Diabetes and Obesity—Time Bombs to Be Defused

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Seventeen years ago I wrote a commentary entitled "Obesity: A Time Bomb to Be Defused" (1). At that time the prevalence of obesity (defined as a BMI >30 kg/m^2) was 20% in men and 24.9% in women. In the intervening 17 years, it has risen to 33.5% in men and 36.1% in women—clearly in the wrong direction (2). After reading the article by Esparza-Romero et al. (3), I would expand the title of this earlier commentary to say that both obesity and diabetes are time bombs to be defused and that nothing much has happened in the past 17 years to prevent these bombs from exploding.

That obesity is a major public health problem has been recognized for more than 40 years (4). Obesity continues to increase particularly rapidly in those who are more overweight (5). Obesity is an important contributor to the rising tide of diabetes (6). Although genetic factors provide a key background for these events and may account for up to 20% of the variance in BMI, it is clear that environmental factors play a major role (7,8). In the 17 years that have passed since I wrote my earlier commentary, both problems have only become more severe and threaten the future economic base of health care in many nations (9).

Like obesity, diabetes has become more prevalent in the past 50 years (10). A relationship between diabetes and obesity was recognized by Joslin nearly 100 years ago (10). In this issue of *Diabetes Care*, the study by Esparza-Romero et al. (3) contributes important new information to this problem from two cross-sectional studies on the prevalence of obesity, prediabetes, and diabetes in Pima Indians and non-Pimas living in Maycoba in Sonora, Mexico, that was undergoing Westernization in lifestyle between 1995 and 2010 while the studies were done.

Although it is a relatively small study, it shows that every measurement of body composition and glucose metabolism increased in this 15-year interval in the non-Pimas. The authors review the rising prevalence of obesity and diabetes in the context of nutritional and cultural changes occurring even in this rural part of Mexico. The transition that the subjects underwent has been elegantly captured by Popkin (11) in the term "nutrition transition." The nutrition transition described by Popkin has occurred in many regions of the world and clearly applies to the Pimas and the non-Pimas living in Maycoba, Mexico. According to Popkin, several factors underlie this transition. They include shifts in the agricultural system and the subsequent growth of the modern retail and food service sectors across all regions and countries. There are also changes in technology affecting physical activity and inactivity, growing pervasiveness of the mass media, urbanization, and penetration of modern food systems into all sectors of society. The resulting major shifts in diet are toward increased intake of refined carbohydrates, more added sweeteners, edible oils, and animal-source foods and a reduction in the intake of legumes and fruits and vegetables. Four sets of interrelated macroeconomic and technological factors have played major roles in these shifting patterns of dietary and activity/inactivity. The first is technology in the broadest sense, including labor-saving equipment. The second is urbanization. A third factor is the remarkable shift in per capita income and general economic welfare relative to the cost of food. The fourth factor is the enormous expansion of global trade in services, providing access to modern technology and manufacturing.

Most of these features identified by Popkin (11) were evident to Esparza-Romero et al. (3) in their discussion of the basis for the increases in obesity and diabetes in Maycoba. To provide a "quantitative" estimate of the impacts of modern society on this population, they used a "modernization index" consisting of ownership of such items as a refrigerator, telephone, television, car, washer, cell phone, iron, DVD player, mixer, furnace, fan, electricity, Internet, solar panels, and radio. This index was a very strong predictor for obesity in both Pimas and non-Pimas alike.

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Obesity increased sharply in both ethnic groups and in men and women, but overweight did not increase or had only a small increase. This is probably a reflection of putting cut points on a continuous variable (Fig. 1). As a population fattens, the BMI curve shifts to the right. The large part initially is below 30 kg/m^2, but as weights increase and the curve shifts to the right, there is a proportionally larger increase in the very heavy group with little or no change in the "overweight" group. As the population studied by Esparza-Romero et al. showed a shift to the right in their BMI, it would have been interesting to look at the proportion whose BMI was above 35 kg/m^2 or above 40 kg/m^2 if there were enough in that group at the beginning. These "more obese" individuals might have had a greater increase in their prevalence of diabetes than those with BMI between 30 and 35 kg/m^2.

The principal variables associated with diabetes were age, hard occupational activity in men, percentage of calories from fat (increased) or carbohydrate (decreased) in women, and percentage of calories from protein (increased). For obesity only, the modernization index has a high association. The increased intake of fat and lower carbohydrate intake in women may have played a role in the development of obesity (12) and is counter to the suggestion by some that it is "increased" carbohydrate that causes obesity.

The decrease in hard occupational physical activity in men may also have played a role in the development of obesity. In a study of trends for activity patterns in the U.S., Church et al. (13) claimed that they could account for a significant amount of the weight gain from the decline in work-related physical activity and the increase in leisure-time activity. The lower rate of diabetes in the Pima men may be a consequence of their doing more hard occupational activity than the non-Pimas. In the Diabetes Prevention Program (DPP), increased physical activity was associated with reduced incidence of diabetes in settings where the decrease in food intake was minimal (14).

The prevalence of diabetes increased in the Pima and non-Pima women and non-Pima men but did not rise significantly from the 5.8% found in 1995. In contrast, the incidence rate of diabetes in the Pimas living in the U.S. was much higher but stable. This contrast may be a consequence of depleting the available pool of readily susceptible individuals in the U.S. Pima population. This hypothesis was suggested as an explanation for the decline in the incidence of diabetes in the control group in the DPP and may apply to the Pimas as well (15).

