

# Type 2 Diabetes in Massachusetts: A Population Perspective and Its Implications for Public Policy

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Type 2 diabetes is one of the fastest growing public health crises today in the United States and Massachusetts. Most of us are keenly aware of the alarming rise over the past 30-40 years in overweight and obesity. The risk of type 2 diabetes has risen in tandem, making it one of the most common chronic diseases in this country.<sup>15</sup>

Especially if diagnosed late or not well managed, type 2 diabetes is a debilitating disease; it can reduce the quality of our lives, productivity, and life expectancy. It is a serious condition—a primary cause of blindness, kidney failure, and amputation. It also brings an increased risk of heart disease and stroke.<sup>20</sup>

A study from the Centers for Disease Control and Prevention (CDC) estimates that, if current trends continue, by 2050 one in three U.S. adults could have type 2 diabetes.<sup>10</sup> In Massachusetts alone, between 1990 and 2008, the overall frequency of type 2 diabetes nearly doubled, with the number of diabetics in the state jumping from 183,000 to 388,000.<sup>11</sup>

Type 2 diabetes is an extremely expensive disease, with national costs estimated at \$174 billion in 2007.<sup>2</sup> In 2008, the American Diabetes Association estimated that one in five healthcare dollars was spent on someone with diabetes.<sup>2</sup> On average, even after adjusting for age, a person with type 2 diabetes has health care expenses more than twice those of a non-diabetic.<sup>39</sup> As type 2 diabetes develops earlier, the expenses incurred across a lifetime will continue to mount.

Nationally and in Massachusetts, the risk of type 2 diabetes varies by age, gender, and race/ethnicity. In general, older people, men, and people who are Black or of Hispanic ethnicity face a higher risk as do, increasingly, Asian Americans.<sup>47</sup>

Type 2 diabetes also disproportionately affects people with less education and lower income. Further, although once primarily a condition of older adults, it strikes younger adults, adolescents, and even children.<sup>43</sup> However, unlike some diseases of ageing, type 2 diabetes can be delayed and even prevented.

## RISING RISK OF TYPE 2 DIABETES

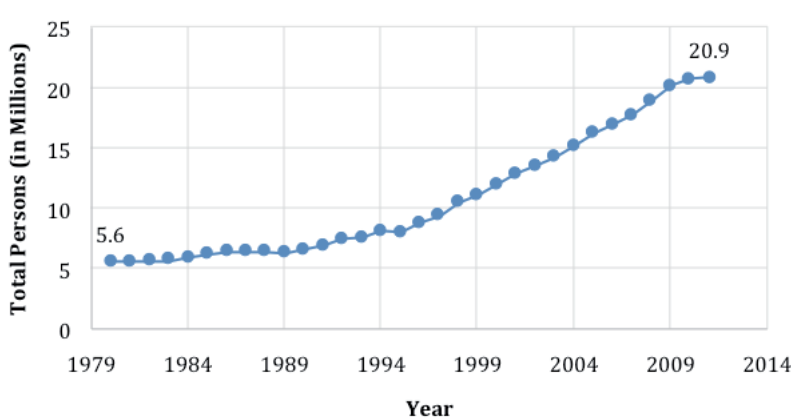
Diabetes mellitus describes a group of disorders in which glucose, the body's main source of energy, is not regulated correctly. Type 2 diabetes (formerly called adult-onset) is the most common, accounting for 90-95% of all cases of diagnosed diabetes. Type 1 or juvenile diabetes, considered an autoimmune disorder, accounts for most of the remaining cases. Diabetes can also occur only during pregnancy (gestational diabetes).

