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DIABESITY®: THE 21ST-CENTURY EPIDEMIC

Sonya Norris
Science and Technology Division

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DIABESITY®: THE 21ST-CENTURY EPIDEMIC(1)

INTRODUCTION

Diabetes was identified as early as 1552 BC, but has been successfully treated only within the past century. The prevalence of this serious disease – i.e., the proportion of affected individuals within a population – has remained steady for most of its history. In recent years, however, there has been an alarming increase in the number of individuals diagnosed with diabetes. This paper will explore the reasons for this drastic change, and discuss the actions that have been taken in Canada and abroad to address this very serious public health issue.

WHAT IS DIABETES?

One symptom of diabetes is frequent urination; this is what characterized the earliest descriptions of the disorder, and led it initially to be described as a disorder of the kidneys. This seemingly harmless symptom of diabetes is a result of the body trying desperately to rid its system of excess glucose, or sugar. When a person is diabetic, his or her body is not able to transport sugar, the body's fuel, from the blood into cells for energy. Normally, when food is consumed, sugar is taken up in the blood; and when blood sugar levels rise, the pancreas secretes insulin, which in turn promotes sugar uptake by cells throughout the body. In a diabetic person, sugar cannot get into the cells, either because the pancreas is no longer producing insulin, or because the body's cells are no longer responding to insulin. The only way left for the body to rid itself of sugar, then, is to excrete it in the urine.

(1) Diabesity is a registered trademark of Shape Up America!

There are three distinct types of diabetes: type 1, type 2 and gestational. Types 1 and 2 have also been known as juvenile and adult, as well as insulin-dependent and insulin-independent diabetes. They are now almost exclusively referred to as types 1 and 2 because the other labels are not accurate. Although type 2 diabetes is often diagnosed in adults and does not usually respond to insulin treatment, this is not always the case, and exceptions are becoming more frequent.

The current diabetes epidemic involves a surge in the rate of type 2 diabetes only. According to the Canadian Diabetes Association, only about 10% of those with diabetes in Canada have type 1. This percentage, moreover, will decrease as the number of people with type 2 continues to increase.

A. Type 1 Diabetes

Type 1 diabetes is often diagnosed in childhood, but can go undetected into adolescence and even young adulthood. Although the cause remains unknown, it involves an auto-immune response in which, essentially, the body attacks itself. In type 1 diabetes, the body attacks and destroys the insulin-producing cells of the pancreas, called beta cells. Because the beta cells have been destroyed, the patient needs to receive insulin in order to properly use sugar.

B. Type 2 Diabetes

Type 2 diabetes is often diagnosed in mid- to late adulthood and results from insulin fatigue. Many years of hard work by the pancreas as it tries to respond to overeating results in cells throughout the body that can no longer respond to insulin, or beta cells that are exhausted and no longer produce insulin.

C. Gestational Diabetes

About 3.5% of non-Aboriginal and 18% of Aboriginal women will develop gestational diabetes, that is, diabetes during their pregnancy. Although this type of diabetes tends to disappear after the pregnancy, it does put these women at risk of developing type 2 diabetes later in life. It also puts the child at higher risk of developing type 2 diabetes during his or her lifetime.

DIABESITY – THE RELATIONSHIP BETWEEN OBESITY AND DIABETES

Not all people who are overweight become diabetic, and not all type 2 diabetics are overweight; however, there is a causal link between excess weight and diabetes. The populations of developed countries have been putting on excess weight for about the last 50 years. During this time, physical activity has been steadily declining and consumption of high-fat and sweetened foods has steadily increased. Ironically, advances and inventions made to make life easier have in fact enabled a far less healthy population. Fast food restaurants, convenience foods and pre-packaged meals have contributed to diets markedly higher in fat, while extensive automation has resulted in a much more sedentary population.

Thus, it is not surprising that obesity rates have risen.(2) Increased caloric intake combined with reduced physical activity, after all, has a fairly certain consequence. The profound health consequences of excess weight, in their turn, are becoming well understood. Excess weight is now an accepted risk factor for type 2 diabetes, for reasons explained below.