The article by Esparza-Romero et al. (3) nicely shows the impact of the nutrition transition on the Pimas and non-Pimas living through modernization in northern Mexico. In the modernization of Mexico, a high intake of soft drinks is a likely cause of the deteriorating levels of obesity and dental disease, which has prompted the Mexican government to impose taxes on these beverages (11). It may be that similar strategies will be needed if the time bombs of diabetes and obesity are to be defused in the U.S. before it is too late.

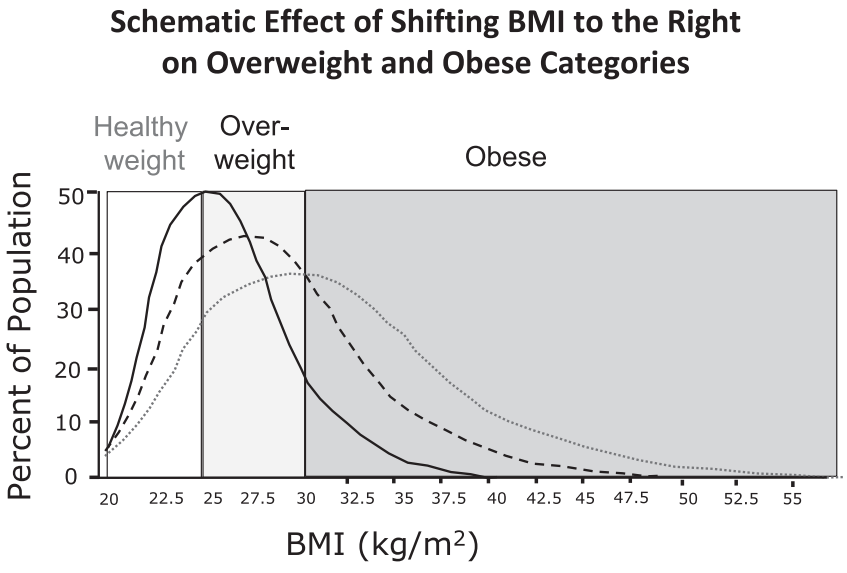

Figure 1—Schematic effect of shifting BMI as a continuous variable through cut points of 25 and 30 kg/m^2.

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References

1. Bray GA. Obesity: a time bomb to be defused. Lancet 1998;352:160–161
2. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of childhood and adult obesity in the United States, 2011-2012. JAMA 2014;311:806–814
3. Esparza-Romero J, Valencia ME, Urquidez-Romero R, et al. Environmentally driven increases in type 2 diabetes and obesity in Pima Indians and non-Pimas in Mexico over a 15-year period: the Maycoba Project. Diabetes Care 2015;38:2075–2082
4. Bray GA (Ed). *Obesity in Perspective. Fogarty International Center Series on Preventive Medicine*. Vol. 2, parts 1 and 2, Washington, DC, U.S. Government Printing Office, 1976, DHEW Publication #75-708
5. Sturm R, Hattori A. Morbid obesity rates continue to rise rapidly in the United States. Int J Obes 2013;37:889–891
6. Selvin E, Parrinello CM, Sacks DB, Coresh J. Trends in prevalence and control of diabetes in the United States, 1988-1994 and 1999-2010. Ann Intern Med 2014;160:517–525
7. Loos RJ. Genetic determinants of common obesity and their value in prediction. Best Pract Res Clin Endocrinol Metab 2012;26:211–226
8. Locke AE, Kahali B, Berndt SI, et al.; LifeLines Cohort Study; ADIPOGen Consortium; AGEN-BMI Working Group; CARDIOGRAMplusC4D Consortium; CKDGen Consortium; GLGC; ICBP; MAGIC Investigators; MuTHER Consortium; MIGen Consortium; PAGE Consortium; ReproGen Consortium; GENIE Consortium; International Endogene Consortium. Genetic studies of body mass index yield new insights for obesity biology. Nature 2015;518:197–206
9. Herman WH. The economics of diabetes prevention. Med Clin North Am 2011;95:373–384, viii
10. Joslin EP. *The Treatment of Diabetes Mellitus With Observations Upon the Disease Based*

Upon One Thousand Cases. Philadelphia, Lea & Febiger, 1916
11. Popkin BM. Nutrition transition and the global diabetes epidemic. Curr Diab Rep 2015;15:631
12. Bray GA, Paeratakul S, Popkin BM. Dietary fat and obesity: a review of animal, clinical and epidemiological studies. Physiol Behav 2004;83: 549–555
13. Church TS, Thomas DM, Tudor-Locke C, et al. Trends over 5 decades in U.S. occupation-related physical activity and their associations with obesity. PLoS One 2011;6: e19657
14. Hamman RF, Wing RR, Edelstein SL, et al.; Diabetes Prevention Program Research Group. Effect of weight loss with lifestyle intervention on risk of diabetes. Diabetes Care 2006;29: 2102–2107
15. Hamman RF, Horton E, Barrett-Connor E, et al.; Diabetes Prevention Program (DPP) Research Group. Factors affecting the decline in incidence of diabetes in the Diabetes Prevention Program Outcomes Study (DPPOS). Diabetes 2015;64:989–998