According to the most recent data from the CDC, in 2010, diabetes affected around 25.8 million people or 8.3% of the U.S. population.<sup>9,1</sup> Of these, 18.8 million actually had been diagnosed, while 7.0 million were

estimated to be living with type 2 diabetes that had not yet been diagnosed and was not being treated. In addition, nearly one-third of U.S. adults are estimated to have pre-diabetes, with elevated levels of blood sugar and an increased risk of developing type 2 diabetes.<sup>10</sup>

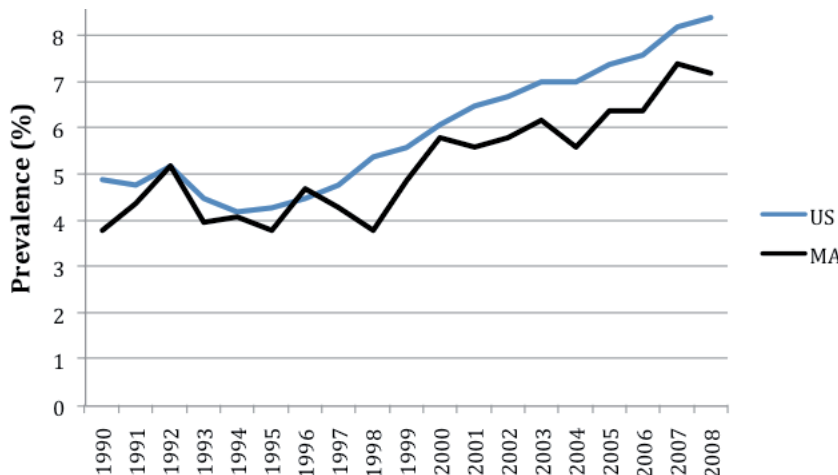
Type 2 diabetes develops progressively, as does the damage it causes. Over time, insulin, a hormone that helps move blood sugar into cells, becomes less effective, eventually leading to insulin resistance, considered a precursor to type 2 diabetes (type 1 diabetics do not produce insulin at all).

In type 2 diabetics, if blood sugar is not controlled, persistently high levels can eventually cause serious long-term complications. Type 2 diabetes can damage every major organ system; it is a primary cause of blindness, kidney failure, and amputation of lower limbs. Type 2 diabetics on average face a two- to four-fold increased risk of heart disease and stroke.<sup>9,20</sup>



**Figure 1: Total Number of People Diagnosed with Diabetes in U.S. Population, 1980-2011.**  
 Source: Centers for Disease Control and Prevention, National Center for Health Statistics, 2013.

Since the 1980s, the frequency of type 2 diabetes has increased steadily, growing nearly fourfold between the mid-1980s and 2011.<sup>12</sup> During this time period, both diagnosis and treatment have improved. While there are fewer cases of undiagnosed type 2 diabetes now than 30-40 years ago, improved diagnosis and treatment alone cannot explain the unrelenting rise in frequency since the late 1980s (see Figures 1 and 2).



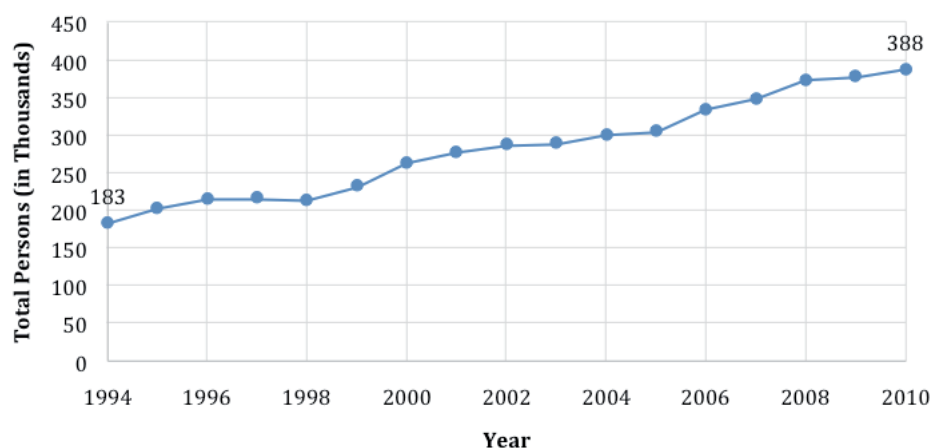
**Figure 2: Prevalence of Diagnosed Diabetes in the United States and Massachusetts, 1990-2008.**  
 Source: Massachusetts Department of Public Health, 2010.

