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Meals and snacking, diet quality and energy balance

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HIGHLIGHTS

- Snacking sometimes facilitates the adjustment of energy intake to requirements.
- By contrast, snacking sometimes faciliates overeating and body weight gain.
- Different definitions and scientific methods can explain some of the discrepancies.
- Deleterious snacking habits should be identified and targeted for behavior change.

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ABSTRACT

The present obesity "epidemic" has been attributed to a growing trend for snacking. Snacking may contribute to excess energy intake and weight gain through different ways, for example: context/environment of eating, frequency of consumption and quality of food choices. The present article reviews data and hypotheses about the role of snacks in diet quality and body weight control. One obvious difficulty in this field is the diversity of definitions and approaches used in cross-sectional, longitudinal, and intervention studies. A brief paragraph reviews the prevalence of snacking in various countries and its recent evolution. The literature addressing the contribution of snacks to daily energy and nutrient intake presents two contrasting pictures. In many reports, snacking appears to facilitate the adjustment of energy intake to needs, and to contribute carbohydrates, rather than fats, to the diet, in addition to valuable micronutrients. Such results are usually reported in healthy, normal-weight children and adults. By contrast, snacking often appears to contribute much energy but little nutrition in the diet of other consumers, particularly obese children and adults. In addition to selecting energy-dense foods, eating in the absence of hunger in response to external non-physiological cues, in an irregular fashion, in contexts (e.g. while watching television) that do not favor attention to the act of eating, might be crucial factors determining the nutritional effects of snacking. While efforts should be continued to harmonize definitions and minimize the influence of under-reporting, interventions aimed at decreasing detrimental snacking should address both food-related aspects and behavioral components.

1. Introduction

Eating is a patterned activity. In humans, in wild animals, and even in laboratory animals with constant access to food, a number of eating events occur over the day, separated by intervals of variable duration. There are obvious physiological reasons (hunger for example) that determine the eating pattern of a living organism in a particular environment. In humans, social constraints also determine how many eating events take place over a day and culture dictates when eating is or is not appropriate. Every child is trained to shape his/her eating behavior according to the culturally appropriate pattern. In Western societies, daily eating is usually organized in three meals: breakfast, lunch, and dinner, that are socially structured eating occasions, occurring at relatively predictable times, with a predictable "menu" of appropriate food options (that vary widely across cultures), consumed in company (family, friends, colleagues), and in dedicated places (dining room, restaurants, cafeterias, etc.) Other eating events also occur in the daily routines of most people. Some experts have expressed the idea that eating events may act differently on nutrient and energy intake, as well as on the body energy balance, depending on whether they are "meals" or other eating events, that is: "snacks".

Increasing rates of overweight and obesity have coincided with the recent erosion of traditional eating patterns and it is legitimate to ask whether any causal influence can be identified on energy balance and diet quality. Actually the impact of the daily eating pattern on the body adiposity status has generated much research [1,2]. The daily number of eating occasions and the circadian distribution of intake are

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important aspects of the eating pattern that are addressed in other contributions to this symposium [3,4]. The present paper will examine the respective role of meals and snacks in diet quality and energy balance.

Consumption of "snacks" in addition to meals has been viewed by many experts as a major contributor to the rise in overweight and obesity. Booth [5] clearly suggested a causal relationship in his view that the "growing trend for "grazing" rather than of the traditional pattern of three proper meals a day is a major factor in the etiology of obesity". This expert opinion has the merit of clarity: "proper meals" are three and any extra intake is a clear contributor to obesity. In practice, however, the actual definition of snacks versus meals is difficult and critically affects study protocols, their results, and their interpretation. Actually data published over the last decades in America and in Europe disagree on the influence of snacking on body energy balance and quality of the diet. The contribution of snacking to the daily diet is one more subject for controversy in the scientific literature. In this short paper, the claims made by opposing parties will be examined and some of the likely causes of disagreement will be addressed.

2. Defining meals and snacks: an area of great scientific creativity

In experimental trials conducted under laboratory conditions, for example in studies examining compensation following a pre-load or the influence of distracting stimuli present at the time of eating, it is easy for the experimenter to decide what is a meal and what is a snack. In free-living conditions, however, the discrimination of meals and snacks can be a great deal trickier and researchers have proposed a variety of solutions to this problem.

Eating patterns in free living persons are studied using a variety of self-declaration methods: one or multiple successive or non-successive 24 h dietary recalls are used in large scale cross-sectional or prospective studies, such as the National Health and Nutrition Examination Surveys (NHANES) (in adults [6,7]; in adolescents [8]); complete descriptions of all intake events occurring over seven consecutive days are obtained in smaller populations using methods such as the Weekly Food Diary [9]. Other methods, such as Food Frequency Questionnaires have also been used to survey habitual intake (for example [10]).

