

## PODCAST 31: DIABETES AND SLEEP

**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](http://hopkinsdiabetesinfo.org).

On today's podcast, we are thrilled to welcome Dr. Jonathan Jun, who will be speaking with us about diabetes and sleep. Dr. Jun is a pulmonary critical care and sleep medicine physician at Johns Hopkins. He specializes in causes and consequences of obstructive sleep apnea, and the interaction of sleep with metabolism. He received his medical degree from University of Maryland School of Medicine and completed his internal medicine residency at Thomas Jefferson University Hospital. He did two fellowship programs at Johns Hopkins; in Pulmonary and Critical Care medicine, and sleep medicine. Dr. Jun now serves as an associate professor of medicine in the Johns Hopkins division of Pulmonary and Critical Care Medicine. He's a member of the sleep fellowship program evaluation and clinical competency committee and provides teaching to medical students and residents at Johns Hopkins. Welcome, Dr. Jun.

**Dr. Jonathan Jun, MD:** Thank you for having me.

**RK:** Well, we are so excited to learn more about the connection between diabetes and sleep from you today. And we all know that sleep is important. But I was wondering if you could talk about: why is sleep especially important and people with diabetes?

**JJ:** Sure. I mean, sleep is a vital part of everyone's life, we probably spend a third of our lives asleep. We do understand that sleep serves a vital function in many ways. It's the time when our metabolism slows down, our sympathetic nervous system calms down, a lot of things need to happen to facilitate and continue normal sleep. And we've learned through a variety of studies, that we can touch on later, how not getting sleep, whether that be the quality of sleep needed, or the quantity of sleep needed, can impact things that are important to people with diabetes. That includes your glucose tolerance, your levels of glucose, even what you eat, and what you choose to eat may be influenced by how well-rested you are. So, there's a lot of interesting overlaps between sleep and diabetes,

**RK:** You're right. We spend so much of our time in sleep, and it is a vital sign, as you mentioned. Is there an amount of sleep that you usually recommend? Or is that more individualized?

**JJ:** If you look at the national trends, we're probably looking at 7-7.5 hours of sleep nationally, in the US, by self-report. That's what people say we're doing. Some studies suggest that that number has decreased over the past few decades. So that's been debated. As far as how much each person needs, that is somewhat individualized. The American Academy of Sleep Medicine says to aim for seven to eight hours of sleep per night. But there are people that can get by with six, and there's some who might need nine or more. And it really depends on your own [body]. You've got to listen to your own body and realize how much you [need]- most of us probably don't get as much sleep as we need. If you're waking up to an alarm clock, like I am, you probably aren't getting the sleep you need. But do take it with a grain of salt as far as the absolute number of hours.

**RK:** Yeah, alarm clock can be particularly jarring in the morning. I think especially when you're sleeping restfully. We talked about sleep being important in general. How does having diabetes impact sleep?

**JJ:** I think of diabetes and sleep as being bi-directional; both things can influence each other. Let's start with maybe the easier angle to take on that, which is if you don't sleep well, your diabetes is probably going to be more difficult to control. A variety of studies have shown that people that tend to sleep a shorter amount of time exhibit things such as higher degrees of obesity, higher degrees of glucose control. What I mean by that is lower control of their glucose; higher HbA1c, for example. A number of studies have been looked at where they took healthy people and kept them awake for most of the night or even sleep deprived them for a few days, and you can see that when you test their glucose, their body's ability to handle glucose, it deteriorates under those situations. In one sense, not getting enough quality sleep can certainly impact the control of your diabetes.

The other way around in terms of how diabetes affects sleep, that's more complicated. For some people who have diabetes that is under good control, there may not be direct detrimental effect of diabetes on sleep. On the other hand, let's say that your diabetes is not in good control, or you need medications, particularly insulin, that might affect your glucose level that can cause your sleep to be disrupted. If your glucose gets too high or too low, that may wake you up. And there [are] a number of hormones that regulate our glucose that are also secreted as a function of the time of the day or when you're asleep and those can be affected by how well you're sleeping. And we can talk later more about specific disorders like sleep apnea. Let's just say to answer your question here, there's a bi-directional effect of sleep on diabetes and both directions apply.