In 2010 alone, nearly 1.9 million people aged 20 or older in the United States were newly diagnosed with diabetes.<sup>9</sup> If type 2 diabetes is diagnosed early, improved blood sugar control can delay the onset of long-term complications. Those diabetics who remain undiagnosed present an additional future public-health burden.

There are disparities in the frequency of type 2 diabetes according to race/ethnic group, gender, and area of residence.<sup>7, 21, 31, 34</sup> There also are similar disparities in long-term complications, burden of disease, and mortality. These disparities heighten the public health burden that type 2 diabetes presents in the United States today.<sup>21</sup>

### TYPE 2 DIABETES IN MASSACHUSETTS

In Massachusetts, an estimated 7.2% of residents have been diagnosed with diabetes.<sup>10</sup> While this overall frequency is slightly lower than in the United States overall, it has risen dramatically over the past 20 years. Since 1994, the burden of diabetes in the Commonwealth has more than doubled, rising from 183,000 cases in 1994 to 388,000 in 2010 (see Figure 3). However, this burden is not distributed evenly across the state or among different groups within our state's population.



**Figure 3: Total Number of Cases of Diagnosed Diabetes Among Massachusetts Adults, 1994-2010.**

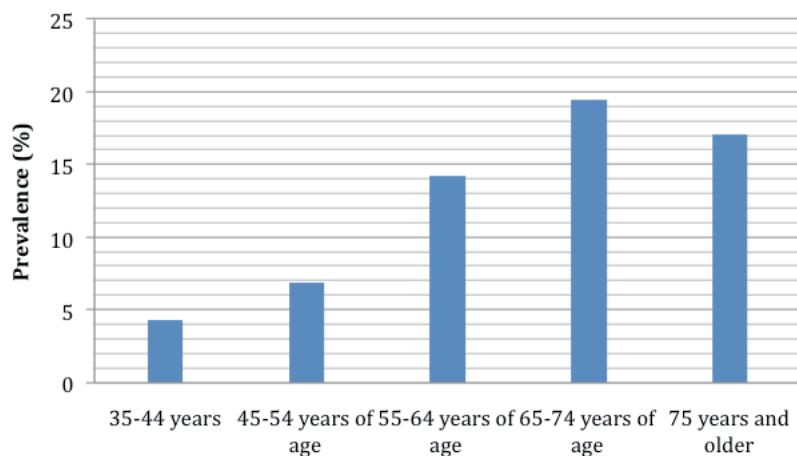
Source: Centers for Disease Control and Prevention, 2014.

The risk of developing type 2 diabetes rises steadily with age. Among people who are 65-74 years old in Massachusetts, nearly 20% have been diagnosed with diabetes, compared with 6.9% of people between 45 and 54 years (see Figure 4).

However, the disease is now appearing in children and adolescents, which was rare until 30 years ago. While type 1 (juvenile-onset) diabetes previously accounted for more than 97% of new cases of diabetes in adolescents, by 2007, nearly half of new adolescent cases were identified as type 2 diabetes.<sup>42</sup>

The early development of type 2 diabetes has direct implications for public health. The longer individuals have the condition, the more likely they are to develop disabling long-term complications and the more health-care expenses will accrue over their lifetime.

