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Ellen Kelsay
That's Dr. Bruce Bekkar, OBGYN and climate activist working to put science and medicine at the center of the climate conversation and inspire action at every level. In this episode, we explore why climate change isn't just about the environment. It's a critical health issue with serious implications for pregnant people and newborns.

I'm Ellen Kelsay, and this is a Business Group on Health podcast, conversations with experts on the most relevant health and well-being issues facing employers.

Bruce, welcome, thrilled to have you on the podcast.

Bruce Bekkar
Thank you. It's really good to join you.

Ellen Kelsay
Well, happy to have you with us today. We have in the past on this podcast, we have covered the topic of climate change, although we've not yet covered it specifically related to pregnancy impacts of climate change. Before we get into the specifics, I would love for you just to set the stage about how climate and changes in climate is affecting human health more broadly.

Bruce Bekkar
Well, I first of all should be upfront with you and let you know that I'm not a researcher. I was a clinician taking care of patients and doing pap smears and hysterectomies and guiding women through pregnancy, getting to deliver their babies. I did that for over 25 years. But along the way, I stumbled in part because I was a graduate of UC San Diego, I was reading an alumni newsletter in late 2006 and I read this article from Scripps Institution of Oceanography, which is one of the top research centers in the country. It was called, *The End of the World As We Know It,* and all of a sudden I learned that this global warming thing was really an incredible threat, in particular to the coastline, to the oceans, that when I wasn't working I was often getting in the water and attempting to surf. It was a really, really upsetting thing to learn about and coming from an institution like that with a worldwide reputation, I took it seriously and I just started learning more and more about it. Getting involved in my community and committees and boards and things like that to help protect us from this problem as it escalated. Along the way, after a few years, it started showing up in the literature that the impacts related to this thing called global warming, and in particular heat and air pollution from the burning of fossil fuels, was not only a threat to the stability of the ocean and the balance of life within the oceans and the sea level, but also to our health. In late 2015, there was a paper that came out. It was a technical report from the American Academy of Pediatrics and it was about the impact of global warming, or as it became known, climate change, on the world's children. There was a particular statement in that report that really caught my eye and it was from the World Health Organization. They said over 80% of the impacts of climate change would fall on children under the age of five. That just blew my mind and it was just such an upsetting thing because you can't imagine a group of us who's less responsible and more vulnerable to the impacts of climate change. The next question that came to me after I was dealing with this information was to think about it as an obstetrician and to wonder whether or not these impacts were starting to affect pregnancy as well, because then you're bringing a fetus, which is as early a life form as we have with our species, onto the earth, and are they at risk also. So I reached into my network of scientists and researchers within the climate community that were health professionals to see if anybody else was concerned about this and interested in looking into it, because again as a clinician, I didn't have any idea how we could look at that question, does climate change threaten pregnancy and births. I was very fortunate to connect to three actual legitimate academic researchers who were as curious as I was. They led us down this path to look at what the literature was indicating. And again, peer-reviewed literature, good science, reliable evidence, and pulling it together, and we had no idea whether

we'd find something that was significant or not, but it took about three years to get through nearly 2,000 studies and come up with 68 of them that met the criteria we were specifically interested in since climate change causes a whole bunch of things to happen on earth in heat, elevated temperatures, and air pollution tied, first of all, to the burning of fossil fuels and also tied to the warming itself. We're talking specifically about ozone and fine particulate matter, or what's known as PM2.5. Anyway, we pulled all this evidence together in these 68 studies and we found that 57 of the 68 studies, the majority of which were on air pollutants, these air pollutants I mentioned, showed a really strong association with premature birth, low birth weight, and stillbirth. As an OB doctor, these are really, really crucial events to reduce in any way that we can and to think that this escalating crisis is putting pressure on normal births and even potentially contributing to stillbirths was quite shocking to us. We submitted the paper to just one journal, to the *Journal of the American Medical Association*, known as *JAMA*. We're really pleased to see that they immediately accepted it. After not much editing at all, they put it out as a publication and it got quite a bit of attention.

Ellen Kelsay
You talked about toxins and heat and pollution and I believe this study that you all wrote and was published by *JAMA* really talks about the multifactorial nature of those things and certainly that some populations might be more prone or exposed to some of those factors, more so than others. Can you maybe break them each down? What did you find in the research? What was published in the article related to all of those different factors and environmental considerations?