**RK:** It does certainly sound like a pretty complex relationship. Like you said, diabetes can be associated with sleep and how you sleep can be associated with management of diabetes. You mentioned sleep quality. We all know when we feel rested. But how would you, as a specialist, define sleep quality?

**JJ:** Subjectively, you can certainly ask how you feel how, well your sleep was, and how rested or energetic you are during the day. Then there's the objective measures which are if we put measurement tools on the body, or around the body to see what your brainwaves are doing at night, how much you are moving, there's a variety of tools that we use in both the sleep lab and at home. Even the commercial space has a lot of devices that you might wear in your hand or wrist like the Fitbit or an Apple Watch, though, they do an okay job of estimating when you might be asleep. So those are ways that we can also measure the behavior.

Subjective feeling about how well you slept is not always correlate that well with the objective sleep quality. But that doesn't mean that people don't know their own body. It just means that we don't understand how we perceive sleep and why it may be different than what we're measuring. And I say they're both important because even if we measure you and say, "You're getting great sleep." If you don't feel great, that's a problem. And we deal with that a great deal in sleep medicine. Let me give you an example of that. There's a concept called sleep inertia, which is how long does it take you to get going in the morning or when you wake up? How long are you still in a fog? And how poorly are you functioning until your body really ramps up and gets going? Sleep inertia can be affected by the time of day that you wake up. It can be affected by what stage of sleep you're in. If you're in a very deep sleep when you're awakened, even if you had slept very well, for the previous seven hours if you wake up from that stage of sleep, you just might not feel so well. But when we measure your sleep, we can tell you slept great. So, there can be discrepancies. I hope that answered your question regarding sleep quality, we also will assess whether there are sleep disorders and we can get into that later about the specific sleep disorders we're looking for.

**RK:** That was really, insightful to hear about all the different ways to think about sleep. Sleep inertia, I know we talk about sleep fragmentation, too. I feel like that's a term that we've heard. And I would be curious to hear what you think about taking naps, for instance, during the day and whether that would be helpful for people with diabetes. What would you say for people who feel like they haven't slept well overnight? Do you think that taking naps or other kinds of short bursts of sleep during the day can help their metabolism? Or what would you discourage that?

**JJ:** Unfortunately, I'm going to have to say what I always say which is "It depends." Napping is neither a healthy nor unhealthy behavior in my opinion. It depends on what your goals are and a little bit about your body's circadian rhythms. Circadian rhythms are basically rhythms of our bodies that are regulated by our brain. All of us operate on a roughly 24-hour cycle of activity and rest. Some people have a very strong circadian rhythm, meaning their bodies are like clockwork; you have a very specific bedtime and wake time and it's very difficult to deviate from that. And people with a strong circadian rhythm may also be blessed (I guess you could say) with the ability to sleep hard and wake up really rested. You're down for eight hours, you're up for the other 16. There are others who have less of a forceful circadian rhythm; where you might not be able to sleep eight hours straight and you're awake for periods in the night and then in the middle of the day, your rhythms demand that you take a rest. This happens to many people as they retire or older folks, they have a little bit of what I would describe as a blunted circadian rhythm. In that setting, napping in my opinion is fine, because you still need to achieve a certain amount of sleep in a 24-hour period. It just doesn't have to be all at once. So, I think napping can be a useful tool when applied correctly. Now if you are someone that struggles with good sleep at night, you have insomnia, then many hours of the night staring at the wall and trying to sleep then, napping in that context, I would say is harmful because we want you to build up a little bit of sleep hunger for the night. And the more hours you're awake, the more that sleep hunger or sleep debt builds up. Now regarding diabetes, I don't think there's a lot of data that says people with diabetes need to handle napping any differently than anyone else. We do encourage for diabetes, I would say, it's important to adopt many healthy behaviors like getting exercise and good activity during the day you have a good regimen for that. And if it involves napping, then so be it. Put that nap in the day. Getting good activity, getting sunlight that is going to be healthy for you as someone with diabetes, and it may help you get good sleep at night as well.