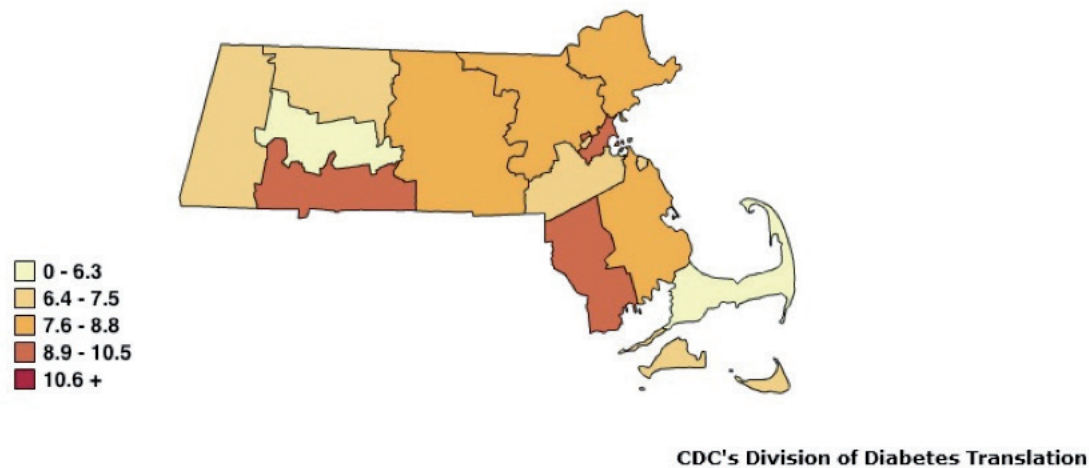
Within Massachusetts, the prevalence (frequency) of type 2 diabetes varies among counties (see Figure 5). Even after adjusting for age, the prevalence ranges from a low of 6.2% in Barnstable County to 9.8% in Bristol County.



**Figure 4: Prevalence of Diagnosed Diabetes in Massachusetts by Age Group, 2009.**

Source: Massachusetts Department of Health and Human Services, 2014.

There also are disparities among cities and residential neighborhoods.<sup>21</sup> The Massachusetts Department of Public Health reported the following age-adjusted frequencies for diagnosed diabetes in the Commonwealth’s larger cities: Lawrence (13.0%) and Springfield (12.0%) had the highest prevalence, while Worcester (8.3%) and Boston (8.8%) had lower frequencies.<sup>40</sup> Even within these cities, the frequency varies considerably among different neighborhoods, typically reflecting disparities by race/ethnic group and income level.



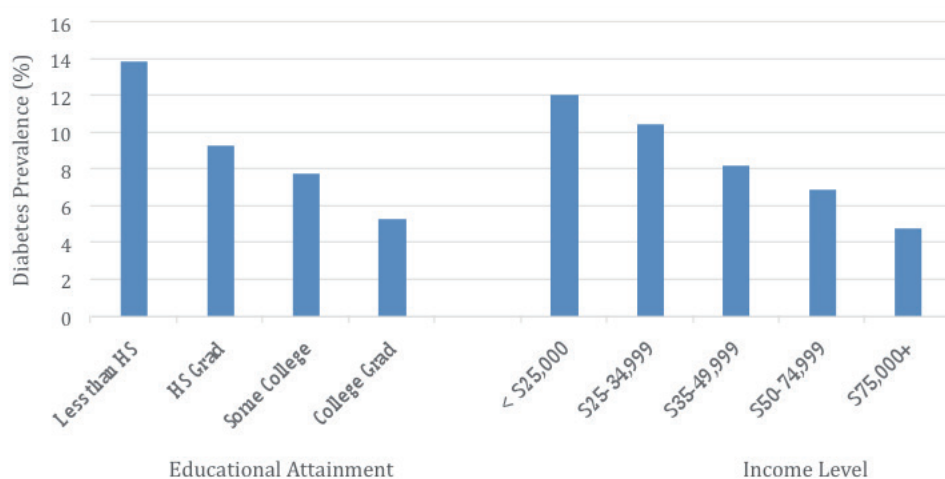
**Figure 5: Age-Adjusted Prevalence of Diagnosed Diabetes Among Adults in Massachusetts, 2010.**

Source: Centers for Disease Control and Prevention, 2010.

In Massachusetts, there are pronounced disparities among racial/ethnic groups. The frequency of type 2 diabetes is highest among Hispanic and Black populations (11.6% and 10.5%, respectively), compared with 7.6% for Whites in 2011.<sup>39</sup> Such disparities indicate a combination of risk factors that interact to contribute to increased prevalence of diabetes, as discussed later.

