

Working Upstream

Confronting the diabetes epidemic

by Sara B. Busarow, MD and Patrick L. Remington, MD, MPH

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The United States is experiencing a diabetes epidemic. Rapid growth has been seen in the percentage of Americans with diagnosed diabetes, from 3.1% in 1995 to 5.5% in 2005. Wisconsin's figures exceed national rates, growing from 4.5% in 1995 to 6.6% in 2005 (see Figure 1).¹ This diabetes epidemic coincides with an obesity epidemic. In 2005, 23.2% of Americans were obese, with a body mass index (BMI) of at least 30 (see Figure 2).¹ Rates of obesity are even higher among people with type 2 diabetes. In 2005, 53.2% of Americans diagnosed with type 2 diabetes were obese (see Figure 2). Wisconsin data from 2001 through 2005 showed that 82.9% of people with diabetes had a BMI of at least 25, compared with only 58.1% of people without diagnosed diabetes (see Figure 3).²

PUBLIC HEALTH: WORKING UPSTREAM

The first lecture in a public health class often begins with a metaphor. In the metaphor, a man is standing next to a river when he hears someone in the water call for help. He jumps in, pulls the person out, and just as he is caring for the person, he hears another scream. He jumps back in the water to save the next person, and before he can rescue this person he hears more calls for help. Just then he notices a group of students along the shore, and he calls them to help. Instead of jumping in the water, one student steps forward and says "Some of us will help you here, but a few of us will run upstream to see why people are falling in the river!"

As in this metaphor, chronic disease can be thought of as developing along a continuum, beginning with health and

progressing through risk factors, illness, disability, and death. While clinical medicine traditionally focuses on caring for individual patients who are already sick, public health focuses on improving the health of the entire population and preventing the occurrence of disease in the first place. On the chronic disease continuum, clinical medicine primarily addresses "downstream" determinants of health, and public health primarily addresses "upstream" determinants of health.

Much of clinical medicine consists of "working downstream," which means providing care to prevent, detect, and cure disease. Downstream approaches focus on interactions between people with health problems in the health care system. A

patient-level intervention targeting risk of retinopathy, such as providing a dilated eye exam, is an example of a downstream approach. In contrast, "working upstream" means studying the causes of health and disease and applying this knowledge to disease prevention through organized community effort. In addition to people with health problems and the health care system, upstream approaches address people who have not yet developed health problems. In particular, public health approaches attempt to modify the environment, through systems or policy changes, so that people can live healthy lives. A population-level intervention targeting obesity, such as a grade school nutrition program, is an example of an upstream, public health approach to prevent diabetes. Both upstream and downstream approaches are important in the fight against diabetes and its complications.

THE TYPE 2 DIABETES CONTINUUM

Type 2 diabetes can be described by a continuum (Figure 4). Stages of the continuum are a healthy lifestyle (exercise and diet) and normal glucose metabolism, pre-diabetes, type 2 diabetes, complica-



Figure 1. Prevalence of Diagnosed Diabetes, Wisconsin vs. United States, 1994-2005. Source: National Diabetes Surveillance System, Centers for Disease Control and Prevention, National Center for Health Statistics. Data from the National Health Interview Survey.

tions, and disability/death. Exposure to risk factors and preventive strategies affects patients' movement along the continuum. Some risk factors are modifiable, such as physical activity and nutrition, while other risk factors are not modifiable, such as family history and ethnicity. A major goal of public health is to minimize modifiable risks through population-level interventions.

