PODCAST 41: World Diabetes Day, Epidemiology of Diabetes

Dr. Rita Kalyani, MD: Welcome to Diabetes Deconstructed, a podcast for people interested in learning more about diabetes. I'm your host, Dr. Rita Kalyani at Johns Hopkins. We developed this podcast as a companion to our patient guide to diabetes website. If you want a trusted and easy to understand resource for diabetes or to listen to previous podcasts, please visit hopkinsdiabetesinfo.org. Today, we are thrilled to welcome Dr. Justin Echouffo, MD, PhD. Dr. Echouffo is currently the associate director for student and resident education in the division of endocrinology, diabetes and metabolism, as well as an associate professor of medicine at the Johns Hopkins University School of Medicine.

He is a physician scientist with training in endocrinology and epidemiology. His clinical practice focuses on diabetes, especially type 2 diabetes, as well as obesity and lipid disorders. His research also examines the links between diabetes, obesity, and related cardiovascular disease. Welcome, Dr. Echouffo.

Dr. Justin Echouffo Tcheugui, MD PhD: Thank you Dr. Kalyani. It's really a pleasure for me to be on the podcast today.

RK: We are so excited to have you here on our special World Diabetes Day podcast to talk about what diabetes is like in other parts of the world and what is being projected for future diabetes rates as well.

I wonder if you could start off by telling us about some statistics related to diabetes around the world. How do diabetes rates compare in different countries around the world?

JE: In terms of global statistics of diabetes in the world, the International Diabetes Federation usually releases numbers around all world regions regarding diabetes. The latest estimate, which dates back to 2021, indicates that diabetes prevalence in the adult population age 20 to 79 is estimated around 10.5%. This is quite high in proportion, which corresponds to approximately 537 million people in the world with diabetes, which is a quite high number. That prevalence of diabetes is quite similar among men and women. There's really no sex differential in terms of the rates of diabetes around the world, but the rates of diabetes are usually influenced by age. We have the highest rates of diabetes among people who are 75 years of age and above.

There's also a differential in the prevalence of diabetes between the urban and rural areas in the world. With a prevalence in the urban area overall being around 12% compared to 8% in rural areas. The prevalence is also much higher in high-income countries at around 11% compared to low-income countries at around 5%.So that's an overview of the how diabetes looks like around the world.

Obviously, there are differences across regions of the world, as I said, with high prevalence in high-income countries, but the low-income countries are quickly catching up and the prevalence is projected to be much higher in those countries by 2045.

Maybe in the rest of the conversation, we are going to go into the details of those numbers.

RK: Those numbers are just astounding to hear. 1 in 10 adults around the world have diabetes and more than 500 million people are living with diabetes around the world. It sounds like those rates are projected to grow even greater and even faster in the future.

You talked a little bit about regions of the world, specifically low-income and high-income countries. Can you tell us a little bit about what those terms mean and which countries are the ones that are really projected to have the greatest numbers now and grow in the future?

JE: In terms of the current numbers and which countries have the sort of the highest number of people with diabetes, they're mostly in high-income countries, but also in middle-income countries. The four top countries where you have the highest rates of diabetes are China, where currently there are approximately 141 million people with diabetes; followed by India, where there are about 74 million people with diabetes. Then in the third position, we have Pakistan, where there are approximately 30 million people with diabetes, and then followed by the United States (US), where we have about 32 million Americans who have diabetes. As you can see, those top countries include one high-income country, which is the US, and the rest, we may argue that those are middle-income countries. It is quite understandable because the populations in those countries are very large. India and China have the largest populations in the world.

I think this is also related to a rapid urbanization, especially in China, India, and also in Pakistan. The rate of urbanization is associated with change in lifestyle, especially change in nutritional habits as well as change in physical activity habits. With more physical inactivity leading to obesity and then to high rates of diabetes, especially in China and India and Pakistan.

The other aspects relate to the ethnic groups in those countries. Obviously in India and Pakistan, you have South Asian people who display a sort of high level of susceptibility to diabetes, in addition to these lifestyle factors. That's four of the top countries in which diabetes is very highly prevalent.