Further, there are disparities in how well diabetics fare after diagnosis. Each year between 2002 and 2007, nearly 1,300 deaths with diabetes identified as the underlying cause were reported. However, the overall mortality rate on average is twice as high among non-Hispanic Blacks as among non-Hispanic Whites.<sup>38</sup> In fact, while type 2 diabetes is the ninth leading cause of death in Massachusetts overall, it is the fourth leading cause for death for Hispanics and non-Hispanic Blacks.<sup>38</sup>

Finally, in Massachusetts, diabetes prevalence varies by common measures of socio-economic status: education and income (see Figure 6). Those who have earned less than a high school diploma have a frequency of diabetes 2.6 times that of college graduates. Similarly, those earning less than \$25,000 have a frequency of diabetes 2.5 times that of those earning more than \$75,000 a year.



**Figure 6: Prevalence of Diabetes in Massachusetts by Educational Attainment and Income Level, 2011.**

Source: Massachusetts Department of Public Health, 2013.

### AN INDIVIDUAL PERSPECTIVE: COMMON RISK FACTORS FOR TYPE 2 DIABETES

Type 2 diabetes is a complex disease whose multiple causes are still not fully understood. Like other chronic diseases, such as cancer and heart disease, it is attributed to an interconnected array of risk factors. It is likely that different factors trigger type 2 diabetes in different individuals or populations.

Genetic predisposition can make individuals susceptible to type 2 diabetes, but the dramatic surge in frequency in the United States—and countries around the world—has occurred too rapidly for genetic differences to be primarily responsible. There also is little evidence that genetic differences contribute in a significant way to disparities by race/ethnic group.<sup>21</sup>

At the individual level, evidence across many disciplines—including endocrinology, epidemiology, medicine and health services, nutrition science, physiology, and toxicology—identifies specific risk factors. These include:

- **Poor nutrition**, including a higher-carbohydrate/glycemic diet,<sup>23,44</sup> such as from soda and sweet drinks,<sup>6</sup> white rice,<sup>30</sup> and a diet low in fiber or fruits and vegetables.<sup>18</sup>
- **Inactivity and sedentary activities.**<sup>5,24,30</sup> Blood-sugar levels can be managed by physical activity at different levels of intensity, including strength training.<sup>22</sup> That is, all kinds of physical activity—as opposed to sitting—are important not because they cause weight loss, but because they trigger physiological effects that help regulate blood glucose entirely independently of diet.

- **Overweight and obesity.**<sup>48</sup> People who are obese face a higher risk of type 2 diabetes. However, across populations, obesity does not fully account for the increase in new cases. In some populations, obesity may only account for about 25% of new cases.<sup>25</sup>

Prevention has often focused on these common risk factors that individuals would seem to be able to control. However, these individual health behaviors themselves are influenced by environmental exposures and social conditions.

### A POPULATION PERSPECTIVE: ENVIRONMENTAL AND SOCIAL DETERMINANTS OF TYPE 2 DIABETES

At national, state, and local levels, there are disparities in the risk of type 2 diabetes faced by different groups living in different residential locations. These patterns suggest that social and environmental factors are also influencing the risk of type 2 diabetes, not just individual behaviors.

From a population perspective, health disparities occur because environmental and social determinants influence health and health behaviors. Key risk factors are understood to interact with each other at the individual and population level. Biologic factors (such as genetics, obesity, and high blood pressure) interact with individual health behaviors (including diet, physical activity, and disease self-management), which are influenced by an individual's age, socio-economic position, racial/ethnic background, level of acculturation, and so on.

These individual factors in turn are influenced by the intermediate factors of available health care (access to care, quality of care, etc.) as well as the surrounding physical and social conditions (including the safety of a community or neighborhood, the availability of green space and food, the average socio-economic status).

Finally, the intermediate factors themselves are influenced by social conditions and social policies and the institutions that shape them.<sup>19,21</sup> In this way, our surroundings are understood to directly and indirectly influence our health.

