

Healthy Eating at School to Compensate for the Activity-Related Obesigenic Lifestyle in Children and Adolescents: The Quebec Experience^{1–3}

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ABSTRACT

In this article, we describe the Quebec experience about the determinants of childhood obesity and the search for solutions, which are well adapted to the constraints of the current lifestyle. As expected, it is likely that a decrease in physical fitness and its related sedentariness as well as suboptimal food habits have contributed to the increase in overweight prevalence that was observed between 1980 and 2000. Our research experience suggests that other less suspected activity related factors have also played an important role in the occurrence of the obesity epidemic. This is particularly the case for short sleeping and demanding mental work, which are features of our modern lifestyle. Because there is no foreseeable prospect for a change in sleep and mental work habits, we argue that compensations in other factors may be necessary to prevent weight gain in this new context. We thus developed a concept of food design aiming at the maximization of the satiating properties of a food or a meal course. In this context, we were successful in the design of healthy lunch bags for students of a school located in a low socioeconomic area. Indeed, for a majority of menus, an optimal compromise seemed to be reached between nutrient composition, satiating potential, palatability, and financial accessibility. In summary, the Quebec experience reveals that childhood obesity is a complex problem that partly results from unsuspected environmental factors that deserve creative solutions to at least partly compensate for their effect. *Adv. Nutr.* 2: 1675–1705, 2011.

Introduction

Population data have repeatedly emphasized the increase in obesity prevalence over the recent decades and they also indicate that this trend has not been linear over time. This is the case in the province of Quebec, Canada, where a

substantial increase in the percentage of overweight children and adolescents was observed between the years 1980 and 2000 (1). Since that time, a plateau in overweight prevalence seems to have been reached, which suggests that interventions that have been implemented to counteract the phenomenon have been to some extent successful.

The variations in overweight prevalence recorded in the last 3 decades were expected but were also explained by some unsuspected factors that are part of a desired modern lifestyle. Because some of these factors constitute the basis of socioeconomic competitiveness in a globalized world, they will likely remain an important component of our lifestyle and will impose some compensations in terms of healthy practices. Thus, in addition to the description of this context, the main preoccupation underlying the publication of this paper is the description of solutions such as a lunch bag project that was designed to offer healthy food in a low-income elementary school.

To better understand in order to better intervene

The obesity epidemic that has become apparent in the 1980s has inevitably raised questions pertaining to the determinants

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of fat gain and its related positive energy/lipid balance. Indeed, although it remains reasonable to attribute the causality of the problem to sedentariness and suboptimal macronutrient intake, other potential explanations have emerged from the relevant literature. As further described, these factors include low calcium intake, short sleeping, and demanding mental work.

Low calcium intake. The first research data providing a convincing demonstration of a negative association between calcium intake and body weight were reported by McCarron et al. (2) at the beginning of the 1980s. Interestingly, there was at about the same time in Quebec a school based program providing free availability of milk to children at snack time. We thus had a sort of natural convergence between new knowledge and application in a free-living context.

The follow-up of this convergence subsequently revealed that it was a matter of dissociation. Indeed, the school based distribution of milk was of short duration and was followed by a dominance of soft drinks over milk and yogurt in the vending machines of the schools of the Quebec City area (3). This development appears to be in the wrong direction, because Carruth and Skinner (4) reported a negative relationship between calcium/milk intake and body fatness in children. Furthermore, the investigators also showed that a negative association exists between milk intake and soft drink consumption (5).

Experimental studies have also been performed to document mechanisms underlying the calcium/milk-body weight relationship. Melanson et al. (6) reported a significant positive relationship between daily calcium intake and fat oxidation in individuals tested in a whole body indirect calorimeter. Evidence has also repeatedly been published regarding the potential of calcium, particularly from milk, to accentuate fecal fat loss via the formation of intestinal insoluble soaps (7,8). Finally, in accordance with the concept of calcium specific appetite control (9), we have showed that low calcium intake can modify the control of energy intake in a way that reduces weight loss in obese women who are very low calcium consumers (10).