In terms of the regions of the world, the highest prevalence is in higher-income countries, but the middle-income countries are catching up very quickly. It's projected that in the sort of middle-income countries by 2024, there will be an increase in the number of people with diabetes by at least 200 million people.

It is also projected that by 2045, the highest relative increase in the number of people with diabetes is going to be in Africa. I must point out that the numbers in Africa, although in absolute numbers and also relative numbers, look low compared to the high-income countries- there are issues with how the data is collected in those parts of the world. There are not enough national surveys to (capture) the real prevalence of diabetes. A high number of people with diabetes, especially in Africa, may go undiagnosed. I think that there is an underestimation in the number of people with diabetes in that part of the world. So, the current numbers and the future numbers are probably much higher than what we know now.

RK: Thank you for bringing up that important point that part of what we know is based on the data that we have. There are parts of the world where it's hard to get good numbers on how many people actually have diabetes. Whether it's related to testing facilities or having a

central registry or a central database, the numbers that we are hearing about today that you are talking about are probably an underestimate, wouldn't you say, of what's truly out there?

JE: Definitely.

RK: When you talk about prevalence, just for our audience, you mentioned the actual numbers in these countries, China, India, Pakistan, and USA. But when you talk about prevalence, that takes into account how many people are actually in the country as well.

JE: Yes.

RK: You said, China and India being the two most populous countries in the world, you might expect that they'd have greater numbers of people with diabetes. But when you talk about prevalence, that's really giving us a sense of the proportion of the population that has diabetes. If I heard what you said correctly, it sounds like in low- and middle-income countries (LMICs), such as in Africa and the Middle East that the prevalence (the proportion of people that live with diabetes) is higher. Is that right?

JE: It's higher. About 80% of the overall (global) population of people with diabetes live in these low- and middle-income countries.

RK: Wow, that's such a large number. Being here in North America it is important for us to realize that there is truly an epidemic of diabetes, not only within our country. When 80 percent of the people with diabetes in the world live in low- and middle-income countries, it really behooves us to think about, on a global scale, what we can do to address this public health issue.

From what I recall in some parts of the world, you mentioned that the overall prevalence is about 10%, but I seem to recall that in some parts of the world, it can be up to a third of the population that has diabetes. Isn't that right, in some parts of the world?

JE: That is correct. So, there are some parts of the world, especially in the Middle East. In those low- and middle-income countries in the Middle East, I think that India is also evolving and going towards that end of the spectrum, where about a third of the population has diabetes.

RK: It is important to recognize that when we give these numbers that 10% in the world have diabetes, not only is it probably an underestimate based on the reasons we talked about, but there is a wide range.

JE: Yeah, it is a wide range. As I said, the upper spectrum or the high spectrum is even more than 10% and the lower spectrum is about 5%.

RK: It is pretty remarkable and really drills down the importance of why this has become such a huge public health issue. One of the terms that I've seen used more often, and perhaps you could shed light on this, is this low- and middle-income countries versus high-income countries.

In the past we used to say, developing and developed nations. There are reasons why we don't use those terms anymore. I wonder if you could comment briefly on the use of the terminology now that we are using on the podcast and that is commonly used.

JE: Yes, I think it has much more to do with the level of economic development in those countries, so it's not that far away from the former concept of developed or underdeveloped. We want to use a more appropriate language and (label) countries on the basis of economic viability, if I may say so.

There is some sort of looseness because when you classify China these days as a middle-income country, is it really a middle-income country? You classify India as a middle-income country, it's basically just an average because there are certain areas in India that are not that different from high-income countries.

Places like Brazil or places like Russia, which are also to a certain extent upper or middle-income countries. It is not very clear cut; it is an evolving concept. The countries are not necessarily permanently in a category. But places like in Africa where there's much less economic development are going to be low-income countries.

RK: It is changing, right? As you said as well, and I think it sounds like China at times might be called an upper- to middle-income country versus a middle-income country. I'm sure it is somewhat reflective of how things have been going in recent times.

JE: Yes, it is a World Bank definition. So that has been adopted by the International Diabetes Federation to classify and to rank the country on the basis of their economies.

RK: And do you think that there's a correlation or an association between where a country ranks on the scale of upper, middle- or lower-income to the prevalence of diabetes? Or is it variable?