Research has found that fat cells promote insulin-resistence, due to an adaptation that emerged in early man several thousand years ago to promote fat storage and limit fat burning in order to optimize survival during times of famine. Ironically, in developed countries' current environment, this capability ensures the survival of the fat itself at the expense of the whole person. This phenomenon is explained in more detail in the following section of this paper ("Prevalence of Diabetes in Different Populations – The Role of Thrifty Genes").

In tracing the link between fat and diabetes, it is important to understand that fat is not an inert substance that just takes up space within the body. Nor is it simply a warehouse of stored fuel. Fat, or adipose tissue, actively interacts with its surroundings by responding to and secreting hormones and other chemicals.

The body contains two types of fat, subcutaneous and visceral. Subcutaneous fat is just below the skin and is essential for insulation and protection. Visceral fat collects in the abdominal cavity, and it is this fat that is more of a risk factor for diabetes. The "apple and pear" analogy is often used in reference to these two types of fat. "Pear-shaped" individuals have excess weight below the waist (subcutaneous), while "apple-shaped" individuals have excess weight concentrated in their midsection (visceral). In either case, the number of fat cells is established in childhood and remains unchanged. It is the amount of fat stored within the cells that may vary.

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(2) For more details on obesity in Canada, see Sheena Starky, *The Canadian Obesity Epidemic*, PRB 05-11E, Parliamentary Information and Research Service, Library of Parliament, Ottawa, July 2005.

Visceral fat is more metabolically active than subcutaneous fat, which explains why it is more liable to produce metabolic disorders than is subcutaneous fat. Not only does visceral fat produce more of, and respond more to, the chemicals and hormones described below; its location within the body can also be detrimental. Fat cells can become so overstuffed that fat can spill over into the internal organs and affect their functioning. Specifically, in the case of diabetes, the pancreas and liver may be affected.

When more calories are consumed than burned, the excess energy is stored as fat, within the pre-established number of fat cells. Fat cells produce a protein, called resistin, that causes tissues – especially the liver – to be less sensitive to the action of insulin. This reduced sensitivity is a two-fold problem. First, as mentioned previously, cells' lack of response to insulin inhibits their uptake of glucose. Second, the body tries to compensate for resistence to insulin by producing even more insulin. This strategy succeeds for a time in controlling blood sugar; but blood insulin levels are elevated. Insulin promotes the liberation of fatty acids from food (which in turn must be stored within fat cells), and inhibits the release of stored fat for use as energy. The net result is thus an increased tendency to store fat and gain weight.

Adiponectin is another substance produced by fat cells. Adiponectin stimulates muscle tissue to burn glucose by increasing insulin sensitivity, which in turn increases the liberation of fatty acids from fat cells to produce more glucose. This is one of the body's weight control mechanisms. However, the production of adiponectin diminishes as the fat cells expand, thus causing further increase in fat accumulation.

Thus insulin resistance that is brought on by excess weight means that, although the pancreas is producing insulin as it should, cells throughout the body are not responding normally to it. The pancreas then secretes even more insulin in an attempt to maintain glucose and fat balance in the body. This strategy works for a time until the beta cells of the pancreas can no longer sustain the strain of overproduction, and insulin production ceases.

It is assumed that multiple factors converge to cripple insulin production. At least some of those factors are linked to obesity, including damage to the insulin-producing beta cells of the pancreas due to fat deposits in the tissue (caused, as mentioned earlier, by visceral fat spilling over into the organs). It is also thought that certain chemicals (as yet undefined) secreted by fat cells may interfere with the function or survival of beta cells. [(3)]

(3) Another factor further complicating the issue of weight gain is that the hormone leptin, which is normally produced by fat cells and which sends a message to the brain to stop eating, does not seem to work properly in obese people.

