Obesity and the Environment: Where Do We Go from Here?

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The obesity epidemic shows no signs of abating. There is an urgent need to push back against the environmental forces that are producing gradual weight gain in the population. Using data from national surveys, we estimate that affecting energy balance by 100 kilocalories per day (by a combination of reductions in energy intake and increases in physical activity) could prevent weight gain in most of the population. This can be achieved by small changes in behavior, such as 15 minutes per day of walking or eating a few less bites at each meal. Having a specific behavioral target for the prevention of weight gain may be key to arresting the obesity epidemic.

There is no sign that the rapid increase in obesity seen over the past two decades is abating. Recent data from the 1999–2000 National Health and Nutrition Examination Survey (NHANES) (*1*) show that almost 65% of the adult population in the United States is overweight, which is defined as having a body mass index (BMI) greater than 25 kg/m^2, compared to 56% seen in NHANES III, conducted between 1988 and 1994 (*1*). The prevalence of obesity, defined as BMI greater than 30 kg/m^2, has increased dramatically from 23 to 31% over the same time period. Children are not immune to the epidemic, with the prevalence of obesity in children and adolescents up by 36% (from 11 to 15%) during this time. The future is not hopeful unless we act now. BMI distributions estimated from the last two NHANES studies are shown in Fig. 1. When we projected the data to 2008, assuming that weight gain continues at the present rate, we found that the obesity rate in 2008 will be 39%. The rest of the world is catching up. The World Health Organization (WHO) has declared overweight as one of the top ten risk conditions in the world and one of the top five in developed nations (*2*). Worldwide, more than one billion adults are overweight and over 300 million are obese (*2*). Most countries are experiencing dramatic increases in obesity. As an example, the prevalence of overweight individuals in China doubled in women and almost tripled in men from 1989 to 1997 (*3*).

Obesity increases the risk for type 2 diabetes, cardiovascular disease, and some cancers (*4*). Particularly disturbing is the 10-fold increase in incidences of type 2 diabetes among children between 1982 and 1994 (*5*). Obesity has been estimated to account for 5.5 to 7.8% of all health care expenditures (*6*) and to lead to at least 39.2 million lost work days each year (*7*).

The Rand Institute (*8*) recently reported that obesity is more strongly linked to chronic diseases than living in poverty, smoking, or drinking. This report equated being obese with aging 20 years. Obese individuals spend more on health care and on medications than nonobese individuals (*8*). Overweight and obesity are also associated with increased prevalence of psychological disorders, such as depression (*9*).

What Is Driving the Obesity Epidemic?

There is growing agreement among experts that the environment, rather than biology, is driving this epidemic (*10*, *11*). Biology clearly contributes to individual differences in weight and height, but the rapid weight gain that has occurred over the past 3 decades is a result of the changing environment. The current environment in the United States encourages consumption of energy and discourages expenditure of energy (*10*, *11*). Possible factors in the environment that promote overconsumption of energy include the easy availability of a wide variety of good-tasting, inexpensive, energy-dense foods and the serving of these foods in large portions. Other environmental factors tend to reduce total energy expenditure by reducing physical activity. These include reductions in jobs requiring physical labor, reduction in energy expenditures at school and in daily living, and an increase in time spent on sedentary activities such as watching television, surfing the Web, and playing video games.

Although there is good agreement that the environment is fueling the obesity epidemic, the relative contributions of factors influencing food intake and physical activity are not clear. Numerous changes in both have occurred simultaneously with the rise in obesity, and their magnitude and impact have not been well documented and are probably impossible to estimate retrospectively.