JE: It is variable because it's tricky in the sense that even within the low- and middle-income countries, it all depends on whether people are in urban or rural area, right?

Because of urbanization, there's an increase in the prevalence in urban areas because of the change in lifestyle and (this is reflected) in the rates of diabetes. The other aspect is that the economic level of a country will correlate with the ability to address the epidemic in many ways. In the ability to put into place preventative measures, to prevent the occurrence of obesity and to manage the disease. That will influence the pool of the new number of people who have diabetes, and it will also influence the overall pool of people who have diabetes.

So, my understanding is that a lower socioeconomic level over time is going to be correlating with a high prevalence of diabetes.

RK: That is so interesting that in some ways the level of economic development of the country may reflect its capacity to support people with diabetes for prevention efforts and then also for treatment.

That is very interesting. Now you mentioned urbanization. I wonder if we could turn to that just briefly to talk about what we mean when we say "urbanization." It sounds like even within a country there could be regions of the country, urban versus rural, where we could see differences in diabetes rates, even within the country because of urbanization. Can you talk a little bit more about that?

JE: One of the quintessential examples to illustrate the urbanization phenomenon is an example from the studies of British epidemiologist Geoffrey Rose. He conducted studies in the Maasai population, which it's an ethnic group that lives in Kenya.

What he did at the time was in the late 1980s, early 1990s, he went to Kenya and look at the Maasai people living in Nairobi, which is the capital city of Kenya and compared the sort of metabolic profile or the health profile with that of the Maasai people living in the rural areas. So traditionally the Maasai people are pastoralists, they look after cattle. What they do is that the Maasai people are running around with the cattle during the whole day, so that's a lot of physical activity. They also live on meat, from the cattle and then milk, mostly.

So, when they move to cities, or to Nairobi, what happens is that there is a change in their nutritional habits. They don't follow the traditional Maasai diet anymore, and they adopt a more Western style diet, and they are essentially physically inactive. As a result of that, the rates of metabolic disease, including diabetes, are much higher in the Maasai people living in Nairobi compared to the Maasai people that remain in this ancestral land. The other thing is that the Maasai people living in Nairobi, are using modern equipment. So the mode of transportation, they don't do any physical activity, they use cars, and they use public transportation to do the stuff that we do around here.

So as a result of that, they are definitely more obese, and they have more diabetes. So, urbanization is changing the lifestyle that is related to the development that is happening in those countries. Moving from a sort of traditional way of life and less mechanized way of life to a more developed way of life.

RK: It's interesting that the concept of being more modern is almost associated with this concept or these trends in urbanization. Like you talked about, more mechanization, changes in diet, decreased physical activity, even the environment changes in that setting too, in terms of what people are exposed to. We are seeing this all around the world

JE: It's all around the world, so it's rapidly happening. It happened rapidly in China; it’s rapidly happening in India. It's rapidly happening in a lot of the so-called middle-income countries, but it's also happening in the low-income country.

RK: And then we are also seeing parallel trends and rises, like you said, in obesity and diabetes.

Do you think that urbanization and metabolic diseases have to go hand in hand? Or do you, from your opinion, think that there are things we can do to prevent or mitigate it, knowing that these trends in urbanization will continue?

JE: They definitely go hand in hand because studies are showing that the trends of the rise in diabetes parallel the rates at which urbanization is happening. What can we do to prevent those rising trends in diabetes? I think fundamentally we must rethink, in a more modern environment, we have to rethink our approach to physical activity and also nutrition. I can use the example of England that I know a little bit about. In the policies for transportation, there could be a conscious effort to push people to a certain extent to be more physically active.

For example, in England, there's the notion of park and ride. What people do, what public transportation and the public policies in terms of transportation do, is try and force people to be more physically active by creating an incentive for people to park their car somewhere in a public parking and then to ride a bike to the office. The other thing is that in public areas, for example, in malls, where the escalators and things like that, what people have done, especially in the southern part of England, is remove some of the escalators in those places and force people to do a little bit more physical activity in the normal daily life.