The type 2 diabetes continuum begins with a healthy lifestyle and concomitant normal glucose tolerance (Figure 4). Normal glucose tolerance is defined as a fasting blood glucose less than 100 mg/dL and a plasma glucose less than 146 mg/dL two hours after a 75 g oral glucose load.^{3,4} People with normal glucose tolerance may still be at increased risk for developing diabetes. Major risk factors for type 2 diabetes include overweight/obesity, physical inactivity, family history, race/ethnicity, hypertension and dyslipidemia.^{3,4}

Next on the continuum is pre-diabetes (Figure 4). Pre-diabetes is defined as impaired glucose tolerance (a plasma glucose of 146 to 199 mg/dL two hours after a 75 g oral glucose load) and/or impaired fasting glucose (a fasting blood glucose of 100 to 125 mg/dL).^{3,4} Pre-diabetes represents the early metabolic abnormalities that precede diabetes. The majority of people with pre-diabetes eventually develop type 2 diabetes.³ Factors that increase the risk of moving along the continuum from pre-diabetes to type 2 diabetes are overweight/obesity, physical inactivity, family history, race/ethnicity, hypertension and dyslipidemia.^{3,4} As first-line treatment for pre-diabetes, the American Diabetes Association strongly recommends modest weight loss (5-10%) and regular physical activity (30 minutes per day). These lifestyle modifications can substantially delay or even prevent development of diabetes.

To promote healthy weight, both community interventions and intensive individual counseling are recommended.³ Because of the difficulty of treating people with diabetes, public health approaches to prevent obesity may be a more cost effective strategy in the long run. Additional important interventions include smoking cessation, blood pressure control, and lipid control.⁴ Along with lifestyle modifications, the ADA recommends treatment with metformin in a subset of high-risk

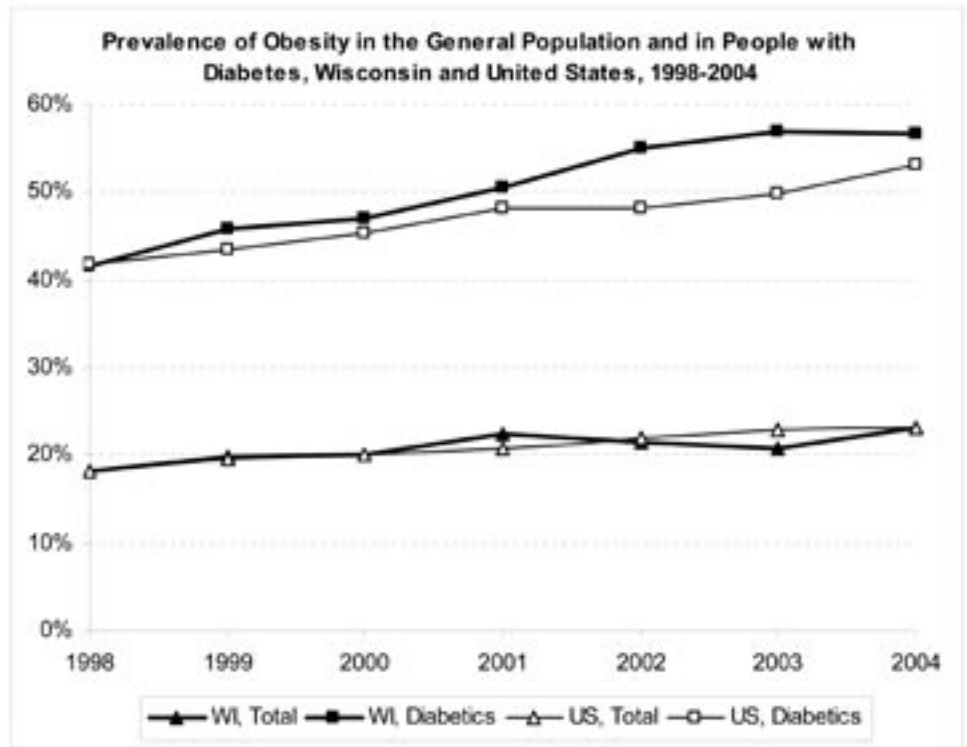


Figure 2. Prevalence of Obesity in the General Population and in People with Diabetes, Wisconsin vs. United States, 1998-2004. Source: National Diabetes Surveillance System, Centers for Disease Control and Prevention, National Center for Health Statistics. Data from the National Health Interview Survey.