The numerous environmental factors that affect eating and physical activity behaviors may merely be symptoms of deeper social forces that are responsible for our present environment. Our ancestors aspired to create a better life for themselves and their children. This goal meant building a society in which more people would have access to affordable food, the amount of hard physical labor required to subsist would be reduced, and there would be an opportunity to enjoy some leisure time. These aspirational values are the modern version of the Aristotlean "good life." The assumption is that high productivity will make the "good life" possible and technology will fuel higher productivity. The irony is that technology and the accompanying productivity have created a faster and more stressful pace of life, with time pressures for us all (*12*). In his recent book *The Future of Success* (*13*), author and former U.S. Department of Labor Secretary Robert Reich states that ". . . work is organized and

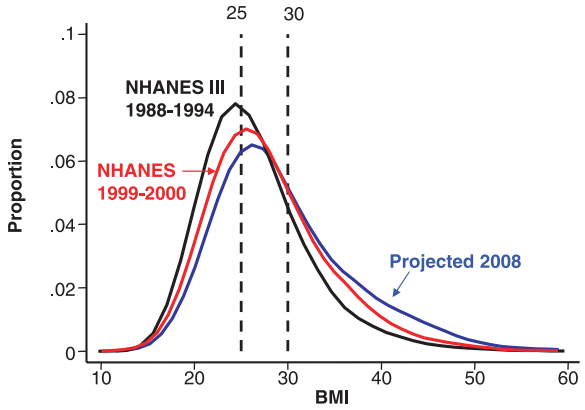

Fig. 1. BMI distributions were estimated from the National Health and Examination Surveys from 1988–94 (NHANES III) and from 1999–2000. Information from these distributions was used to predict the distribution for BMI in 2008. The cut-off points for overweight (BMI = 25) and obesity (BMI = 30) are shown.

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rewarded in America in a manner that induces harder work." We no longer have sufficient time for traditional food preparation, which has created the demand for prepackaged and fast food. Time pressures have fueled the need to get places faster, which causes us to drive rather than walk, to take the elevators instead of the stairs, and to look to technology for ways to engineer inefficient physical activity out of our lives. Our relentless quest for improved productivity and efficiency has fueled increased demand for getting better and better deals, that is, getting more for less (*13*).

A testament to this trend is the dramatic increase in the number of large retail discount stores dedicated to bringing more goods to consumers at the lowest possible cost. Valuing more for less is a key driver behind the rise of "supersizing" as a strategy for competing for the consumer's fast-food dollar. Changing family structures have also shaped the food and physical activity environment. The entry of large numbers of women into the workforce and the increase in single-parent families have changed the structure of many families and increased the value of convenience. Now, more than ever, we value the ability to conduct many aspects of everyday business without ever having to step out of our cars.

Health is only one factor contributing to the decisions that people make every day about food and physical activity and, because its consequences are long-term, it often has less impact than factors with immediate influence, such as short-term reward and convenience. It is no wonder that our previous attempts to change health behavior have not been entirely successful: We have been trying to change the long-term outcome by targeting only the health-related fraction of the total equation explaining an individual's behavior choices.

As discussed in the Viewpoint in this issue by Friedman (*14*), our biology, which evolved in times of frequent famine, is now essentially maladaptive in our environment of food abundance and sedentariness. Current social norms and values serve to reinforce behaviors that promote obesity and indeed are themselves powerful forces that help shape and perpetuate the obesigenic environment.

Building for Social Change

Although understanding the contribution of individual environmental factors to the obesity problem would be useful, this may not be possible and is probably not necessary. The solution to the obesity problem lies in identifying feasible ways to cope with and to change the current environment.

There are two fundamental paths that we must pursue simultaneously. First, we must mount a social-change campaign that will, over time, provide the necessary political will and social and economic incentives to build an environment more supportive of healthy life-style choices. We have done this in the past when we, as a society, perceived the need for dramatic action. Social change, however, does not happen overnight. Therefore, we must also pursue a short-term strategy to help individuals manage better within the current environment. People must be given strategies and tools to resist the many forces in the environment that promote weight gain.

The single greatest factor catalyzing social change in previous successful movements was the perception that there was a crisis, one which was clearly visible and threatening to the average citizen. Is obesity a crisis? Clearly, public exposure to the issue has increased in recent years, and U.S. government agencies responsible for the health of the nation have signaled their concern about the increased morbidity and mortality, reduced quality of life, and spiraling health care costs associated with the rising prevalence of overweight and obesity. This concern culminated in the U.S. Surgeon General's call to action on obesity (*15*). Nevertheless, despite the media attention and the high level of government concern, a recent survey revealed that average citizens still rank obesity lower than many other health concerns (*16*).