**RK:** Do you think that diabetes affects the circadian rhythm?

**JJ:** I don't think there is any great data on that yet, that there's a direct impact of diabetes. There can be indirect impacts of diabetes on circadian rhythms. Let's say for example, many people with diabetes, Type 2 diabetes struggle with weight. If you have obesity or are overweight, then you're likely to also have other issues with your sleep and one condition that's very common as obstructive sleep apnea. Obesity predisposes to sleep apnea because particularly, obesity leads to a thickened neck region and enlarged tongue, and that can get in the way of your breathing. So, if you have sleep apnea as a result of obesity, then you kind of have all three things: you've got obesity, you've got diabetes, and you've got sleep apnea. And the prevalence of the sleep apnea is probably going to impair or worsen your quality of sleep at night. And when that occurs, you're going to wake up feeling unrested and then you might need to take a nap, for example. So,

there can be these more indirect influences of sleep on diabetes in that context. Whether or not diabetes itself directly changes your circadian rhythms is not known.

**RK:** Moving on to sleep apnea, which you mentioned, and probably the condition most people have heard of in the context of diabetes, I wonder if you could talk a little bit about what sleep apnea is, what are the signs and symptoms that someone might need to be aware of, if they're concerned, they might have sleep apnea.

**JJ:** Sleep apnea literally means sleep and then apnea means not breathing. Sleep apnea is the condition where the upper airway is getting in the way of your own smooth-breathing ability. Now we're talking about obstructive sleep apnea here. There are other forms of sleep apnea, but I think we'll stick with obstructive today. So, with obstructive sleep apnea, when you fall asleep, most of us are in a reclined position, usually on our back, but maybe even on our side, what happens is gravity works against you, your upper airway, your tongue, muscles, all kind of sag down. And also, when you fall asleep, your muscles relax. And in fact, it's during certain stages of sleep, like rapid eye movement sleep or REM, your muscles are almost completely paralyzed. What that causes is a problem of the upper airway getting impinged upon by your tongue and other structures in the upper airway. That leads to a blockage of airflow. That flow can stop for at least 10 seconds. If we see on a study that your breathing stops for 10 seconds, we mark that as an apnea and then the frequency with which that occurs determines how severe the sleep apnea is. I will want to say something about reassuring people that have seen this in themselves, or maybe their bed partner stopping breathing. First of all, our brains are too smart to let us just stop breathing and not wake up and die. Sleep apnea can contribute to mortality. But for the most part, the issue with sleep apnea is the breathing stops and then it starts again, because your reflexes kick in and make you your brain says "You better breathe" and you do. But that comes at the expense of quality sleep. So, each time you stop breathing, your reflexes kick in, you need to breathe again that causes you to awaken maybe for a split second, such that you may not even realize it's happening. But it's this repeated cycle of not breathing and breathing, not breathing and breathing that goes on throughout the night. And that's what we call sleep fragmentation. Sleep becomes repetitively interrupted, and you could sleep eight hours and wake up feeling like you only slept three. That's in a nutshell what sleep apnea is. It causes a lot of downstream problems. When you don't breathe, right, your oxygen levels get low, your carbon dioxide levels may increase a little bit, your sleep gets fragmented and there are a variety of changes in your chest that take place as well. When you're not breathing, you're attempting to breathe and that causes your chest muscles to kind of pump and attempt to get you breathing and can change some of the pressures inside your chest. And we know that people with sleep apnea do suffer from greater rates of things such as stroke and high blood pressure. The jury's out on whether sleep apnea is the direct cause of those things. Or it might also be some of the obesity that we talked about that many people see that we have that is the real culprit. But I think both things are contributing to impaired quality of life and maybe even lifespan.