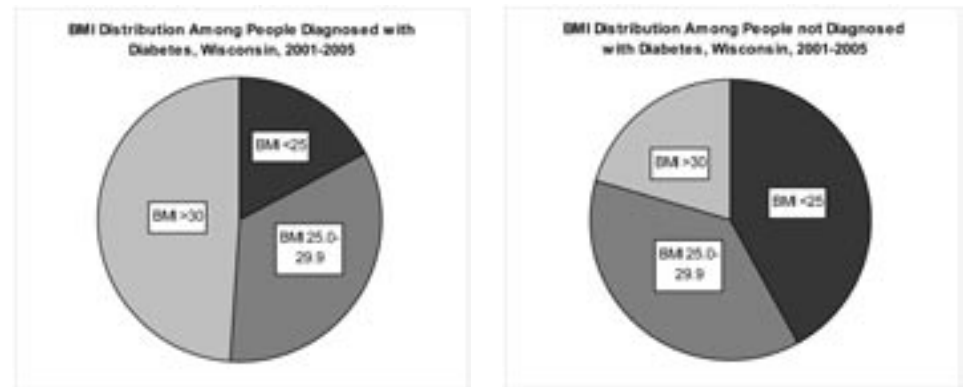


Figure 3. Body Mass Index (BMI) Distribution Among People Diagnosed with Diabetes vs. People not Diagnosed with Diabetes, Wisconsin, 2001 through 2005 Combined. Source: Wisconsin Interactive Statistics on Health, Wisconsin Department of Health and Family Services, Division of Public Health. Data from the Behavioral Risk Factor Surveillance Survey.

pre-diabetic patients.³

Development of overt type 2 diabetes is the next stage on the continuum (Figure 4). Type 2 diabetes is a state of insulin resistance and may additionally include decreased insulin secretion.⁴ The diagnosis of diabetes is made when patients have a fasting blood glucose of at least 126 mg/dL, a casual (non-fasting) blood glucose of at least 200 mg/dL, and/or a

plasma glucose of at least 200 mg/dL two hours after a 75 g oral glucose load. Unless there is clear evidence of significant hyperglycemia, testing should be repeated on a different day to confirm the diagnosis of diabetes.⁴ People with type 2 diabetes are at increased risk for numerous downstream complications, including cardiovascular disease, nephropathy, retinopathy, neuropathy, and foot ulcers (Figure 4).