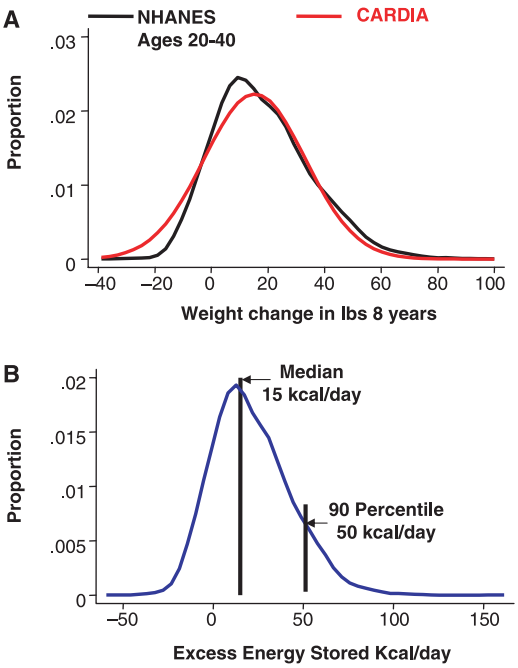

Fig. 2. (**A**) The distributions for weight gain over an 8-year period, estimated from the NHANES and CARDIA studies. (**B**) We used the rate of weight gain estimated from NHANES data to produce a distribution of the daily energy accumulation in the adult population over the 8-year period, assuming a linear accumulation of body energy. This distribution was made with the assumption that 1 pound of weight gain represents 3500 kcal of body energy. The median daily energy accumulation was 15 kcal/day, and the 90th percentile was 50 kcal/day.

Economics also played a key role in previous successful social-change movements (*17*). One way to increase the perception that obesity is a crisis might be to highlight the economic impact of life-style choices on a society already in the midst of a health-care crisis. Obesity not only affects individuals with the problem but has substantial external consequences, such as high health-care costs for everyone.

What can be done to address the obesity epidemic now? Although it is a laudable goal to substantially reduce the number of overweight or obese Americans, this goal may be totally out of reach in the short-term. A more feasible public-health goal is to stop weight gain. To do this, we must identify specific targets for how much we need to decrease energy intake or increase physical activity to effectively overcome the pressures of the environment toward positive energy balance and weight gain.

Identifying the "Energy Gap"

If we know the rate at which the population is gaining weight, it is possible to estimate both the rate at which body energy is being accumulated and the degree of positive energy balance that produced the weight (and energy) gain. This will provide a target for intervention and can be considered as the "energy gap," that is, the required change in energy expenditure relative to energy intake necessary to restore energy balance. In other words, how much more energy expenditure is needed and/or how much less food intake is needed to arrest the weight gain of the population?

On the basis of available data from the NHANES and the Coronary Artery Risk Development in Young Adults (CARDIA) study (*18*), we estimated the distribution of the rate of weight gain within the population and the amount of excess energy storage that would be required to support this population-wide pattern of weight gain. The average 8-year weight gain was 14 to 16 pounds in the longitudinal CARDIA study, whose subjects were 20 to 40 years of age, and among subjects of the same age in the cross-sectional NHANES data set. Assuming a linear rate of gain over the 8 years, this suggests that the average weight gain among subjects (20 to 40 years old) in the population is 1.8 to 2.0 pounds/year.

Assuming that each pound of body weight gained represents 3500 kcal, we estimated how much body energy was accumulated. Figure 2 shows that the median of the distribution of estimated energy accumulation is 15 kcal/day, and 90% of the population is

gaining 50 or fewer kcal/day. This means that an intervention that reduced energy gain by 50 kcal/day could offset weight gain in about 90% of the population (Fig. 2B).