**RK:** Well, it definitely sounds like a condition that needs to be evaluated if someone is concerned about it. And we know that, as you mentioned, people who have diabetes and obesity in particular are much more likely to develop sleep apnea. What are some symptoms that someone might have or that their bed partner might notice that might prompt further evaluation?

**JJ:** So I would divide that into the night sleeping period and then the day period. So, during sleep if you have sleep apnea, you might notice it by feeling like you can't breathe, you might wake up with a gasping sensation. You might wake up with night sweats, you might wake up with your heart pounding, you might wake up with a headache, and a dry mouth. Importantly you might not notice any of that. It may be your bed partner that sees you looking like you're not breathing throughout the night. There might be several episodes of that. They may hear you snoring. Snoring, I will say, is a sign of sleep apnea but it's not the same. You can snore very loudly and yet not have sleep apnea because snoring means air is moving but when it stops moving, things are quiet. The bed partner may notice snoring or stopping and starting pattern of the snoring. So that would be the nighttime period. You may also just wake up repeatedly for no apparent reason just looking at the clock and you notice only 30 minutes have passed and it doesn't feel like your breathing was impacted but it may have been the stimulus for you to be awake.

So then when you wake up in the morning or throughout the day, you may wake up feeling unrefreshed. When you wake up with symptoms like a dry mouth or headache, you may still be sleepy throughout the day and we have certain questionnaires that we often ask people to gauge how sleepy they are. For example, asking you "Are you likely to fall asleep when you're driving or in a public place?" Those are some questionnaires that we use to estimate the severity of the sleepiness. So those are some of the things that I would say could be hints at sleep apnea. Importantly, it can be very subtle. And the really formal way to truly evaluate if you have sleep apnea or not, is to do a test. Traditionally, that has been done in a sleep lab where you have to stay overnight in a room and get a bunch of wires put on to measure: your oxygen, your breathing, your movement, your brainwaves, and we still do that. Right now, many people are opting and able to do home sleep testing. So that means that you can pick up a relatively simple piece of equipment to wear at home, that's usually just a finger oxygen sensor, something that goes under your nose to measure the airflow, and often a belt around the chest under the armpits to measure your breathing muscle movement. And you just wear one of those at home for a night and bring it back or mail it back, there are programs that do that too. And we can get an answer about sleep apnea from a home test as well.

**RK:** Wow, that's great to have the availability of home sleep tests, and probably really helps address getting sleep evaluated for so many more people that may not want to come overnight and stay in a sleep study or a sleep clinic. I wonder if you could talk a little bit about how the oxygen deprivation or the apnea affects blood sugar levels? Do you think having sleep apnea could worsen blood sugar levels in people with diabetes?

**JJ:** The short answer is maybe. There have been a lot of research studies on this topic; some done in mouse studies, where you subject mice to periods of low oxygen, and in those studies, it does look like just lowering the oxygen by itself can raise your glucose levels. In humans, it's a little less clear. Take healthy people and make them hypoxic, like lower their oxygen levels; that oftentimes is if you take a look at people traveling to high altitudes and so forth. The data on glucose changes is a little less clear. A couple studies that were done here at Hopkins, one was done by Dr. Naresh Punjabi, many years ago, and they have kind of simulated sleep apnea in healthy people and by either waking them up repeatedly; the fragmentation or lowering their oxygen levels during the night in a pattern that we call intermittent hypoxia. And it looks like if you test people the following morning after doing this or you'd see them awake and do this for the oxygen exposure, it does change your glucose tolerance. So, it does seem like even if you could kind of deconstruct sleep apnea and simulate it in a lab environment, it does seem like it can affect your glucose levels. The reason why I say it's controversial is because we've also done a number of studies looking at treating sleep apnea with CPAP, the mask that is worn, usually on the nose, to help with the breathing. There are a few studies that show the CPAP lowers your glucose but many others that show that it does not. And so, it may really depend on some variables that we just don't know yet and maybe the type. It may be specific to a person, or it may be specific to the type of sleep apnea they have, where the glucose might be affected.

