Increased food energy supply is more than sufficient to explain the US epidemic of obesity

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ABSTRACT

Background: The major drivers of the obesity epidemic are much debated and have considerable policy importance for the population-wide prevention of obesity.

Objective: The objective was to determine the relative contributions of increased energy intake and reduced physical activity to the US obesity epidemic.

Design: We predicted the changes in weight from the changes in estimated energy intakes in US children and adults between the 1970s and 2000s. The increased US food energy supply (adjusted for wastage and assumed to be proportional to energy intake) was apportioned to children and adults and inserted into equations that relate energy intake to body weight derived from doubly labeled water studies. The weight increases predicted from the equations were compared with weight increases measured in representative US surveys over the same period.

Results: For children, the measured weight gain was 4.0 kg, and the predicted weight gain for the increased energy intake was identical at 4.0 kg. For adults, the measured weight gain was 8.6 kg, whereas the predicted weight gain was somewhat higher (10.8 kg).

Conclusions: Increased energy intake appears to be more than sufficient to explain weight gain in the US population. A reversal of the increase in energy intake of ~2000 kJ/d (500 kcal/d) for adults and of 1500 kJ/d (350 kcal/d) for children would be needed for a reversal to the mean body weights of the 1970s. Alternatively, large compensatory increases in physical activity (eg, 110–150 min of walking/d), or a combination of both, would achieve the same outcome. Population approaches to reducing obesity should emphasize a reduction in the drivers of increased energy intake.

INTRODUCTION

The relative contributions of increased total energy intake (TEI) and reduced physical activity to the obesity epidemic have long been debated (1–3), and quantitative methods are needed to estimate these relative contributions. Whereas a healthy, lower-energy diet and regular physical activity need to be promoted to prevent weight gain and improve other health outcomes, it is important to know whether one side or the other of the energy balance equation is the major driver of the increase in obesity. This would help to prioritize policies and programs so that prevention efforts could be better targeted toward reducing the underlying drivers of the epidemic. It also has clinical implications for understanding and countering weight gain in individuals.

We previously analyzed the relations between body weight, TEI, and total energy expenditure (TEE) measured by using doubly labeled water techniques for children (n = 963) (4) and adults (n = 1399) (5). Energy flux was assumed to equal TEI and TEE because, on any given day, a population is virtually weight stable. Because these cross-sectional relations are constrained by the first law of thermodynamics, the equations can be used to predict changes in weight in response to changes in energy intake and physical activity. A scatter plot between body weight and energy flux for adults is shown in Figure 1 (5). From the starting point of the mean energy flux and mean weight, a population can gain weight by increasing TEI alone (white arrow), decreasing physical activity alone (black arrow), or some combination of the 2 (vector lines between the 2 arrows).

We inserted food energy supply data from the 1970s and the 2000s into the equations for the white arrow to predict the weight increases, thus helping to answer the question about whether the observed increase in food energy supply (and thus food energy intake) was sufficient to explain actual weight increases for the US population over the same period. This analysis demonstrates the practical application of these equations to answer important public health questions.

METHODS

The National Health and Nutrition Examination Surveys (NHANES) (6) provided the measured mean weights for the US children and adults in the 1970s (1971–1976) and the 2000s (1999–2002). The US food supply data for those same years, adjusted for food loss (spoilage and other waste), were used to estimate the per capita energy supply (7). The food supply data represent the food available for consumption rather than the amount of food actually ingested, so these estimates of per capita energy supply are overestimates of actual consumption, even after adjustment for food loss. In addition, food loss, particularly at the consumer level, is by nature difficult to measure accurately, and the US Department of Agriculture (USDA) acknowledges that even their updated estimates of retail, food service, and

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consumer food losses are probably understated (7, 8). Nevertheless, the USDA states that the food supply data provide a useful indicator of trends in consumption over time because many of the errors in the data are likely to be systematic, thus cancelling out when changes over time are examined (7).

The per capita energy supply was then apportioned between children (2–18 y) and adults. To do this, the 1970 and 2000 US census data (9) were used to derive the child:adult population proportions, and the doubly labeled water studies (4, 5) were used to derive data for energy intake proportions between children and adults (by using the appropriate mean age and weight from the census and NHANES data). The apportioned energy supply data (henceforth called estimated energy intake) were then included in the equations for children (4) and adults (5) to derive predicted weight gains, which were compared with their respective measured gains.

RESULTS

The estimated food energy intake for children was 7.10 MJ/d (1690 kcal/d) in the 1970s and 8.58 MJ/d (2043 kcal/d) in the 2000s and for adults was 10.07 MJ/d (2398 kcal/d) in the 1970s and 12.16 MJ/d (2895 kcal/d) in the 2000s (Figure 2). These data were combined with the mean (± SEM) measured weights from the 2 NHANES surveys for children (39.1 ± 0.9 and 43.1 ± 0.9 kg) and adults (72.2 ± 0.3 and 80.8 ± 0.4 kg) to form the darker solid lines in Figure 3. The predicted body weights from the equations are plotted against the estimated energy intake and are shown as the lighter dashed lines in Figure 3. For children, the predicted mean weights for the 2 periods were 35.1 to 39.1 kg, which made the predicted increase identical to the measured increase (4.0 kg). For adults, the predicted mean weights for the 2 periods were 68.0 to 78.8 kg, which made the predicted increase (10.8 kg) slightly larger than the measured increase (8.6 kg).

The fact that the predicted weight increase was greater than the measured increase implies that, if anything, concurrent physical activity may have increased over this time period, but this was not directly measured.

DISCUSSION

The predicted changes in weights derived from the equations suggest that increase in estimated energy intake is sufficient, by itself, to explain the increase in weight in the US population. Such
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