Taken together, these observations suggest that the notion of healthy eating for obesity prevention is not only a matter of macronutrients, i.e., energy containing nutrients, but also represents an issue that involves a direct contribution of some micronutrients. With respect to the Quebec experience, it seems that the offer of calcium containing food has not progressed during the period when an important increase in overweight prevalence was noted.

Short sleeping. Even if early epidemiological data have documented a relationship between sleep duration and body weight (11), this association was not seriously considered by the scientific community until the report of the experimental work performed by van Cauter et al. (12). In one of their studies, they demonstrated that a sleep restriction over 2 d under controlled conditions of energy intake and physical activity resulted in a decrease in plasma leptin (12).

In addition, sleep restriction was also found to increase plasma ghrelin as well as the sensations of hunger and appetite. In this regard, it is relevant to point out that statistics of the US National Sleep Foundation clearly established that people are allocating less time to sleep compared with values recorded 40–50 y ago (13).

The survey of this literature prompted us to examine the existence of a link between sleep duration and body weight in children. We analyzed data collected in the preliminary phase of the Quebec en Forme project, which showed a negative correlation between these 2 variables in boys (14). Compared with other factors, the predictability of overweight by short sleep duration exceeded that of physical inactivity, watching TV, low familial income, low parental education, and parental obesity (14). We also extended our analysis to test the hypothesis of a preferential fat deposition in the abdominal area in short sleepers. This hypothesis was confirmed by demonstrating that waist circumference in short sleeper children was greater than what was predicted by their BMI (15). These observations are consistent with the results we obtained in adults, because short sleepers were characterized by increased body weight and fat mass as well as lower than predicted plasma leptin levels (16). Finally, it is interesting to note that short sleepers are also more predisposed to hypoglycemia (17), which may be related to the enhancing effect of sleep restriction on high sugar snack consumption (18).

In summary, short sleeping, independently of physical activity participation, appears as an important determinant of the risk of overweight in children and adults. On the basis of the currently available data, this effect might be mediated by the inadequate recovery of the hormonal profile allowing an optimal appetite control.

Demanding mental work. The broad dissemination of computerization theoretically had the potential to accentuate the proneness to overweight by further reducing physical fitness via a decreased practice of vigorous exercise. To investigate this hypothesis, we used data from the Quebec en Forme project that were collected at the beginning of the 2000s and compared them to those obtained in the 1980 Canada Fitness Survey (19). This comparison clearly showed that in both boys and girls, aerobic and muscular fitness substantially declined over this period during which obesity prevalence markedly increased.

Beyond the observation that physical fitness has decreased in children during a period of proneness to overweight, an important question has also to be addressed regarding the impact of demanding mental work. Specifically, the question pertains to whether the increased cognitive effort that is promoted by computerization is per se an obesigenic factor. Our first attempt to answer this question consisted of preliminary experiments that revealed that demanding mental work increases spontaneous energy intake and glycemia instability (20). Subsequently, the testing of university female students showed that knowledge based work exerts a trivial quantitative impact on energy expenditure but induces a considerable

increase in spontaneous energy intake (21). More recently, we confirmed the hyperphagic effect of mental work and we demonstrated substantial individual differences in the effort related to a given cognitive task (22). Accordingly, we found that female students deploying a greater cognitive effort exhibited a more pronounced glycemia instability and spontaneous energy intake compared with participants for whom mental work was less demanding (23). Finally, the examination of the activity profile of young girls indicated that the amount of school homework is an independent predictor of the proneness to accumulate abdominal fat (24).

To summarize, there is evidence suggesting that as far as the daily activity schedule of children is considered to explain the increase in obesity prevalence, physical sedentari-ness is not the only relevant factor to be studied. Indeed, our research experience reveals that the increase in demanding mental work promoted by computerization and the pressure to perform in a modern context represents an independent factor that can favor a positive energy balance.

About the solutions

It is not easy to find solutions to a problem like obesity, particularly when the search for a solution brings us in conflict with ourselves. Indeed, all the potential determinants of overweight discussed above are part of a more turbulent way of living and that is a matter of spontaneous choices by children and adults. In this context, 2 types of solutions are emerging. The first one is the attempt to solve the problem at the level of its roots, which is at best partly achievable. Indeed, under conditions of great competitiveness within and between communities, computers will not disappear and their use will continue to significantly alter the daily activity schedule, including the time allocated to sleeping.