The other thing in terms of nutrition is to make sure that what is available to people meets a certain number of requirements in terms of quality. With less processed food or foods that are less rich in carbohydrates are offered to the population. What I'm trying to say is that at the policy level, at the societal level, that's where action should be much more than at an individual level. People are going to, in terms of nutrition, they're going to use whatever is available to them in their environment.

Their ability to be physically active, they're probably going to go with whatever the environment is offering. An environmental change, a societal change in the so-called developed societies is probably, in my opinion, the way to go in terms of prevention of the levels of obesity and in effect is going to be a reduction in the levels of diabetes.

RK: I appreciate your input, and your thoughts based on not only your experience having lived in England, but also the research that you do in this space as well- in prevention and systems level changes. While it sounds like urbanization and metabolic diseases often go hand in hand, they don't have to with thoughtful consideration of the societal policies we put in place.

Also, walkability, I thought, was interesting, not having escalators in a mall and really for those who are able to go up the stairs and don't have physical disabilities or physical limitations to really encourage that. The whole notion of park and ride, when I think park and ride here in the United States it's usually parking your car and either carpooling with someone else in their car or going on a bus. The notion of a park and ride, as you've described it, and as you've seen in England, is parking the car and then riding a bike. I love the idea that you can do both and get physical activity at the same time. But it also takes having bike lanes or having safe places to be able to bike and putting those systems in places, so it really is at a larger scale.

JE: It is larger scale. So, it's housing; it's transportation. Another sort of quintessential example is the example of the Netherlands where, I don't know if you've ever been to Amsterdam, you see the sheer number of bikes that you have in Amsterdam.

So, the result of that is if people are biking 30 minutes twice a day to work and back from work, they definitely have the level of physical activity recommended by the American Heart Association. So yes, it requires a system level effort in a modern society, in addition to the individual level effort.

I think the individual level efforts are key, they're important, but my sense is that changes at the societal level are critical.

RK: It sounds like they might also need to be tailored to the culture and the norms of the country. Where you're trying to instill these policies, for instance, in parts of the world, where it might not be typical for all members of a population to be out in public and exercising. Those kinds of things also need to be incorporated in terms of what is acceptable in that culture and how we can work within the cultural norms to really foster healthy behaviors. Isn't that right?

JE: It's right. The whole concept of being physically active varies from one society to the other. I don't think that having a gym membership as we usually recommend here in the US will necessarily work for everywhere in the world, or within every group in the US. Based on my personal experience of the African community, I don't think going to the gym is an accepted practice. So, the question becomes within the cultural norms of such a community, what are the things that people could do to increase their level of physical activity?

In that regard, my take is that "every little helps". It's very difficult to say, for example, to a woman who is not used to doing a certain number of things or to be physically active in public, to just come out and go to the gym. I would say starting with simple things like just stepping out and walking is important and it's critical.

I usually say that "every little helps." Within the cultural norms of the community, the little things that could be done and that are acceptable in that community will go a long way to increase the level of physical activity. The other aspect in terms of the cultural norms is in terms of the diet. There is no universal diet. The nutrients are the same, but the approach to food or eating is different from one part of the world to another. In some cultures, using carbohydrates or a diet without carbohydrates is not conceivable. These are things that must be considered.

I've seen this even in my clinical practice where you send, for example, a South Asian man to the nutritionist, sometimes there's no satisfaction because they're, they are given sort of general recommendations that do not account for South Asian food, the components in the South Asian food or the whole concept of eating in the South Asian culture. So those things have to be taken into account to be able to see meaningful changes or changes that are going to be beneficial to managing or preventing diabetes.

RK: Yeah, I fully agree. Incorporating the knowledge of the cultural context in the way that we, for lack of a better word, prescribe lifestyle therapy, whether it's physical activity or

nutrition management. Diets range around the world; some are more corn based, some are more rice based, some are more bread or wheat based, and you can't change that overnight in a conversation. Instead, acknowledging the context within which the individual is coming from is important as we try to really help that particular individual reduce the risk of diabetes and the complications as well.

We've talked a lot about urbanization and environmental forces or societal forces that might increase the risk of an individual developing obesity and diabetes. We didn't really touch upon genetic factors, these differences that we are seeing around the world in prevalence. Certainly, trends such as urbanization do contribute, but are there genetic factors for why people in some parts of the world might be more likely to develop diabetes than others?