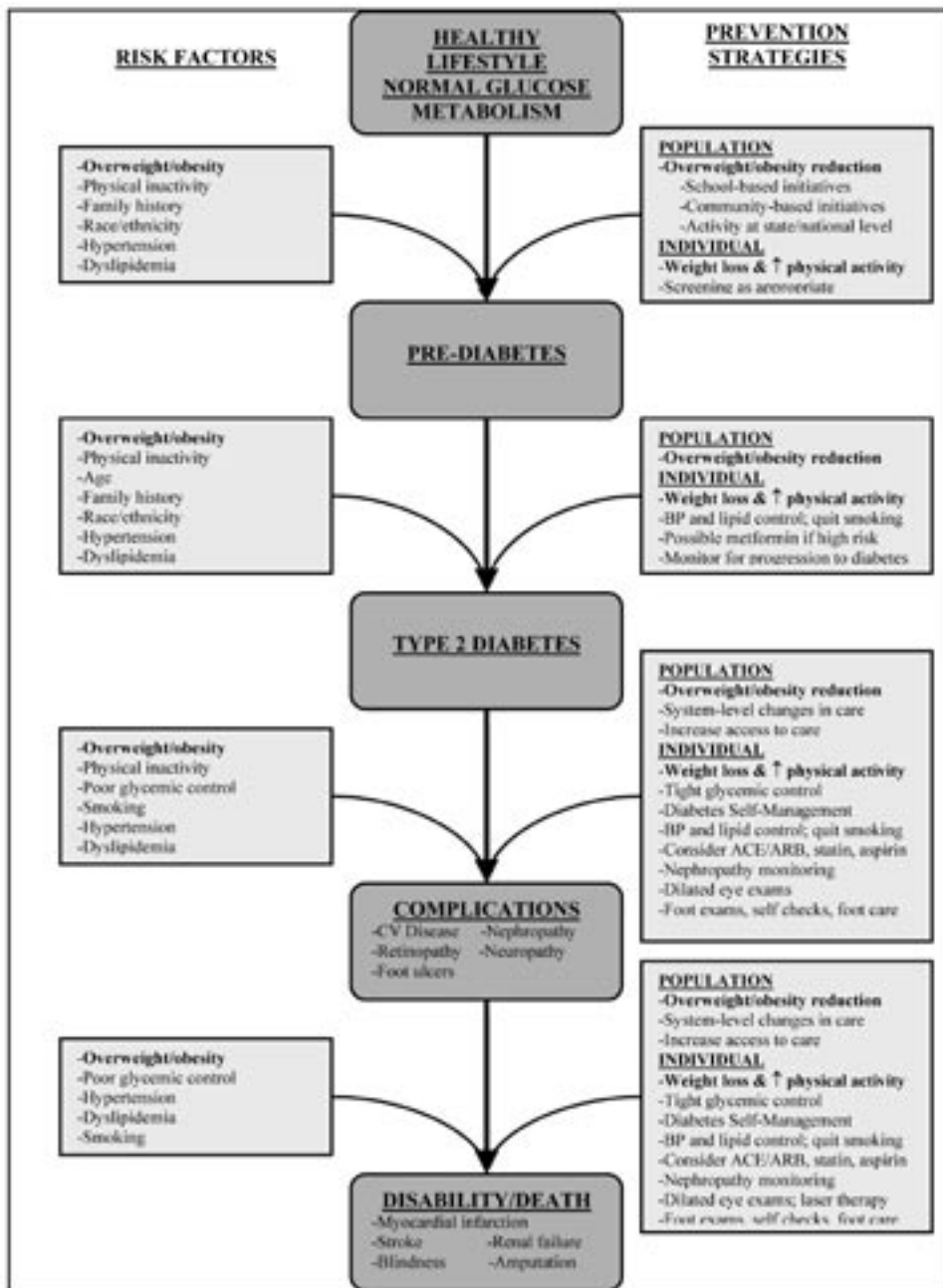


Figure 4. The Type 2 Diabetes Continuum

These complications can, in turn, lead to disability and/or death from myocardial infarction, heart failure, stroke, renal failure, blindness, and limb amputation. Risk factors for progression to these complications and disability/death include overweight/obesity, physical inactivity, poor glycemic control, smoking, hypertension and dyslipidemia.^{3,4}

High-quality diabetes care can help with prevention and early detection of complications (Figure 4). For most patients, blood glucose control can be

achieved with a combination of weight loss, dietary changes, physical activity and medication. Home blood glucose monitoring and regular hemoglobin A_{1c} testing can be used to measure blood glucose control. Tight blood glucose control can decrease the likelihood and severity of complications.⁴ Patients should be monitored regularly for the development of complications so that early intervention is possible when needed. Care of all diabetic patients should include regular foot exams, nephropathy monitoring and dilated

eye exams. To avoid limb amputation, aggressive foot care and wound treatment are crucial if peripheral neuropathy and/or foot sores develop. The risk of renal disease can be decreased by controlling blood glucose and blood pressure as well as using angiotensin converting-enzyme inhibitors (ACE-Is) or angiotensin receptor blockers (ARBs) when appropriate. Regular monitoring of urine microalbumin and/or estimated glomerular filtration rate (eGFR) is useful for early detection of kidney disease. Blood glucose control can also decrease the risk of retinopathy, and regular dilated eye exams can lead to early detection and treatment of eye disease.⁴