The second type of solution that is potentially valuable is based on the development or the accentuation of practices promoting a desirable compensation to the less desirable effect of some factors. It is within this context that we invested research resources in food design over the last years in order to develop a healthy food offer that would be acceptable in terms of palatability and financial accessibility.

Food composition

A healthy food should adequately contribute to micronutrient intake and have a sufficient protein and fiber content. It should also provide lipids and carbohydrates with an optimal composition. In addition, in the context of obesity prevention, a healthy food should facilitate appetite control, i.e. promote satiety with a reduced energy intake. Thus, a healthy satiating food should have a high-nutrient density but a low-energy density.

As described by Yeomans et al. (25), the design and preparation of healthy foods should take into account what they called the palatability dilemma. Indeed, considering that an increase in palatability favors an increase in spontaneous energy intake and that an acceptable palatability is generally a prerequisite for spontaneous consumption, the challenge imposed by healthy food design partly becomes the search

for a compromise between what is too good and not good enough.

The first study that we undertook to test the impact of food design on energy intake and appetite sensations consisted of comparing 2 meal courses of similar energy intake (26). The healthy meal course was a portion of “poulet aux épices” characterized by a low-energy density and lipid content. In comparison to the portion of fettuccine carbonara that was used as a control meal course, the “poulet aux épices” also had a high-carbohydrate, -protein, and -fiber content. As expected, energy intake at dessert following the consumption of the standardized courses was significantly greater (744 kJ) after consuming fettuccine carbonara. This difference persisted at the subsequent meal, because mean energy intake at dinner time following fettuccine carbonara ingestion exceeded by ~1 MJ the intake measured after the consumption of the poulet aux épices course. These observations are concordant with the fact that hunger levels were more pronounced after the consumption of the fettuccine carbonara course.

The evaluation of palatability ratings was another important issue to be considered in this study. We thus used visual analogue scales, which showed that immediately after consumption of the standardized meal course and at the end of the meal, palatability ratings did not differ between the 2 courses. Thus, it seems that we were able to design a healthy functional menu offering an adequate compromise between optimal nutrient composition, appetite control, and palatability appreciation.

A healthy lunch bag at school

The dissemination of the information related to the above described study led to the solicitation of a partnership by a low income elementary school in order to develop a lunch bag service allowing healthy eating at lunch time. Because the school had no kitchen facilities, the healthy meal had to be entirely cold. The other main characteristics of meals were to contain a portion of each food group of the Canadian Food Guide (27), to be low in saturated fat, to be rich in proteins, fibers, vitamins, and calcium, and to be easy to eat and manipulate. Seven healthy meals were developed in accordance with these guidelines and were compared with 1 control meal prepared with junk foods and 1 mixed meal. The related research objective was the measurement of palatability, appetite related sensations, spontaneous energy intake, and satiety quotient for hunger.

The results showed that palatability ratings and spontaneous energy intake were the greatest for the control and mixed meals, which lends support to the idea that an increase in palatability favors an increase in energy intake (25). Among the 7 healthy lunch bags that were tested, 3 of them had a palatability rating that was perceived as too low to confer a sufficient subsequent desire to eat. The palatability of the other 4 healthy meals was coded as good to very good, albeit lower than the control and mixed meals. The spontaneous energy intake measured under these 4 healthy conditions was about one-half that observed under

the control and mixed meal conditions. Accordingly, the satiety quotient for hunger was much higher when children were exposed to the 4 healthy meals with a satisfactory palatability. Finally, it is relevant to emphasize that there was good compatibility between the cost of the lunch bag and the readiness to pay by parents.

Conclusion

The Quebec research experience shows that the increase in overweight prevalence observed in children during the last 2 decades of the last century was partly explained by factors whose influence was unsuspected until very recently. Because some of these determinants, e.g. short sleeping and demanding mental work, are part of a highly desired lifestyle, it will be difficult to significantly reduce their impact in a near future. In our search for solutions, we thus feel more optimistic about strategies of compensation such as the development of healthy food design, as exemplified by the lunch bag concept that we recently tested in a low income elementary school.

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