JE: Yes, there's a combination of both the environment and genetic factors. So we usually say that there needs to be an interaction between the genes and the environment and it seems that interaction leads to more diabetes in some ethnic groups around the world.

If we start with the US where, for example, the environmental change seems to meet in Pima Indians, a sort of a specific genetic substrate, what ends up happening is that we have very high rates of diabetes among Pima Indians. We also seem to have a similar situation with South Asians to a certain extent. They seem to show a high level of susceptibility to diabetes, within the same environment compared to other ethnic groups. Whereby even the rates of progression from pre-diabetes to diabetes are much higher and that happens much faster in South Asians compared to other ethnic groups.

The susceptibility is also much higher in Blacks or in Latinos or Hispanic compared to white populations across the world. So there seems to be a genetic substrate, in addition to the environmental influences that explain the difference in rates of diabetes across ethnic and racial groups.

RK: Thank you for going over that. I think it's important to realize also when we think about prevention that there are some higher-risk groups where we might need to give targeted attention, at an earlier stage, to really prevent diabetes because of the higher risk that they have due to these of genetic factors as well.

JE: Just to add something since you're talking about prevention, even the response to lifestyle changes is not uniform across ethnic groups. In terms of diabetes prevention, it seems that some ethnic groups are more responsive to lifestyle changes than others. And that's something to consider, it's also an indication that there is a sort of genetic susceptibility there.

RK: Wow, that is interesting to highlight that even the response to treatments or response to lifestyle changes can differ as well. It just makes it even more complex and all the more reason that treatment needs to be individualized for the person with prediabetes or diabetes. Now we talked about urbanization; we talked about genetic factors. What about aging? We are seeing people live longer and longer. We are seeing an aging of the population in general. Are people with diabetes living longer? How is that contributing to what we are seeing in terms of epidemiology around the world?

JE: Even before talking about how long people are living with diabetes, let's talk about the effect of age itself, because of the fact that there are higher rates of diabetes in all individuals essentially, for two reasons. It's the natural process of the body that, as people are aging, their metabolism is deteriorating and consequently, there will be more diabetes as people are growing older. High rates of diabetes in older individuals. So that's one aspect.

The second aspect that you alluded to is the fact that, especially in high income countries where we have the resources and then we have access to the appropriate medication, people with diabetes are living longer. Here I would highlight that this is much more relevant to type 2 diabetes than type 1 diabetes. So, we have people who are living longer and as a result, people of a certain age are increasing the overall pool of people with diabetes around the world. That's in a nutshell, what I can say about aging.

RK: Yes, and it is important because we are going to see more and more older adults who, like you said, are at higher risk of developing diabetes. Almost a quarter of our older adult population lives with diabetes. Currently another half is at risk for diabetes with prediabetes. Then as people develop diabetes, they live longer compared to the past. Also, from a societal perspective, thinking about how we are going to support all these older adults with diabetes and really prevent complications as well.

JE: Maybe something to add in terms of aging or age, it is the fact that the age at which the diagnosis of type 2 diabetes is made seems to be an important factor in terms of the severity of the disease. Emerging data indicates that an early age of diagnosis seems to be an indicator of a more severe form of disease, a more rapidly progressive disease, with a high rate of complications. Even when complications are occurring, they're much more devastating. So much so that an early age of diagnosis of type 2 diabetes is associated with a high rate of cardiovascular complications and sometimes even a poorer control of the disease. So early age of diagnosis seems to be an indication of a much more aggressive form of disease, which is usually associated with a higher degree of obesity.

RK: We are seeing that also with the rise of obesity in children, aren't we?

JE: Definitely

RK: With children and adolescents being diagnosed with diabetes at a younger age, being at higher risk of complications than their adult counterparts. So, both older ages have higher likelihood of developing diabetes, but if you are diagnosed at a younger age, there is a much higher risk for (some) complications.

You touched upon your experience in England, having lived there before. I wonder if you could share a bit more about your experience living in Africa and what you've witnessed there in terms of how diabetes was diagnosed and managed and how it might be different than what we see in North America and other parts of the world.

