Penn State researchers take on the epidemic of diabetes and obesity

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Michelle Obama is worried, and she's not alone. On Feb. 9, the First Lady kicked off a national initiative called "Let's Move" that aims to end childhood obesity within a decade. "The truth is we don't have a moment to waste," Obama noted, "because a baby born today could be less than a decade away from showing the first signs of high cholesterol, high blood pressure, and type 2 diabetes, if he or she is obese as a child."

Obesity and type 2 diabetes are two sides of the same coin, explained Robert Gabbay, director of The Penn State Institute for Diabetes and Obesity.

"Obesity is the single major risk factor for developing the disease, which in turn is a leading cause of heart attack, stroke, blindness, amputation, and kidney disease, as well as death."

Portrait of an epidemic

The USDA's 2010 dietary guidelines report calls the obesity epidemic "the single greatest threat to public health in this century." In the past 30 years, the prevalence of obesity (defined as being 20 to 40 percent above one's medically approved weight) has tripled in the United States. In less than a decade, the prevalence of diabetes has nearly doubled to an estimated 24 million people.

According to the Center for Disease Control and Prevention (CDC) the

disease -- specifically type 2, the more preventable kind that accounts for 90 percent of all diagnoses -- afflicts at least 8 percent of the national population. Another 57 million Americans have been diagnosed with pre-diabetes, a condition indicating higher than normal blood-glucose levels and an increased risk for diabetes. What's more, physicians estimate that another 25 percent of people already have diabetes without knowing it. Many symptoms, such as frequent urination, excessive thirst or hunger, and fatigue, go undiagnosed, greatly increasing the chance for severe complications.

Perhaps most chillingly, the face of type 2 diabetes is getting younger each year. What used to be a disease of our grandparents and parents is becoming a disease of our children, noted Bob Gabbay. Even the names for the disease's two types reflect this shift. In 1997, "adult-onset diabetes" -- a condition where the body still produces insulin but is resistant to its glucose-regulating effects -- was renamed type 2 diabetes. "Juvenile diabetes" -- the far more rare condition, marked by an inability to produce insulin -- became known as type 1.

Said Gabbay, "As a society, we are just now starting to absorb the extent of this problem. The predictions for children are finally ringing the alarm bells. If we don't do something, our kids won't even have the life expectancy we have -- and the years they have may not be healthy ones."

From molecules to Medicare

"At Penn State, we're trying to meet this crisis head on," added Gabbay. "Our researchers are tackling things from the molecular level all the way to public health initiatives, with a shared goal of eradicating obesity and diabetes and helping those with these conditions live better."

Each spring, over 160 Penn State-affiliated clinicians and scientists gather for an annual retreat sponsored by Milton S. Hershey Medical

Center, the Penn State College of Medicine and multiple colleges at University Park. The gathering exists, in part, to give colleagues in disparate divisions a sense of the breadth and depth of diabetes and obesity research taking place under their own institutional umbrella.

"We are always trying to facilitate greater ties between University Park and the College of Medicine," noted Gabbay. "The clinical, applied and basic research we do is stronger because it takes places at multiple colleges and campuses. And the links we create between scientists, health care providers, clinics and hospitals make a difference across central Pennsylvania and beyond."

It’s complicated

One of the greatest challenges is how to get patients to make lifestyle changes to avoid the devastating and often preventable complications of diabetes. Obesity, hypertension, cigarettes, alcohol, and processed foods can set a diabetes patient on a crash course for heart disease, stroke, nerve death, kidney disease, and blindness, among other ailments.

"One of our great strengths is in eye research," Gabbay noted. The JDRF Diabetic Retinopathy Center at Penn State (supported by the Juvenile Diabetes Research Fund) is "one of the world’s largest retinopathy centers for the study of eye disease and diabetes. Many of our investigators started in the lab and are now testing new treatments on patients to prevent blindness."

Joyce Tombran-Tink embodies that spirit of discovery. She is the co-discoverer of a promising protein called pigment epithelial derived factor (PEDF), which she describes as "important for its ability to protect nerve cells from dying and prevent blood vessel leakage in the eyes and brain." Research based on her discovery could benefit many kinds of neurodegenerative disease, including diabetic retinopathy,

which causes about 24,000 new cases of blindness each year.

Diabetic nephropathy -- defined as deterioration of kidney function caused by elevated blood sugar levels -- is another devastating complication. Often almost symptom-free until its more advanced stages, the disease can cause weakness, swelling, insomnia confusion -- and can ultimately lead to dialysis and even death. Diabetes is the leading cause of end-stage renal disease in the US, accounting for about 40 percent of new cases.

"Evidence is pointing to diabetic nephropathy being a disorder of the immune system," said Alaa Awad, assistant professor of medicine. High blood sugar and high blood pressure can clog the waste-cleansing capacity of the kidney's glomeruli, tiny capillaries that filter the blood. Toxins begin to build up in the bloodstream and the body responds by unleashing macrophages -- white blood cells that ingest foreign material and stimulate other immune system cells. Explained Awad, "My research investigates how this immune response can lead to destructive inflammation. My colleagues and I are exploring new therapeutic modalities to prevent or delay the progression of renal tissue damage, particularly as it relates to immune cells called macrophages, dendritic cells and lymphocytes."

While Awad's research relates to end-stage disease, Andras Hajnal's attention is fixed on the root causes of "diabesity" itself. Hajnal, associate professor of neural and behavioral sciences, recently published a study in the Journal of Neurophysiology suggesting that obesity gradually numbs the taste sensation of rats to sweet foods and drives them to consume larger and ever-sweeter meals. Hajnal's findings could uncover a critical link between taste and body weight, and reveal how being fat preconditions the brain to become hooked on sugary food. "When you have a reduced sensitivity to palatable foods, you tend to consume it in higher amounts," he said. "It is a vicious circle."