We did a study a few years ago where we had people that are using CPAP regularly, we said "Discontinue your CPAP for three nights, and we're going to measure your glucose on and off of therapy." Interestingly, what we saw was, during the night people had an IV in their arm, and we measured glucose every 30 minutes, and we did see that during the night when they were asleep and they were exposed to sleep apnea, that their glucose levels increased, and it was lowered by CPAP. But by the time they woke up in the morning, the glucose levels had more or less normalized. So that suggests there might be a temporary change in your glucose levels, just during sleep. I don't know if it's related directly to the low oxygen. Remember, that sleep apnea is not just a low oxygen state, it's many things. It's also waking up repeatedly. And so, the sleep fragmentation could be playing a role in that instead of or in addition to low oxygen levels.

**RK:** Sounds like there's a lot going on overnight with glucose and insulin metabolism, perhaps many aspects that we're still learning more about. But interesting to hear that in the absence of treatment for sleep apnea that perhaps during that nighttime, the glucose levels are temporarily higher and how that might impact then the person with diabetes. You mentioned some treatments such as CPAP for sleep apnea. I wonder if you could talk a little bit more about the treatments that are usually offered.

**JJ:** First line therapy for obstructive sleep apnea nowadays is CPAP, that stands for continuous positive airway pressure; C-P-A-P. Basically, it's just a fan. It's a fan in a box and a tube brings the air from that fan to the nose usually and by pushing that extra air in the nose, you'll create a little bit of what we call a pneumatic splint. You're pushing the air-powered splint to open up the airway and keep your tongue and other structures out of the way. CPAP is very effective. The downside of CPAP is a lot of people have a hard time getting used to it, right? Other therapies for sleep apnea include something called an oral appliance, which is a mouth basically a bite guard in the mouth, but it's made by a dentist, and it positions your jaw in a manner that raises or allows the lower jaw to protrude slightly that can be enough to help alleviate some of the obstruction in some individuals. Certain surgeries can be offered for sleep apnea. Back in the olden days before CPAP was invented, tracheostomy was a treatment. Thankfully, we almost never need to do that anymore. But other surgeries, including removal of tonsils that might be in the way, reduction of the tongue size, something called maxillomandibular advancement, which is our jaw surgery to move bone structures. And another surgery that you may have seen commercials about is called Inspire, which is a nerve stimulator device. So, there are nerves that control the muscle tone of the airway, including the tongue and the nerve that supplies that is called the hypoglossal nerve. There are many companies that have looked for ways to stimulate the hypoglossal nerve and make the tongue stiffened or slightly protrude during sleep. And that gets it out of the way during sleep, that's what Inspire is. It's a hypoglossal nerve stimulator, basically a pacemaker that's implanted under the skin the same way a cardiac pacemaker is, but the wires don't go to your heart, they go up to the neck and into the tongue region and stimulate the tongue muscle during sleep, and hopefully get you breathing, by getting the tongue out of the way. It is reserved for people that have tried other things and people that have a pretty severe case of sleep apnea. Those are the candidates that we would evaluate for Inspire therapy.

**RK:** It's so neat to hear about some of the newer therapies and that there continue to be new developments and options for people with sleep apnea. At what point would a person with diabetes be referred to you, as a pulmonologist/sleep specialist, for evaluation of a sleep disorder? Would it be if they have any symptoms? Or when would you recommend that someone with diabetes who's concerned come to see you?

**JJ:** We often see people that are referred from their doctor due to symptoms and some of the symptoms that we described earlier. I would say in the absence of those symptoms, I don't think we need to go and screen everyone on the street for sleep apnea. It seems like some of the some of the detrimental impacts of sleep apnea are certainly related to the impact on your quality of life. So that's the common way that we see people come into our clinic; referral for symptoms. Now, that being said, we administer a questionnaire to many people, that is called the *STOP-Bang questionnaire*. And I guess maybe that could be shown in the show notes or something, because it's a lot to go through here. But basically, we're asking people, whether someone has witnessed them stop breathing, whether they have high blood pressure, what their BMI is, if they have an elevated BMI, if they're male, if they have an enlarged neck. There are several of these factors. You could basically screen yourself with a tool like that and see if you check in enough boxes and that could be something to prompt an evaluation.