JE: I was born in Africa; I still have parents there and lived part of my life there and had my sort of initial training there. Historically, even if you go into traditional textbooks, it was thought that diabetes was a rare disease in Africa, but I don't think it's the case any longer. I think the thought that it was rare is probably because it wasn't diagnosed. It's underdiagnosed,

and a lot of people have diabetes, especially type 2 diabetes, for a very long time before it comes to medical attention. So, people are diagnosed late in the process, meaning that by the time they present to their physician, they generally have complications. Those complications can be acute complications, in terms of hyperglycemic crisis, like diabetes ketoacidosis or hyperosmolar hyperglycemic state. As a matter of fact, my maternal grandfather died of diabetic ketoacidosis with type 2 diabetes. This tells you something about the state of diabetes in those places.

The other thing with the high rates of long-term complications is that there's also an inherent difficulty in not just diagnosing but also managing the condition in that context where the resources are very limited. Both in terms of the medication and all the devices that are necessary for an appropriate management of diabetes. But it's also limited human resources in terms of people with the appropriate training to take care of diabetes. So, the number of primary care physicians is low and then also the number of specialists and even in terms of the nurses with sort of specialist training in diabetes or diabetes management is very limited. As a result, people with diabetes do not live as long as we will here in America. It is a very different context; it is a very different situation to what we have here in America.

The other thing that I forgot to mention is that I believe, in African context, a lot of heart attacks are probably related to diabetes. So that goes undiagnosed. It's an important risk factor as important as hypertension. Now it's increasingly being recognized because there are now national policies for diagnosing diabetes or detecting diabetes earlier. Things are slowly changing. So, it's still an underdiagnosed disease in that context and poorly managed disease in that context. As a result, there's a very high rate of complications.

RK: It's so interesting because, in the United States, we've had such an emphasis on risk tests and diagnosis at an earlier stage and screening programs. But what I'm hearing from what you're saying, in Africa and in many parts of the world, I've seen this in India as well, is that individuals don't present to their healthcare provider to get diagnosed. Or if they are, in the diabetes range, perhaps the way it's communicated your borderline, diabetic or you have a touch of diabetes or a touch of sugar, it's also the way that it's communicated to the person living with the condition in terms of how urgent it is to get treated for it. That idea of underdiagnosis and late diagnosis makes it difficult, not only to know the numbers, like we talked about earlier in the podcast for how many people have diabetes, but also to reduce the complications from the disease if people are getting diagnosed later, or they're not getting diagnosed at all. Perhaps many people who die of heart attacks in the African diaspora may have undiagnosed diabetes. That's such an interesting contrast to what we see in higher-income countries, where a lot of the focus has been on diagnosis. Do you think part of that is related to access? You mentioned limited primary care doctors that are available. Do you think that not having as many touchpoints with the healthcare system contributes to people not getting diagnosed? Do you think knowledge or awareness perhaps could be emphasized more? In your opinion, what do you think might be the reasons? Or is it a cultural factor that people don't see it as important to address right away? Why is it that we are seeing these delays in diagnosis as you talked about?

JE: It's definitely multifactorial. It's a combination of all the things that you just mentioned. I think there are not enough touch points to get healthcare, that's one aspect. Access to healthcare is limited, and even available healthcare in terms of the resources; resources are

also limited to diagnose. For example, we do point-of-care A1C here, and I don't think that's readily accessible in many areas in Africa. There needs to be an effort to make those things available and accessible to the population. There is also another aspect which has to do with knowledge - knowledge within the medical community and knowledge in the general population overall. So, I think the diabetes knowledge is limited. But also, understanding or awareness of the condition in the general population is also limited, that may be influenced by cultural factors. How do we conceive of diabetes? Do we even think that it's a disease? Because in a context where people are just being told that their blood sugar is elevated and they don't necessarily have an active complication, they may not necessarily believe that they are sick, or that they have any sort of medical problem. The other thing is they may look for alternative ways of addressing the issues because there are traditional local healers, that people still believe in. Then they consult those people, and they are not equipped to address diabetes appropriately. So those factors come into play here.