PREVALENCE OF DIABETES IN DIFFERENT POPULATIONS – THE ROLE OF THRIFTY GENES

In Canada, the Aboriginal population is three to five times more likely to develop diabetes than the general public. In the United States, the American Indian, African American and Hispanic populations are more at risk than the Caucasian population. Many researchers and clinicians support the theory of "thrifty genes" to explain the higher rate of diabetes among these populations.

The theory of thrifty genes was proposed over 40 years ago,(4) and the subsequent pattern of the diabetes epidemic has lent support to it. Both the National Institutes of Health in the United States and Health Canada refer to the theory in their explanations of diabetes prevalence in different populations. The theory proposes that survival of early human beings was dependent on their ability to survive times of scarce food and frequent periods of famine. This required the ability to be extremely efficient at storing any excess food energy for future needs – a trait that, as explained above, is associated with insulin-resistence. Those who carried such thrifty genes survived and passed them on to the next generation. Those who did not were more likely to die before reproducing.

When human beings began living in groups and created agriculture and domesticated animals, their food intake was more dependable, and people who had not inherited thrifty genes were more likely to live to reproducible age than their predecessors. In this way, thrifty genes began to disappear.

Today, western populations have the lowest prevalence of these genes, because Europeans made early progress in securing food supplies and minimizing the starvation risk. Only 20-35% of Europeans, and those descended from Europeans, now carry thrifty genes. While inhabitants of Europe were enjoying relative abundance, ancestors of the indigenous peoples of the Americas, Asia, the Pacific and Africa continued to struggle under harsher conditions. Their thrifty genes remained vital to their existence.(5) It is thought, for example, that as many as 90% of Africans and their descendents may possess them. The suboptimal climate and food supply of Africa prompted some migration to Eurasia, where conditions were somewhat better, and so thrifty genes became less common in their descendants. About 50% of Asians may still have these thrifty genes, according to the theory.

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(4) J. V. Neel, "Diabetes mellitus: a thrifty genotype rendered detrimental by progress?" *Journal of the American Medical Association*, Vol. 14, 1962, pp. 353-362.

(5) A. Gutersohn *et al.*, "G protein beta3 subunit 825TT genotype and post-pregnancy weight retention," *The Lancet*, Vol. 355, 2000, pp. 1240-1241.

Canada's Aboriginal people "are genetically predisposed to store energy from the diet very efficiently, due to the nomadic lifestyle of their ancestors."(6) Migration to urban centres, as well as loss of traditional food sources on-reserve, has produced increased obesity and, subsequently, higher diabetes rates.

THE IMPACT ON HEALTH OF TYPE 2 DIABETES

If type 2 diabetes is diagnosed early enough, it can be reversed, even prevented, by proper weight control, nutritious diet, adequate exercise and vigilant control of blood sugar levels. If blood sugar is not well controlled and fluctuates drastically, it will, over the course of years or decades, have disastrous health implications. In Canada, diabetes is the seventh leading cause of death. Some of its major health complications are listed below.

- Heart attacks and strokes (cardiovascular disease)

  These are the most serious complications associated with diabetes; heart attacks and strokes kill about 75% of people with diabetes. There are several mechanisms involved in this increased risk.

  - Excess weight is in itself a risk factor for cardiovascular disease. Fat cells produce an inflammation-triggering chemical (C-reactive protein), which causes inflammation of blood vessels, causing them to become narrower and promoting cholesterol deposits and blood clots, which can lead to a heart attack or stroke.
  - When obesity is further compounded with high blood pressure and high cholesterol levels (in a disorder called metabolic syndrome), cardiovascular problems are even more likely.
  - When blood sugar levels are chronically high, glucose goes wherever it can. Insulin is not required for glucose to enter nerve cells, red blood cells or the cells that line blood vessels (endothelial cells). Excess sugar in the blood attaches itself to molecules in these cells in a process called glycation. This in turn causes swelling and impairs blood flow to the heart and brain, thereby increasing the risk for heart attack and stroke.