Cardiovascular disease is a major downstream complication of diabetes. The risk of cardiovascular disease was assessed among diabetic participants in the Framingham Heart Study between 1975 and 1998, and the age- and sex- adjusted hazard ratio for diabetes as a cardiovascular risk factor was found to be 2.5 (95% confidence interval 1.9 to 3.2).⁵ Because people with diabetes face such an elevated risk of cardiovascular disease, it is important to aggressively address related risk factors. Smoking cessation is critical. Blood pressure and lipids should be tightly controlled, with use of medications as needed. Blood pressure should be below 130/80 mmHg. HDL-cholesterol should be above 40 mg/dL for men and above 50 mg/dL for women. LDL-cholesterol should be at least below 100 mg/dL and should be below 70 mg/dL for patients with increased cardiovascular risk. Triglycerides should be below 150 mg/dL.⁴ Aspirin, statins and/or ACE-Is/ARBs should be used when appropriate.⁴ Weight loss and regular activity are critical to prevention of cardiovascular-related morbidity and mortality. In addition to positive effects on blood pressure and lipids, weight loss and regular activity can independently improve patients' cardiovascular risk.⁴ Even patients with established cardiovascular disease can benefit from weight loss and increased physical activity, though individual patients should check with their physicians before beginning an exercise program.

THE POTENTIAL OF OBESITY PREVENTION

Many diabetes-related interventions have focused on the care and treatment of

individuals who have already developed diabetes, working in the health systems that provide their care. This strategy is important for improving the quality of life, lowering the rate of complications, and decreasing disability and death. However, a larger impact may be possible from upstream obesity prevention interventions. By modifying this major risk factor, it is possible to prevent disease from occurring in the first place. A large population stands to benefit from obesity prevention efforts, which lower not only the risk of diabetes but also diseases such as heart disease, stroke and cancer. In addition, weight loss and regular physical activity can decrease the incidence and severity of complications among people who have already developed diabetes. Obesity prevention and intervention initiatives can have far-reaching benefits with minimal risk of harm.

Approaches to the diabetes epidemic may be most effective if they target multiple stages along the continuum (Figure 4). One way to do this is to develop many separate interventions focused on numerous different risk factors. For example, a program could have components that encourage fasting blood glucose screening, facilitate diabetes self-management programs, assist with the development of diabetes patient registries and improve access to ophthalmology services for patients with diabetic retinopathy. Another way to do this is to develop one intervention focused on a risk factor that affects numerous stages along the continuum. Overweight/obesity prevention efforts affect progression between all of the stages of the continuum, from normal glucose metabolism through disability and/or death (Figure 4).^{3,4}

People with normal glucose metabolism can reduce their risk of developing pre-diabetes and type 2 diabetes through modest weight loss and increased regular physical activity.^{3,4} Weight loss and regular physical activity can prevent or delay progression from pre-diabetes to type 2 diabetes.^{3,4} People who have already developed diabetes can improve their blood glucose control, blood pressure, and lipids, which in turn decreases the risk of complications.⁴ Even patients who have already developed complications and disability can limit further progression and maximize

functioning through the effects of weight loss and regular physical activity.⁴

CONCLUSIONS

Type 2 diabetes and obesity have reached epidemic levels in the United States. As a society, we must find ways to prevent further growth in the burden of diabetes. The progression from a healthy lifestyle and normal glucose metabolism through complications of diabetes occurs along a continuum. Using the concept of a type 2 diabetes continuum, risk factors and prevention strategies can be identified for each stage of progression. Clearly, obesity and overweight are the major risk factors at each stage of progression. Accordingly, public health approaches that begin far upstream, creating healthy environments in which people can be active and maintain a healthy diet, offer the most promise as long-term strategies to prevent obesity, diabetes and the resulting complications. Such interventions are important strategies along the entire continuum. The best way to confront the diabetes epidemic today is to use a balanced approach that

works along the entire diabetes continuum—from downstream treatments at the river's edge to public health interventions that focus upstream on healthy people in healthy communities. ●

Sara B. Busarow is a master of public health student at the University of Wisconsin Population Health Institute, UW School of Medicine and Public Health in Madison. Patrick L. Remington is the director of the University of Wisconsin Population Health Institute, UW School of Medicine and Public Health in Madison.

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