RK: The second part of what you mentioned was the availability of treatments. I wonder if you could talk about whether treatments for diabetes are similarly available around the world and why we might see differences in access to treatments. It seems like in the ideal world, everyone should have the same access, but why are we not there yet? Why has this been such a challenge?

JE: It's definitely a challenge. If we look at things through the lenses of equity, everybody should have access to the same resources around the world. But you can imagine, there are huge disparities in terms of the availability of diabetes medication around the world. There are many reasons. Some of the reasons, for example, include that these medications must be produced by someone, right? The cost of production is very high. Many of the low-income countries cannot produce those medications due to the cost of production, especially if you take the example of insulin. So, you move from human insulin to analog insulin; the cost of production is very high. It's financially untenable for those low-income countries.

The other thing is that the market, in terms of medication, is in the hands of a few multinational companies. For more than 90 percent of diabetes medication, the market is controlled by a small number of companies. So, the low- and middle-income countries will not, or cannot compete. They don't own those multinationals, the side dictating the prices of the medication. It is simply not affordable for those countries or to the population in those countries. Those countries cannot regulate the prices of medication. They are generic medications that patents no longer exist for, but those medications in terms of effectiveness may be limited. So, we've been using metformin, metformin is generic. There are other medications like sulfonylurea that are generic that could be affordable in those areas. But are these medications enough to be able to control diabetes?

The other aspects are the devices, that is, all the technologies, the continuous glucose monitors (CGMs), or, in some instances, the pumps, or even the glucometers. Before thinking about CGMs, there are glucometers, with manufacturers in high-income countries. Those things that are critical for self-management are not available in those low- and middle-income countries. In places where you don't have these devices, it does affect diabetes management.

The last thing is the infrastructure; even to get access to those medications, there must be an infrastructure in terms of the pharmaceutical infrastructure—that doesn't exist. So, they will

not have access to those medications. Globally, there are no efforts to make those medications available to those countries.

RK: Access is so important when we talk about social determinants of health, or when we talk about inequities or disparities in care. As we know, there are so many new developments, medications, and technologies, such as pumps and CGMs. But the cost can be prohibitive; access can be prohibitive for many people around the world, and that really is an issue that needs to be addressed. It is not enough to have things on the market just in the higher-income countries, but they really must be accessible, especially since, as you mentioned, 80 percent of people with diabetes live in low- and middle-income countries.

That's a huge issue, and I appreciate you talking about it.

JE: Maybe it's bound to be worse with the newer medications, right? So, we have all those Glucagon-like peptide-1 (GLP-1) receptor agonists that are emerging as powerful medications. If in the US, it's not accessible to everybody, because of insurance issues, you can imagine that in those places (low- and middle-income countries), the situation is even going to be worse.

RK: We have disparities right here in the United States, as you mentioned, for the GLP-1 receptor agonists, sodium-glucose cotransporter-2 (SGLT2) inhibitors, and other medications; we can only imagine what it's like in parts of the world where insurance might also be limited. It is a huge issue and one that we could probably have a whole separate podcast on.

One last question that I have for you, as we talk about the global environment, people don't live in silos anymore. People don't just stay in one country; we are a very mobile population; people are moving; they're immigrating. Focusing now back here on the United States, as we think about immigration and people coming from their home countries, their traditional diets, and the traditional activity levels to perhaps a more Western lifestyle, a more urban lifestyle. How does that impact the risk of diabetes for these migrant communities? And how does that impact the way that we manage diabetes in a country that's becoming increasingly multicultural? I wonder if you have some comments.

JE: The fact that people move from one country to another country influences their rate of diabetes, especially that rate of diabetes is compared to that observed in people who are born in the US. The general tendency is that for newcomers or first-generation migrants there is an issue that has to do with acculturation. The result of that is the rates of diabetes in those communities, if you look at, foreign-born blacks, foreign-born South Asians, or foreign-born Latinos, that tends to have an effect on the rates of diabetes, right? Which generally tends to be slightly higher than that of those people who are born in the US. This raises the question—why is that the case? I think as we mentioned, there could be a genetic component, but we think that this is probably related to the cultural effects or cultural factors that have to do with physical activity patterns and nutritional patterns. In terms of addressing diabetes, if one is very keen on addressing the rates of diabetes in the community, those cultural aspects must be taken into consideration. What happens with migrants is that they tend to want to retain the nutritional habits or the physical activity habits of the home or their original culture. Any intervention in those communities to address, prevent, or manage diabetes must take those things into consideration.