- Kidney damage (renal disease)

  Excess sugar in the blood also damages the tiny blood vessels of the kidneys. Kidneys are responsible for filtering toxins out of the blood and excreting them in the urine. The damaged blood vessels become "leaky," and protein that cannot normally pass out of the blood and into the kidney starts to be excreted in the urine. This is the first measurable sign of kidney damage, even before symptoms appear. If kidney damage continues to progress, the kidneys become incapable of properly excreting excess water. This leads to a condition called edema: fluid begins to accumulate in tissues such as those around the ankles and within the abdomen; even the lungs may fill up with fluid.

(6) Health Canada, *Diabetes in Canada*, 2nd ed., 2002.

- Vision problems and blindness (glaucoma, cataracts, diabetic retinopathy)

  Chronic high blood sugar results in damaged blood vessels, as described above. Damage to the tiny blood vessels of the eye, causing breaking and bleeding, is called retinopathy. The eye tries to grow new blood vessels, but these do not develop normally and the problem worsens. Retinal detachment can occur, resulting in blindness. In addition to retinopathy, diabetics are 60% more likely to develop cataracts than the general population and 40% more likely to develop glaucoma, meaning that pressure inside the eye is elevated. If left untreated, glaucoma can cause also blindness.

- Numbness (or pain) in the extremities (peripheral neuropathy)

  Chronic elevated blood sugar can cause glycation of nerve cells: glucose attaches itself to the nervous tissue and damaged nerve cells cannot transmit information properly. Damage to the peripheral nervous system can cause either numbness or, conversely, burning pain in the arms, legs, hands and feet. Sores to the bottom of feet can easily go undetected if there is numbness, especially in overweight individuals who cannot easily inspect their feet. Impaired blood flow to the extremities due to the damaged blood vessels already described mean that the body's own defence systems for healing, as well as distribution of administered antibiotics, are severely reduced. An infected wound can become gangrenous and require amputation. The Canadian Diabetes Association states that 4-10% of diabetics (both types 1 and 2) will develop foot ulcers over the course of their lifetime, and that as many as 24% of those individuals will require a foot or leg amputation when an ulcer does not heal. That is potentially as many as 50,000 amputees in Canada.

PREVALENCE AND COST OF DIABETES IN CANADA

The World Health Organization (WHO) states that in 1985, worldwide prevalence of diabetes was 30 million. By 1995 it had shot up to 135 million, and only five years later, in 2000, it had reached an estimated level of 171 million people. By 2030, the WHO projects that this number will soar to 366 million. The WHO's projections include surges in the prevalence of diabetes not only in developed countries but also in developing ones, where the rate of overweight and obesity is climbing in urban centres. The WHO figures suggest an increase in the number of Canadians with diabetes from just over 2 million today to 3.5 million by 2030. These increases are due to type 2 only.

In 1999-2000, 5.1% of adult Canadians had been diagnosed with diabetes.(7) The actual prevalence of the disease is assumed to be significantly higher, because estimates suggest that as many as 30% of diabetics are undiagnosed. Prevalence of diabetes in adulthood also

(7) National Diabetes Surveillance System, *Responding to the Challenge of Diabetes in Canada*, Ottawa, 2003, p. ii, available at: http://www.phac-aspc.gc.ca/ccdpc-cpcmc/ndss-snsd/english/pubs_reports/pdf/WEB_NDSS_English_Report-nocover.pdf.

increases with age to a peak of approximately 15% by age 75. The Web site of the Public Health Agency of Canada's Centre for Chronic Disease Prevention and Control indicates that there are 60,000 new cases of diabetes each year, almost all of which are type 2. Canada's situation is much the same as that of other developed countries, according to WHO data.

The health care costs associated with diabetes are already disproportionate in Canada. While people with diabetes make up 6% of Canada's population, they experience an inordinate share of those health crises most costly to treat: 32% of heart attacks, 43% of heart failure cases, 51% of new dialysis cases and 70% of limb amputations. Rising rates of diabetes will almost certainly produce increased health care costs for Canada unless effective preventative measures are taken to halt the epidemic.