**RK:** It's good to know about those risk factors, and you mentioned increased neck size. Thanks for mentioning that. Is there usually a cut-off that someone at home could use to measure their own neck size?

**JJ:** Yeah, we have measurement tools. It's hard to do that. So, we usually say but if you're above a 17 on a collar that will be something that we would consider as elevated.

**RK:** And are there any special considerations of these treatments for people with diabetes? Are they offered the same way as they would be to people without diabetes?

**JJ:** Yeah, good question. There's no diabetes specific type of therapy, I would say, given the close relationship between obesity and diabetes, that CPAP is probably going to be the more preferred route of therapy because other therapies such as the oral appliances, and the Inspire device, for example, they probably don't work as well in people with severe obesity, whereas CPAP can work very well across a very wide range of BMI.

**RK:** And for people with diabetes and obesity, could weight loss help with some of their sleep symptoms?

**JJ:** Very much. so. And I'm sorry I neglected to say that earlier. I think we focus a lot on the medical devices. But we do know that weight loss can be a very potent way of leading to remission of sleep apnea. And of course, other comorbidities like the diabetes itself. I think this audience knows that weight loss is a challenge. And so that's why we work to things like CPAP and at the same time, we are counseling our patients to try and lose weight. There is no formula for exactly how much weight needs to be lost. In large population studies, a certain amount of weight can translate to a certain percentage of a reduction in the Apnea-Hypopnea Index (AHI). But I usually don't bother telling people that because everyone's body shape is very different. You could be someone that loses just a small amount of weight in the right places and that would mean the upper neck region. And that can have a very big impact. And conversely, you might unfortunately lose a great deal of weight, but it's not in the right places. And you still have sleep apnea for other reasons. That's not just obesity. I should make that clear too. If you have certain bone structure, there's genetics behind this. There are certain demographic groups and racial groups that are more predisposed to sleep apnea, even at the same BMI. So that includes people of African ancestry [and] Asian ancestry who, because of the bone structure, are more likely to have sleep apnea, even if they do not have obesity or as much obesity as someone of a white or Caucasian counterpart. So that's something to keep in mind as well.

**RK:** That's really interesting to hear about differences in bone structure. That's something I would have not thought about but makes a lot of sense that there could be ethnic differences in that. And we emphasize weight loss so often for management of diabetes and prevention of diabetes. It seems the impacts on sleep are just one more important reason why weight loss is so important. In addition to weight loss, are there other modifications to the diet or exercise that can be made to help reduce the risk of sleep problems? I know that some of your research has focused on the timing of meals, and I wonder if you want to talk a little bit about how that might impact glucose levels and maybe insulin as well?

**JJ:** Sure. So moving away from the sleep apnea itself as a specific thing, just talking about sleep. So going back to that concept we talked about earlier of circadian rhythms, we do know that there is a natural variation in your body's glucose tolerance or your ability to handle glucose at different times of day. And that goes for people, even without diabetes. There's been a couple of classic studies that have shown that you wake someone up in the morning and measure an oral glucose tolerance test, or OGTT, if you do that, again, in the afternoon, the results are going to be different. And in many people, in fact, it was called, "afternoon diabetes" in some of these older papers. So that tells you that there may be a time of day that is either detrimental or more ideal for eating. And it probably varies by what your internal clock is like. We did a study of young healthy people and fed them dinner at either 6pm or 10pm, and gave them the exact same meal in a lab

environment in random order, but the same food. And had them all go to bed at 11pm regardless of what time they had dinner. We did find that those where everyone got both meals, so when people ate the same meal at a later time, the 10pm condition, their sugar levels were significantly higher with that later meal than they were at the 6pm time. And not only that, the fat levels, the ability of your body to burn the fat that was contained within the meal was also impaired slightly at the later time. So that does tell you that when you eat can make a difference, at least in an acute lab environment. Whether that would carry out over months and years is less clear. And we have studies ongoing looking at how your timing of eating can affect your metabolism. And we're also measuring your body's rhythms by measuring a hormone called melatonin, so we can tell what time your melatonin is rising. And we think that that might be the wrong time to eat when your melatonin is still around. But yeah, I think, that to answer your question, there is certainly an impact of dietary timing on metabolism. And it's not a one-size-fits-all either. It really depends on what your internal rhythms are and when you might want to be eating to be affected by that.