Some aspects have to do with tailoring the message for those communities and making sure that they can understand the message. Sometimes, there may be a need to use the original language because some people do not speak English. In terms of delivery of physical activity intervention, those must account for the cultural norms until they can adopt the norms of the host country, which in this case is the US. Those things must be taken into consideration.

RK: As first generation and second generation live longer and longer, in the United States and we see more acculturation over time, how does that impact the risk of developing diabetes in these migrant communities?

JE: In a lot of migrant communities, as those communities live longer in the country and as they become acculturated, as generations pass, the rates of diabetes become similar to that of the host population. The newer generation populations are much more like the host populations, and the differences overall will disappear with time.

RK: So, it seems like there are many factors, right? Retaining the native diet, but also changing behaviors in the new host country that might either increase your risk initially or, over time, might make the risk similar to people that also were born in that country from other ethnicities. It is also another factor, like you said, to consider in the way that we deliver care, particularly lifestyle interventions, to acknowledge that context as well.

JE: Yes, maybe one thing also in terms of the cultural aspect is the notion of how those people relate with the health system. The first generation is going to have some challenges in terms of relating to the health system or in navigating the health system. That is probably going to, over time, disappear because the next generations are more accustomed to the practices in the host country.

RK: Just to clarify a point: for those people who are first-generation or just immigrating, their risk of diabetes does increase over time?

JE: It does increase for them, yes.

RK: But in subsequent generations, you're saying for their children and their children's children the risk for those individuals who are born in the US might become more equal to other people born in the US.

JE: It may become more equal to the local populations. Unless you belong to an ethnic group that intrinsically has a susceptibility that is higher than that, for example, in the US of US born Whites.

RK: It is so interesting to hear about all the different factors that we've covered today: urbanization, aging, immigration, differences in genetic factors around the world, differences in access to care, and even resource allocation and availability of health care providers. We have touched upon a lot of topics. You have offered eye-opening insights into the epidemiology of diabetes around the world, describing how management and treatment might be different. It has been so great to hear about your experiences living in other parts of the world.

I wonder, in parting, as we have a very global audience listening to our podcast today, what would you say to people around the world who have diabetes, who are challenged in their local environment to really get the outcomes that they desire? How would you suggest they approach some of these challenges that we've talked about that might vary depending on where they live around the world?

JE: I think, irrespective of the environment across the world, in terms of managing diabetes, the best success is obtained when it is a collaborative effort; a collaborative effort with the participation of the patient. The patient is really at the center. They are the ones driving the process, but with the help of the providers, and I'm saying 'the providers' here because it's not just the primary care provider, but there are other members of the team, be it the people who are doing diabetes education and even the pharmacist.

So, it takes a village to have good outcomes for someone with diabetes. Those people who are struggling should not try and do it alone. They should look for help. They should try and maximize the very limited resources that they have and use all possible resources to try and address the problem. Essentially, they are not alone, and they should not do it alone. They should do it in collaboration with others. Sometimes, even peers hearing from other patients can be very helpful because that could point to resources that they are not aware of within their own environment.

RK: Dr. Echouffo thank you so much for all your insightful comments and for providing your expertise on diabetes in different countries and around the world. I think what you said, 'It takes a village,' is a great sentiment as we talk about the different villages around the world, and whatever your village may be, it does take a partnership. Really the person with diabetes is at the center of it, but it takes a village. We are fortunate to have you on the podcast today and really thank you for all your time.

JE: Thank you for having me today.

RK: I'm Dr. Rita Kalyani, and you've been listening to Diabetes Deconstructed. We developed this podcast as a companion to our Patient Guide to Diabetes website. Our vision is to provide a trusted and reliable resource based on the latest evidence that people affected by diabetes can use to live healthier lives.

For more information, visit hopkinsdiabetesinfo.org.

We love to hear from our listeners. The email address is hopkinsdiabetesinfo@jhmi.edu.

Thanks for listening. Be well and see you next time.