In many cases, the format of the dietary survey pre-defines categories of eating events for the respondents to complete. For example, in the study of short-term dietary compensation in free-living adults carried out by McKiernan et al. [11], respondents were asked to declare their intake at seven pre-determined eating occasions: breakfast, morning snack, lunch, afternoon snack, dinner, evening snack, and overnight. Similarly, the French CREDOC, a national organization that conducts regular surveys of life conditions in the French population, uses a dietary questionnaire that specifically asks for intake at main meals and during inter-meal periods [12]. A conservative approach is defining snacking as any eating outside the culturally accepted "main" meals [13]. In some American studies, snacking refers to ingesting a particular type of food. In American English, "snack food" is one category of food comprising items of low micronutrient quality and usually rich in fat and/or sugar. The specific impact of intake of "snack foods" was investigated in a longitudinal study of weight change in American children and adolescents [10]. No such category exists in some other languages (e.g. French) although similar foods are available and are ingested at "main" or other eating events. In a study of Scottish children [14], meals and snacks were defined using a food-based classification system based on "core" and "non-core" foods. "Core" foods were defined as those normally eaten as part of a meal, and "non-core" foods and drinks as those easily consumed out with a meal, for example, biscuits, cheese, fruits and soft drinks. Clearly, core and non-core foods could be defined differently in other cultures.

Other survey approaches do not impose a pre-determined definition of meals and snacks. The Weekly Food Diary was developed by De Castro [9]. In the Weekly Food Diary, all eating events are recorded for seven consecutive days and their parameters (time and place of occurrence, duration, size, palatability, psychological state before and after the event, number of people present, etc.) are reported. Factors determining the size of the eating event (duration of pre-intake fast, level of experienced hunger, estimated stomach content at the beginning of intake, etc.) and the consequences of the eating event (duration of satiety, experienced hunger and satiety, etc.) can be quantified and their relationships can be mathematically studied. In animal models, a quantitative recording of all daily eating events has made it possible to understand the critical determinants of the daily eating pattern and the major influence of the satiety period in the organism's energy balance [15]. In humans the Weekly Food Diary has similarly revealed that a large number of influences (including major physiological factors such as hunger and non-physiological factors such as number of people present) exert a small but significant effect on the size of an eating event. Their influences have been integrated in a General Intake Regulation Model [16]. The Weekly Food Diary method actually asks the respondents to indicate whether they themselves consider each eating event to be a meal or a snack, but each eating event is defined according to the same rules (it must contain at least 50 kcal and be separated from preceding and following eating events by at least 45 min). In this method, meals and snacks, as defined by the respondents, are treated alike by the mathematical data processing.

Besides these definitions based on the observations and reporting of behaviors, an original approach was proposed by Chapelot and colleagues [17,18] on a physiological basis. According to this view, regardless of the time of consumption or macronutrient composition, a crucial difference between meals and snacks is the presence or absence of a physiological triggering stimulus. First described in laboratory animals [19], a small transient decline in blood glucose concentration occurs just before the onset of a meal and has been confirmed in several human studies [20,21]. This peripheral event is presumed to signal a shortage of glucose in tissues and to trigger eating via the activation of glucose-sensitive neurons and modulation of neuropeptide secretion in specific areas of the central nervous system. In every day settings, the availability of palatable foods may trigger intake at high levels of satiety and in the absence of the biological profile usually associated with meal onset [22]. Marmonier et al. [23] proposed to define a meal as an eating episode (whatever its size or timing) motivated by hunger and therefore preceded by a particular metabolic pattern (a drop in glycemia). In contrast, a snack would be defined as an eating episode not triggered by hunger but instead elicited by an external non-physiological stimulus. Because of differences in metabolic status immediately before a meal or a snack (when a meal is triggered by physiological hunger, blood glucose and insulin concentrations are low and fatty acid concentrations are rising), the utilization of energy substrates is hypothesized to be quite different [24].

3. Prevalence of snacking in Europe and America

Snacking, defined as eating outside of main meals, is a very common behavior, as established by numerous cross-sectional and longitudinal studies carried out in various areas of the world. Children, adolescents and adults in various parts of Europe and America snack at least once and often several times a day ([25–28] among others). Snacking is observed at any time of the day (morning, afternoon, evening).

Culture determines the number and times of daily eating episodes. Comparisons of snacking behavior in different parts of the world have been published. A survey of 16 486 university students in 21 European countries reported the intake of 2.8 daily meals and 1.6 daily snacks [28]. Differences in number and type of eating events appeared between countries. While less than 8% of this population was overweight or obese, 17.4% of men and 43.8% of women were trying to lose weight, which was associated with a decreased daily number of snacks. A cross-cultural comparison (Netherlands, France, U.S.A.) of non-obese healthy young adults using the Weekly Food