For type 2 diabetes, a growing body of scientific evidence supports the roles that environmental exposures and social conditions can play, including:

- **Residential neighborhoods**, including safety of a neighborhood, green space, sidewalks (“walkability”), and well-stocked grocery stores.<sup>3</sup>
- **Chronic stress**, through the “fight-or-flight” or acute stress response, which helps the body respond to threats.<sup>13,14</sup> Physiologically, chronic stress is associated with increased risk of the metabolic syndrome, a combination of risk factors including obesity, insulin resistance, and increased blood glucose levels.<sup>13,28</sup> Exposure to stressors can also increase negative health behaviors, such as a poorer diet and inactivity.
- **Environmental contaminants.** A growing number of studies have investigated the effects of environmental exposures on obesity, insulin resistance, and type 2 diabetes. These environmental exposures include persistent organic pollutants,<sup>35,36,49</sup> particularly PCBs, pesticides such as DDT, and dioxin;<sup>49</sup> arsenic;<sup>46</sup> and traffic-related air pollution.<sup>32</sup> Some of these contaminants can linger in the environment for extended periods of time. They can also accumulate in the body, and evidence links them with metabolic changes, obesity, and type 2 diabetes.<sup>49</sup>
- **Changes in gut ecology.** The microbiota that inhabit our intestines are critical to health. Research shows that the gut microbiome may contribute to obesity and type 2 diabetes. In addition, its microbiota may interact with environmental exposures.<sup>45</sup>

Just a few generations ago, type 2 diabetes was considered a disease of affluence.<sup>29</sup> Today, in Massachusetts, as in the United States and diverse countries around the world, as the frequency surges, it is disproportionately affecting people of lower socio-economic position.

Understanding how wider social and environmental conditions influence individual risk factors like lack of exercise and poor diet conditions is necessary in order to develop more appropriate interventions.<sup>37</sup> In addition, type 2 diabetes can be influenced by and also contribute to poor social outcomes because it can bring its own financial burden.<sup>28</sup>

Type 2 diabetes requires unrelenting attention and 24-hour management of blood-sugar levels. Routine health behaviors that influence blood sugar can be difficult to change because they are deeply influenced by broader social determinants. To be effective, interventions need to address the conditions and deficits of the given community.<sup>16</sup> These interventions can better prevent and lessen the consequences of diabetes if they take social determinants into account, including those specific to certain groups and cultures.<sup>1</sup>

Considerable evidence suggests that exposure to certain contaminants, particularly endocrine-disrupting chemicals, can trigger metabolic changes found in individuals with obesity and/or type 2 diabetes.<sup>27</sup> In addition, a relatively new body of research looks at how the vital microbiota in our digestive system affect the risk of obesity and type 2 diabetes — and also how they may interact with common exposures in the surrounding environment. As we come to understand better the broader social and environmental context of the rising risk of type 2 diabetes, we will be able to design interventions that more fully take these into account.

### EVIDENCE FROM CURRENT STUDIES IN WORCESTER AND NICARAGUA

Disparities in Massachusetts by race/ethnic group reflect national trends, in which Blacks, Hispanics and, increasingly, Asian Americans face an elevated risk of type 2 diabetes compared with non-Hispanic Whites. They also reflect the quickly rising rates in many Latin American and Asian countries.<sup>4,47</sup> Asian Americans also tend to develop type 2 diabetes at lower body weights than people of other racial/ethnic groups.<sup>41</sup>

We have been studying type 2 diabetes in communities in Massachusetts and Central America that hold important lessons about prevention and management. In Worcester, we are working with Vietnamese-Americans, who increasingly face an elevated risk of type 2 diabetes, to probe what programs, information, and health care this community needs.

We also are working in Estelí, Nicaragua, a rural region where type 2 diabetes has quickly become a leading cause of illness and death. In Managua, the age-adjusted prevalence of type 2 diabetes is similar to that of the United States.<sup>4</sup> However, several key risk factors are absent in these rural communities. There are low rates of smoking and, at least among women, little alcohol use. Also, most people do not have motor vehicles. Still, in these rural towns, type 2 diabetes has quickly become a leading cause of illness and death.

In Worcester and Nicaragua, we are investigating why these groups face a disproportionate risk, and what interventions might be most effective for management and prevention of type 2 diabetes. We expect that insights we gain also will be applicable both to other countries in Central America and Asia as well as to populations within the United States that face an elevated risk.