Where is the excess 50 kcal/day coming from? Excess energy is not stored at 100% efficiency, owing in part to the metabolic costs of storing various ingested fuels. Rather, energy derived from mixed composition diets is stored with an efficiency of at least 50% for nearly everyone (*19*, *20*). That is, for every excess 100 kcal consumed, at least 50 kcal of energy are deposited in energy stores. On the basis of the information in Fig. 2, this would mean that most of the weight gain seen in the population could be eliminated by some combination of increasing energy expenditure and reducing energy intake by 100 kcal/day. We note that many studies suggest that the efficiency of energy storage is much greater than 50% for most people, which would require less change in energy intake or energy expenditure.

Of course, our estimate is theoretical and involves several assumptions. Whether increasing energy expenditure or reducing energy intake by 100 kcal/day would prevent weight gain remains to be empirically tested. However, we believe that in order to prevent weight gain on a public-health level, we need a quantitative goal for how much change in energy balance is needed. Our estimate suggests that the behavior change needed to close the energy gap may be small and achievable without drastically altering current life-styles. For example, energy expenditure can be increased by 100 kcal/day just by walking an extra mile each day. Similarly, it is possible to reduce energy intake by 100 kcal/day just by taking a few less bites of food at each meal.

Closing the Energy Gap

Although there are a great number of strategies that could be tested for closing the 100 kcal/day energy gap, two deserve particular attention.

Increasing life-style physical activity. It would take most people only about 15 to 20 minutes total to walk an additional mile each day. Walking a mile, whether done all at once or divided up across the day, burns about 100 kcal, which would theoretically completely abolish the energy gap and hence weight gain for most of the population. A mile of walking for most people is only about 2000 to 2500 extra steps, and these steps could be accumulated throughout the day as life-style activities, for example, taking the stairs, parking a little farther from a destination, conducting a walking meeting. A statewide intervention program in Colorado uses step counters to motivate people to increase steps by 2000 per day (*21*) and is currently being evaluated across the state.

Reducing portion size. It should be possible for many people to eat 100 kcal/day less without changing the types of food they eat or their typical meal pattern. For instance, eating 15% less (about three bites) of a typical premium fast-food hamburger could reduce intake by 100 kcal. For a typical adult with an energy intake of 2000 to 2500 kcal/day, this is only a 4 to 5% reduction in total daily energy intake. The challenge is producing such a reduction consistently in daily life. Restaurants and producers of packaged, ready-to-eat food could reduce portion sizes by 10 to 15%, although the consumer's perception of value would need to be preserved. What about changes at home? One potential criticism of this approach to closing the energy gap is that the body might compensate for any decrease in energy intake or increase in physical activity. However, small to moderate increases in physical activity have been shown not to be accompanied by compensatory increases in intake (*22, 23*).

Closing the Energy Gap in Children

It is particularly important to improve the health of our children. Children are a vulnerable population, because they may not be prepared to make informed health-related choices on their own. Because childhood obesity seems to be increasing at a disturbing rate, it may be possible to have a meaningful impact sooner in this population. As a society, we should be more willing, for example, to carefully manage the food and physical activity environments of our children at home, in school, and in other places frequented by children. If the energy gap in children is 100 kcal/day or less, as it is for adults, this could be done without a major restructuring of the home or school environment.

The Future: Where Do We Go from Here?

We must inspire people to make behavior changes within the current environment that are sufficient to resist the push of environmental factors toward weight gain. This will require conscious effort on the part of most people to make behavior choices that counteract the environmental pressure. These behavior changes must be aimed to close the energy gap, which we have estimated to be 100 kcal/day, a change that is enough to stop weight gain. We believe this goal can be accomplished with small behavior changes that fit relatively easily into most people's life-styles and are not sufficient to produce physiological compensation by the body.

It is not likely that we will ever return the environment to one in which such cognitive control of body weight is not required. We should consider how to make sure that everyone has the information and tools needed to cognitively manage energy balance. This might involve, for example, providing better information about appropriate portion size, the energy value of food, and physical activity energy equivalent of food. It might also involve cognitive skill building, probably beginning early in school, for how to achieve a balance between intake and expenditure.

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