks consumed outside the context of the three main meals.

Meals are very often consumed at a regular basis on fixed times of the day within particular social and environmental contexts (e.g., home, restaurant, canteen).

Most meals are not composed of one type of food, but contain different foods and/or courses (Meiselman, 2002). Meals are also often consumed in the company of other people implying that people share their foods with others. Sharing foods with others is not new from an evolutionary perspective; primates and social predators are also known to share foods. Primates as well as grazing animals spent a large time of their days searching, and subsequently eating foods immediately. This pattern of eating has more resemblance to snacking than to the eating of meals.

Meals in modern industrialized societies are consumed on a more regular basis than snacks. Data from Hulshof (1994) (see De Graaf, 2002) referring to 141 young Dutch adults in the early 1990s demonstrated that the average within-subject coefficient of variation (standard deviation/mean) of energy intake was about 30–40% for breakfast, lunch and dinner, compared to 90–125% for morning, afternoon and evening snacks. This implies that for most people snacks are not consumed at a regular basis (Table 1).

Most snacks in the industrialized world have a high-energy density. Sweet snacks such as cookies, cakes, pies, ice cream, and chocolate candy bars contain high amounts of sugar and fat. On average their energy content is about 1500–2000 kJ/100 g (400–500 kcal/100 g) (NEVO, 2004; Whybrow, 2005). Savory snacks such as potato chips are also high-energy density products with about 2200 kJ (550 kcal)/100 g, even in its 'low fat' (so-called 'diet' or 'light') form (2000 kJ or 500 kcal)/100 g). Sugar/fat-containing soft drinks or yoghurt-like beverages, which are also regularly consumed outside the context of the three main meals, do not have a high-energy density by themselves (170 kJ/100 g), but as they are consumed in large portion sizes they still result in a considerable energy intake (400 kJ) per portion of 250 ml. The high-energy density of current snacks stands in strong contrast to the low-energy density of most foods in Paleolithic diets, which predominantly consist of minimally processed plant-based foods and foods from animal origin (Cordain et al., 2005). For example, most fruits and vegetable contain less than 100 kJ/100 g (NEVO, 2004).

Table 1
Mean of within-subjects coefficients of variation in % for energy and macronutrient intakes at separate eating occasions during the day ($n = 141$)

Energy/nutrient	Eating occasion						
	Brkfst	Morning	Lunch	Afternoon	Diner	Evening	Total
Energy (MJ)	34	125	41	95	40	90	20
Carbohydrate	35	121	41	89	43	84	21
Protein	42	148	47	125	40	128	22
Fat	52	160	54	139	59	135	33
Alcohol	244	265	245	219	229	169	159

Subjects recorded their intake during 6–9 separate days. (Data from Hulshof, 1994).

From a large number of recent studies we know that humans easily overeat on high-energy dense foods (e.g., Blundell, Lawton, Cotton, & MacDiarmid, 1996; Rolls & Bell, 1999). In addition, it has been demonstrated that already in infancy individuals learn to like tastes and flavors that are associated with a high-energy density (e.g., Birch, McPhee, Steinberg & Sullivan, 1990). We like energy-dense foods and we easily consume considerable amounts from them. This tendency for passive (unconscious) overconsumption of energy/fat makes sense from an evolutionary point of view: being able to ingest more energy than you expend is beneficial because it allows for energy (fat) storage that may be required in times of food scarcity.

Eating frequency and body weight

As noted in the introduction, it is often assumed that the number of snacks that are eaten during the day has increased in the last decades and will continue to increase in the near future. Actual longitudinal data on the contribution of meals and snacks to the daily energy intake do not confirm this assumption, however. For instance, data from Dutch food consumption surveys show that the average contribution of snacks to the daily energy intake was relatively constant (about 30–35%) in the past 15 years (data were collected in 1988, 1992/1993, 1997/1998, and 2003; RIVM/TNO, 2004; Voedingscentrum, 1998). Data from the US Bogalusa heart study in 10-year old children show that the average total number of eating episodes even decreased from 6.6 in 1973 to 5.2 in 1994 (Nicklas et al., 2004).

The presumed increase in snack consumption is often regarded to be one of the changes in the dietary pattern that contributes to the increase in the prevalence of obesity (Jahns et al., 2001; Zizza et al., 2001). However, the relationship between eating frequency and body weight is not consistent across studies. Some studies find a positive relationship between number of eating episodes and BMI, whereas other studies find an opposite effect (Bellisle, McDevitt & Prentice, 1997). A recent large-scale ($n > 5000$) Swedish study found that on average obese people consumed snacks more frequently than lean subjects do (Bertéus Forslund, Torgerson, Sjostrom, & Lindroos, 2005). In line with this observation, reported energy intake increased with increasing snacking frequency (Bertéus Forslund et al., 2005). In contrast with these findings, however, a recent 7-year follow-up longitudinal study among 196 non-obese girls did not find any relationship between the consumption of energy-dense snacks and weight status (Phillips et al., 2004).

If eating frequency exerts an influence on body weight status, it works through its effect on ad libitum energy intake, and not through effects on expenditure. Given a certain energy intake, energy expenditure through diet-induced thermogenesis (i.e. the increase in energy expenditure after ingestion of food) has been shown to be