These studies investigated:

1. risk factors for type 2 diabetes in rural Nicaraguan towns, including recent changes in diet, physical inactivity, pesticide exposure, low birth weight, and stress;
2. the burden that type 2 diabetes places on families and communities;
3. the ways that people understand the causes of type 2 diabetes and its management;
4. social and cultural factors that influence the management of type 2 diabetes;
5. interventions at the family and community levels to improve diabetes management and prevent new cases.

Our results indicate the following:<sup>17, 33</sup>

- There is little culturally appropriate medical care or type 2 diabetes information for Vietnamese-Americans in Worcester, who comprise more than 50% of the city's Asian population;
- Before diagnosis, type 2 diabetics and their family members generally knew little about the disease or its symptoms and treatment. Many did not know that the disease existed or they did not understand how serious it is;
- After diagnosis, type 2 diabetics and their family members still did not fully understand what the disease is, how they were being treated, or what they needed to do to manage the disease. A 49-year-old Vietnamese male described thinking that the medication alone could control his blood sugar: "When I ate more sweet food, I just took more medication. Then the diabetes affected the kidney, and it was too late";
- Individuals see their health-care providers as experts and do not feel comfortable questioning them or asking for clarification or additional information;
- Dietary recommendations need to be culturally appropriate and affordable. They should not focus on "American" food, and telling Central Americans, Hispanic Americans, and Asian Americans to "eat less rice" — common advice to type 2 diabetics — is ineffective if rice is a staple food;
- Both groups point to stressful events as triggers for the onset of type 2 diabetes and continued high blood sugar levels;
- In close-knit families, family and social support may be the most important factor for successful management of type 2 diabetes. Changes in the diet of the whole household can ease the burden of managing this disease. Said family members: "The best way to support the diabetic is to eat what they eat," and, "This is a family problem."
- Interventions that target family and community-level behaviors can also reach diabetic family members who have not been diagnosed and pre-diabetic and susceptible individuals.

### IDEAS FOR THE FUTURE

As Massachusetts policymakers consider the need for a statewide program for prevention of type 2 diabetes, it is important to remember the magnitude of this relatively new health problem, the toll that it takes on individuals and their families, the disabilities and shortened lives it can cause, and the significant and growing health care costs.

It is also important to remember that, although serious, type 2 diabetes can be prevented and that prevention efforts may work best at the community level. Our research and that of others support the following:

- With such pronounced disparities by race/ethnicity, there is a need for culturally and linguistically appropriate programs, health information, and practitioners to help ease the burden in different racial/ethnic groups.<sup>33</sup>
- Programs that target youth, families, and communities could reach pre-diabetics and the undiagnosed, and foster critical family and social support.<sup>17</sup>
- In an effort to reduce childhood obesity, state policies — including in Massachusetts — have established measures to do some or all of the following: display calorie content of restaurant and fast-food meals, increase taxes on or reduce sizes of soft drinks and sweetened beverages, remove such products from school vending machines, increase school physical activity time, improve quality of school lunches, and reduce marketing of calorie-dense foods to children.<sup>26</sup>
- Interventions focused on diet, activity, and weight loss can be as effective as — or more effective than — common prescription medications, which also may have side effects.<sup>16</sup> They can help with both blood sugar management and prevention, and they could also help reduce the risk of other chronic diseases that share the same risk factors.



Our health behaviors — so critical to the prevention and management of type 2 diabetes — are not just a matter of individual choices. They are influenced by the people we live with and the place where we live, the work we do and the people we do it with, and our city/town and state. Lessons from anti-smoking, HIV/AIDS, anti-drunk-driving, and other public health drives offer evidence that to improve the public's health in a meaningful way and support individuals' own behaviors, social norms about diet, physical activity, and chronic disease management themselves must change.

<sup>1</sup> Although some national and state data include type 1 diabetes, because type 2 diabetes accounts for most cases, the statistics reflect trends in type 2 diabetes alone. Gestational diabetes is not included in some national survey data.

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