**RK:** Those are such fascinating studies to hear about. It does seem like this is kind of the way of the future. We recommend dietary changes in people with diabetes. But the timing of when people eat, it would seem to make sense that of glucose tolerance or the ability of the body to respond to insulin changes in a cyclical way or a circadian way throughout the day that matching our meals might make sense, and that the timing and eating the same carbohydrate content could matter. So, it was really so fascinating. But about exercise? How does exercise help us sleep?

**JJ:** We know that all of us have experienced what it's like to have endured a tough day where we've been physically exhausted. And obviously that is going to usually translate to a deep sleep that night. It may be a little bit more than just that though. Your exercise causes several positive things in your cardiovascular system and your hormonal system. For example, rigorous resistance exercise is going to elicit an anabolic response from your body, meaning that growth hormone is going to be secreted and growth hormone is one of those funny hormones that comes out only when you sleep, it comes out in the first period of the night when you sleep though. At least there have not been what I would consider really high quality, like randomized trials, on this topic. But we know from the physiology that if you push yourself hard in a resistance type of workout pattern, your body is probably going to respond to that by sleeping harder and leading to the greater secretion of growth hormone. Okay? That hormone is during the deepest stages of sleep what we call stage three, which also happens to be the very beginning of the night for most people. Though, we would imagine that someone working out pretty hard will need more sleep and it will translate to probably getting better sleep if you're someone that struggles with insomnia, for example. The regularity of our activities also matters. So, we don't have to dwell on like, super intense workouts. I'm talking about just "Are you getting outdoors? Are you being active?" Because the rhythmic nature of activity also helps to anchor our circadian rhythms. In addition to that most of the activity involves being outdoors and/or at least being in light, brightly lit environments. So another major anchor towards getting good sleep is getting good light, at the right time. So that means being in outdoors and getting bright blue light in your eyes during the morning hours. That helps to also facilitate better sleep overtime at night. And in fact, many people that struggle with a condition called delayed sleep phase, where they're sleeping late and would be sleeping in, in the morning and they can't get up. One of the therapies we recommend is getting up and making sure you get a lot of bright light in the morning and avoiding that same light in the evening. I know we started this question with exercise, but I think it ties into all this other stuff. Rhythms of activity and when you're doing things matters.

**RK:** Yeah, that is really interesting to hear about growth hormone and growth hormone also has effects on blood sugar as well. It can increase blood sugar, so it does seem like it's all tied together like you were mentioning. Even in our guidelines from our professional societies, the American Diabetes Association over the past, I would say two to three years, we have seen sleep listed as one of the lifestyle behaviors, if you will, that has become increasingly an emphasis for us to screen for and ask about for our patients. It's so great to hear about the different techniques that you recommend as a pulmonologist to your patients. What about devices? You mentioned blue light? What about the use of devices before sleep? Is there a time after which devices should be put away for sleep purposes? 30 minutes before? How do you think that impacts sleep?

