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# Food texture trumps food processing in the regulation of energy intake

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In recent years, there has been a growing research interest in the possible role of ultra-processed foods (UPFs) in a wide range of noncommunicable diseases (NCCDs). Almost all of this research is correlational in nature. The first attempt to explore how UPFs might contribute to one of the many implicated NCCDs involved a crossover randomized control trial (RCT) conducted under metabolic ward conditions and that compared ad libitum energy intake on diets high or low in UPFs (1). The high UPF diet led to a greater intake of energy and to weight gain compared with the diet low in UPFs. The data showed that the high UPF arm was also associated with a higher energy density and with an increased eating rate.

As far back as the heyday of dietary fiber research in the 1970s, it has been known that food texture influences eating rate and energy intake. The eating rate of an intact apple is slower than that of the same apple presented as a juice (2). Food texture matters when it comes to eating rate, and eating rate is now firmly established as a contributory factor to weight gain (3). Using concealed video technology and specialized algorithms, it is now possible to get extensive measures of eating rate and to quantify its elements: bite size (g), chews per bite (*n*), and oral exposure per bite (*s*).

Texture was not studied in the original RCT. Thus, it is possible that in that study, the UPF diet had a softer texture that led to the observed faster eating rate and thus contributed to weight gain. In this issue of the *American Journal of Clinical Nutrition*, Teo et al. (4) examine the relative importance of the degree of processing of a food (ultra-processed compared with minimally processed) and the texture of that food (hard compared with soft) on eating rate. Four lunchtime test meals were studied, half being soft textured and half being hard textured. Each of these comprised 2 arms, one of minimally processed foods and the other of UPFs.

The hard, minimally processed, and hard-ultra-processed meals were consumed at a slower rate, reducing weight of food intake (g) by 21% and energy intake (kcal) by 26%, with the intake of the hard and soft meals almost exactly matched gram for gram independent of the degree of processing. If energy density played a role in influencing eating rate, it was minor compared with texture. A similar observation was made by the same group with thick and thin soups varying in energy density (1.01 compared with 1.57 kcal/g). Texture significantly influenced eating rate, whereas energy density had no effect and showed no statistical interaction with any measure of eating rate (5). However, there is bound to be some correlation between

energy density and food texture, an area that most certainly needs further study.

The food category of UPFs contains a wide variety of food types, united only by the presence of food additives (6). In most Western countries, these foods account for >60% of energy intake, and the recommendation of the advocates of NOVA is that UPFs should be avoided, a strategy that would pose a major problem in public health nutrition. However, as the present study shows, foods classified as ultra-processed can vary in both texture and energy density, and including them all in 1 category, simply because of their additive content, is not helpful to those charged with formulating dietary advice to minimize NCCDs. Indeed, a recent publication from the Lifestyle prospective study examined the contribution of UPFs to the development of type 2 diabetes in >70,000 adults followed for 41 mo (7). The authors used principal component analysis to identify 4 clusters of UPF intake. Two of these clusters showed a positive link between consumption of these foods and onset of type 2 diabetes, although the odds ratio of developing diabetes was low (1.16; 95% CI: 1.09, 1.22) for one cluster and 1.15 (95% CI: 1.08, 1.21) for another cluster. A third cluster failed to find such an association, and the fourth cluster showed a reduced risk of UPF intake on the occurrence of type 2 diabetes (0.82; 95% CI: 0.76, 0.89). Another study examined the eating rate of foods varying in their degree of processing and found that indeed, the UPF category had the fastest eating rate (8). This observation was dwarfed by the very large variation in eating rate within each level of processing. Taken together, these studies, along with that of Forde et al. (4) in the present journal, clearly indicate that within the gross category of UPFs, there is great heterogeneity of attributes of relevance to public health condition.

UPFs have been linked to many NCCDs besides energy imbalance, and for each of these putative links, research needs to move beyond the present correlational studies to involve many more mechanistic studies. Such studies are challenging but quite

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Abbreviations used: NCD, noncommunicable disease; RCT, randomized control trial; UPF, ultra-processed food

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feasible and within the competence of most research units (9). Food processing, necessitating the use of food additives and hence classified as UPF, is likely to grow in the coming decade with increased demand for analogues of meat and dairy products (10, 11). If processing is to become a driver in public health nutrition, it will have to be based on evidence of its function in the etiology of NCCDs.

The present study shows that the texture of foods is more important than the degree of processing in terms of eating rate. With increasing evidence that eating rate is a major driver of energy intake, strategies to manipulate the texture of processed foods will arise. However, texture is not a word that consumers easily understand, and such terms as *hard* and *soft textures* are not within the lexicon of the world of food regulatory affairs. But if science is to drive policy, then this issue of texture, either in food reformulation or in public health nutrition advice, is simply a challenge that has to be embraced.

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