Junk food nation

Leann Birch and Barbara Rolls have spent their careers investigating just such vicious circles. Frequent collaborators and co-authors, they are equally frank in their assessment of the problem. "Most of us know what we should be eating, but it doesn't necessarily affect what we do," said Birch, director of the Center for Childhood Obesity Research.

Rolls, director of The Laboratory for the Study of Human Ingestive Behavior and author of five books including The Volumetrics Weight-Control Plan, nods in agreement. "Leann and I are in the midst of a study among preschoolers that looks at how to get vegetables into the diet," she pointed out. "We know that big portions of calorie dense foods loaded with fat, sugar and salt are the main problem. Part of our logic is that if portion size has such a powerful effect on intake, how about using it positively to get these kids to eat more of the foods they should be eating?"

Explained Birch, "We're trying simple things such as increasing the portion size of veggies at the start of a meal. Lo and behold these preschoolers eat more vegetables. By the same token, for adults, having a big salad at the start of a meal reduces overall calorie intake."

"The real question," added Rolls, "is how to reach parents who are reinforcing bad food choices at home because that's what they like to eat. We now have two generations of adults who haven't really cooked. We have to return to a model that values quality over quantity."

Quality may be an especially hard sell in an era of economic hardship. Americans are clearly falling far short of the USDA's minimum recommendation of five fruit and vegetable servings per day -- and we're paying the price for our poor nutrition. But it's not entirely our own fault, believe Birch and Rolls. "We don't have to learn to love some

tastes," Birch explained. "Studies show that infants are born with a preference for the sweet taste. What's more, fat carries a lot of the flavor characteristics of foods. So when children are eating food that is high in sugar, fat and salt, it's pushing other things out of the diet that you have to learn to like, such as vegetables."

When they say "vegetable" Birch and Rolls are envisioning fresh produce such as carrots, spinach, and green beans. But to the frustration of nutritionists the USDA and public schools consider French fries a vegetable. In fact, said Rolls, "New data show that the most commonly consumed 'vegetable' among toddlers and preschoolers is French fries." The same study concluded that 75 percent of preschoolers are eating too much saturated fat, and 84 percent are taking in too much sodium per day.

Finding a carrot in the desert

Geography, class and race play an undeniable part in this epidemic. Studies reveal that fresh produce is least available in the poorest rural and urban communities -- dubbed "food deserts" -- particularly in African-American, Hispanic and Native American neighborhoods where obesity and malnutrition often go hand in hand. Michelle Obama has zeroed in on these underserved areas, pledging $400 million to help and calling for more grocery stores and farmers markets in these communities.

"There are kids coming out of places like central Philadelphia who've never even seen a banana," said Rolls. "How do we expose people to the huge array and the vast pleasure you can get from eating really good produce? The reality is we don't have much will power, and we're not thinking of our health in the future, or health care costs, or the personal and societal consequences of obesity. We're eating for the moment, and going for what tastes good and is cheap and, importantly, what we find

readily all around us—unless we can change that, I think we're in big trouble."

She paused thoughtfully, and then added, "Ultimately, we have to convince the food industry to make some changes. I think our only hope is to change the food supply so it becomes the default to go for the healthier food."

A new model for success

There's good news mixed with the bad, insisted Gabbay. "An interesting strength at Penn State is the window of opportunity we've identified to help pregnant women and diabetes prevention."

For instance, the Active MOMS study, led by associate professor of kinesiology Danielle Downs and funded by the National Institute of Diabetes and Digestive & Kidney Diseases, examined the impact of exercise and other health behaviors on pregnant women with gestational diabetes.

The interventions help, said Downs. "It appears that the environment the fetus is exposed to during pregnancy plays a big role in whether the baby will eventually develop diabetes. There's this critical early intervention time during pregnancy and infancy when we can really make a difference."

In the end, said Gabbay, the hopeful aspect of the 'diabesity' epidemic is the same thing that makes it so frustrating. "Diabetes and obesity are incredibly expensive diseases," he noted. "Most of the costs are from long term complications which we can prevent, so not only is there a huge cost but there's a huge opportunity to save money and lives by delivering better care."

"One in seven health care dollars are already spent taking care of diabetes," he added. "Unless we make a huge change, one-third of children born today will develop diabetes in their lifetime, a quadrupling of the number of people with diabetes. To just simply take care of all those people…" –he trails off mid-sentence, then added emphatically, "We don't have a health care system that could do that."

Is it possible to avoid this frightening fate? "Yes, it's not magic," said Gabbay. "We know that if you control blood pressure, cholesterol and blood sugar we can prevent most of the complications of diabetes. But what percent of people with diabetes in the United States have all three of these controlled? Only about 7 percent. That's 93 percent who are not well controlled. That speaks to the system really failing us. It's going to take everyone at all levels -- patients, physicians, corporate and governmental initiatives, and academic research -- using all the tools at our disposal in order to correct our course."

To that end, said Gabbay, "At Penn State, we've developed a study where we provide an online tutorial about diabetes and then connect people to a social community for support. We are working through the governor's Office of Health Care Reform to improve chronic-care delivery. We are developing a computerized registry to be able to track patient outcomes and prevent people from falling between the cracks." Will it be enough? We may not find all the answers, he admitted, but we've rolled up our sleeves and are hard at work. And most importantly, "We are determined to be part of the solution."

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