**JJ:** One of the important sleep-related hormones is called melatonin. And the rhythm of your melatonin is determined by a special center in your brain called the suprachiasmatic nucleus (SCN). And so, for most people, your melatonin levels start creeping up towards dusk and they start going back down during the dawn. That tells you that melatonin is under control by light and that happens because when we open our eyes, light of a certain wavelength, particularly blue, hits the back of our eye signaling to the brain that it is daytime. And that leads to a suppression of melatonin. And then when you're in darkness, the melatonin levels are allowed to be elevated. So, when you wake up in the morning and you turn on a bright light, your melatonin levels are going to go to zero and they're going to remain close to zero until dusk arrives. Having light in your eyes at the right time, being the morning, is very good for anchoring circadian rhythm. If you get too much blue light in the evening, you're going to suppress your melatonin levels and potentially interfere with sleep. Now some people are very sensitive to that. Even a tiny amount of light is going to really impact their melatonin. Other people or reasons that we don't yet understand, probably genetics, it takes a lot brighter light to cause that to happen. In terms of devices, many societies will say avoid using them 30

minutes up to I've seen guidelines up to two hours before bedtime. I don't think there's a magic number to that. Know that looking at YouTube on your phone is not just light. It's also a lot of stimulation and other things going on in your mind. So, I would say if you're struggling with insomnia, then avoid bright light in the evening, avoid stimulating programming you might be watching, you know, for all those reasons, both the morning light and stimulation.

**RK:** Dr. Jun, it's been so great to hear from you about all the different ways that sleep is important, both quantity and quality, how diabetes can impact sleep and how sleep can impact diabetes management and to hear about specific conditions such as sleep apnea that are particularly prevalent in people with diabetes and obesity and the treatments that continue to be available to really successfully treat this condition and perhaps even improve management of diabetes itself. For our listeners who might wonder how they can improve their own sleep hygiene or sleep practices, what would be the tips that you would leave them with to focus on in their own life?

**JJ:** Yeah, I would say a lot of recommendations that you may have heard before that involves making sure that you have a healthy, relaxing bedtime routine that comes around the same time most days. Try and stick to that regular schedule. Make sure your bedroom is relatively cool. Make sure it's dark, make sure it's quiet. I know that's easier said than done. Noise machines, [such as] white noise [and] pink noise a couple of different devices like that can be helpful. But again, it depends on the person. Some people don't find that to be helpful. If you're in a noisy ambient environment and you've got cars honking outside, then white noise probably is helpful to mask some of that. The other thing we would say is again sticking to that regular routine; waking up at around the same time each day trying to get a lot of light and activity in your day. If you suspect a sleep disorder like sleep apnea, make sure you seek medical attention for that, because all that sleep hygiene isn't going to help if you're not breathing. Make sure that you talk to someone about your rhythms; what time do you tend to wake up? What time do you tend to go into bed? That can give you insight into what type of person you are when your melatonin levels might be up and down, and you can kind of shape your schedule around that. I think those are the main things. One thing that we didn't touch on that I will say is, sleep also has a hidden benefit. And that is, when you're asleep, you're less likely to get yourself in trouble with certain things. So what I mean by that is, if you sleep more, you're less likely to be eating. And this has been shown in a couple of studies where that wasn't even the intention of the study. It was just as if you tried to make someone sleep a little bit more than they normally do, make someone eat a little bit less than they normally do or sleep a little bit more than they normally would, you'll see the reciprocal benefit. So, one study asked people to sleep an extra two hours at night, which is a lot. I don't think they achieved that, I think people ended up sleeping about 30 to 60 minutes longer. But they also noticed a reduction in the consumption of food. So not only does sleep promote good things to your body, it also keeps you out of trouble. If you're trying to lose weight, then maybe going to bed is a good thing for that reason and it also keeps your appetite down a little bit when you wake up. In those sleep-deprived studies people woke up and they were hungry when they didn't get enough [sleep], so another indirect benefit.

**RK:** Well, Dr. Jun, thank you so much for sharing all your expertise and all the benefits that sleep has both in the process of sleeping and keeping you away from doing other things such as opportunities to eat. It really is so great to hear from you about all the ways that we can improve our own sleep and I know our listeners have greatly benefited from your time, so thank you today for being with us.

**JJ:** Thank you very much for having me.

**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](http://hopkinsdiabetesinfo.org).

We love to hear from our listeners. The email address is [hopkinsdiabetesinfo@jhmi.edu](mailto:hopkinsdiabetesinfo@jhmi.edu).

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