The economic burden of this disease includes both direct and indirect costs. Direct health care costs include medication, hospitalization, ambulatory care, eye exams, and home care. Indirect costs refer to lost productivity due to illness, injury, disability and premature death. These costs were conservatively estimated at $1.6 billion in 1998; in 2005, the figure would be well over $2 billion and is climbing. Projections of continued increases in diabetes prevalence suggest that diabetes will become an even more significant component of Canada's health care costs.

CANADA'S ACTIONS

In 1999, the Government of Canada pledged $115 million over five years to the development of a Canadian Diabetes Strategy (CDS). Partners in this national initiative include the provinces and territories, various national health bodies and interest groups, and Aboriginal communities across the country. The purpose of the strategy is to establish effective prevention and control measures. Currently, the CDS is running the "Eat well. Be active. Have fun. You can prevent type 2 diabetes" campaign, which includes television spots and information brochures at some pharmacies.

As mentioned previously, the rate of diabetes among the Aboriginal population is three to five times higher than in the general population. In recognition of this fact, over half of the funding from the CDS was allocated to the Aboriginal Diabetes Initiative (ADI). The ADI is designed to provide a more comprehensive, collaborative and integrated approach to decreasing diabetes and its complications among Aboriginal people. It was developed in partnership with Aboriginal people and is overseen by a national steering committee with representation from the national Aboriginal representative organizations (Assembly of First Nations, Inuit Tapiriit

Kanatami, Métis National Council, Congress of Aboriginal Peoples, Native Women's Association of Canada) as well as the National Aboriginal Diabetes Association. The program is divided into two components: the First Nations On-reserve and Inuit in Inuit Communities Program; and the Métis, Off-reserve Aboriginal and Urban Inuit Prevention and Promotion Program. Programs that emphasize holistic approaches and strive to be culturally appropriate are now in place across the country. Aboriginal people are involved in all stages of development, implementation and program maintenance.

The Public Health Agency of Canada also houses the National Diabetes Surveillance System (NDSS), a component of the CDS.(8) The NDSS is a multi-stakeholder initiative involving the federal, provincial and territorial governments, non-governmental agencies, Aboriginal groups and industry. Its aim is to reduce the incidence and complications of diabetes through the development, implementation and national coordination of provincial, territorial and Aboriginal diabetes surveillance systems. The NDSS provides a national, standardized database of Canadian statistics on diabetes and its complications. The system's goals include:

- a national standardized database for diabetes surveillance, with long-term monitoring for diabetes-related complications through the integration of new and existing databases;
- ongoing surveillance of diabetes and its complications in each province and territory, and in the Aboriginal community;
- dissemination of national comparative information to assist in effective prevention and treatment strategies by public health departments, Aboriginal communities, non-governmental organizations and private industry; and
- a basis for evaluating economic/cost-related issues regarding the care, management and treatment of diabetes in Canada.

The NDSS issued its first, and to date only, report, *Responding to the Challenge of Diabetes in Canada*, in 2003.(9) The system claims to be the first example of a coordinated, national use of administrative data for public health surveillance purposes.

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(8) Additional information about the NDSS is available on its Web site at: www.phac-aspc.gc.ca/ccdpc-cpcmc/ndss-snsd/english/index_e.html.

(9) See the "Publications and Reports" page on the NDSS Web site at: http://www.phac-aspc.gc.ca/ccdpc-cpcmc/ndss-snsd/english/pubs_reports/index_e.html.

CONCLUSION

Diabetes is a very serious public health issue that is becoming more prevalent each year, both in Canada and worldwide, due to an increasing tendency toward weight gain. Higher consumption of saturated fats and sugar, increased portion sizes and snacking, as well as more sedentary lifestyles have produced unprecedented levels of overweight and obesity. These, in turn, have brought on the inevitable surge in the rate of type 2 diabetes. This devastating disease is in many instances preventable and largely controllable with proper nutrition, weight maintenance and adequate physical activity. Unless Canadians begin to take proper care of themselves, however, diabetes will continue to take a profound human and financial toll in this country.

ADDITIONAL REFERENCES

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