Bruce Bekkar
Well, one of the researchers that we worked with as we put together the paper is a PhD researcher, Rupa Basu, who was at the California EPA as a division lead. She had been responsible for writing a few of the papers that we ended up selecting because they were directly in line with what we were looking at. Rupa guided us to, in particular as I mentioned, the heat, elevated temperatures, which is a spectrum of impacts, as it turns out. A lot of these topics are pretty complicated, but it's not just higher maximum temperatures. It's also heat waves that last longer than they used to. It's lack of nighttime cooling, but overall it's heat exposure. The others are ozone and fine particulate matter, and we chose those at Rupa's suggestion because that's where the evidence was showing up. That's where the papers were coming out. Again, we decided to focus specifically on domestic U.S. populations because so often the excuse was being made that, oh, this global warming thing isn't real, and if it is, it's certainly not happening here. So we didn't want to have that argument get any hold, so we decided to specifically stay with domestic U.S. populations and those specific exposures. If you're asking what the mechanisms are or what are the ways that these impacts are actually triggering these, as you mentioned, it's a multifactorial problem. If you talk about premature birth, there are a number of factors that contribute to this happening. Everything from a woman's physiology and her overall state of health to whether or not her reproductive tract is normal or it has some sort of an issue with it that threatens keeping a pregnancy to term. Each of those factors weighs in, in a particular instance, to a different degree. We don't want to come out and say that heat causes premature birth because quite often there are a few things that add up to that actually happening. But when we looked at the evidence that was out at the time when we published our study, there were a number of other studies that actually demonstrated a mechanism or a way in which heat would contribute to premature birth. I don't want to say that this is the only one that we need to talk about, but it's well known when a patient would show up in labor and delivery on a hot day, quite often she'd be dehydrated and the dehydration was leading to contractions, probably due to the increased release of oxytocin, which is a hormone that's tied to labor. The first thing you do with a patient that comes to labor and delivery with contractions who's premature is you give them some fluids to drink or you put an IV in and you fill up their tank. Quite often that and a bit of rest will help to calm the uterus down. We know, for instance, that heat is tied to premature birth in that way. There may be other ways as well. But there was also evidence at the time, and this has continued to be demonstrated, that air pollutants probably through triggering systemic inflammation can lead to decreases in placental perfusion, which can lead to a low-birth-weight baby. The mechanisms themselves were out there and now we had arrived at the fact that there was a lot of evidence. Our studies were large. These weren't just isolated studies in different places in the country. They were across the country, over 32 million births in the studies that we noted. So there was just a lot of evidence out there and also evidence of biological, what we call plausibility. In other words, it makes sense

that when you have these air pollutants, you would see these kinds of birth outcomes. So it made sense, and then we had evidence of that connection actually occurring.

Ellen Kelsay
It was quite startling and really quite concerning when you talk about pollution. A couple of notes I have here, that there were direct toxic effects from fetal exposure, altered maternal cardiac or pulmonary function, the inflammation, as you just mentioned, altered placental gene expression, and changes in blood viscosity. So quite profound, the impact just from pollution alone on maternal and infant health.

Bruce Bekkar
Yeah, you know, pregnancy is a miraculous time in a woman's life, and over the course of millennia, there's a really intricate and complex interconnected system that maintains the mother's health, puts a bit of stress on it, but also provides protection for the fetus from external inputs, but there are limits to that. When you talk about ongoing exposure to toxins that we inhale, and part of the problem, one of the pollutants I mentioned is PM2.5, it sounds all very technical, but basically it's a size distinction. There are different variants of PM2.5, but the point is they're all at two and a half microns or smaller, which all you need to know is these are so tiny, these particulates, that when you inhale them, they get almost direct access to the bloodstream. They go deep into the lungs, deep into the alveoli, and because of their absolute tiny size, they get right into the blood, and so they can have their impact very profoundly and very directly. So there are limits to the way that the body's able to protect the fetuses it develops, and I think PM2.5 is one of those tiny, tiny particles that gets past those barriers.

Ellen Kelsay
The study also highlighted the disproportionate effect on pregnant women with certain medical conditions and/or certain races and ethnicities. What did you find there?

Bruce Bekkar
Well, that was fascinating. One of the things that popped out, and it kind of makes sense if you think about it, is that women with asthma were more at risk. So their lungs are already sensitized to allergens and pollutants. You are probably thinking that way it's not all that surprising that we would see an increased risk for women with asthma, but it was also really interesting, we didn't go looking for this, but study after study pointed out that minority mothers and black moms in particular were at risk from these bad birth outcomes, and this in the context of what we already know about maternal mortality, which is for many years it has been well known that black moms are three times more likely to die during pregnancy than white moms are in the United States. If you put that there and then add to that that black women who are exposed to these air pollutants or heat are more likely to have premature births and low birth weight babies and even stillbirths, it's very, very alarming. I think it's really important for us to realize that these sensitive subpopulations within the category of pregnant women are particularly susceptible to these bad birth outcomes, and so we have to pay attention to that and protect them.

Ellen Kelsay
I know you deliberately did not want to have this study apply to non-U.S. populations, although certainly within the U.S. we have different climates. We have certain states that are hotter than others. In your review of the research and literature and in your published *JAMA* study, did you look at any deviations within the U.S. based on pollutants or environmental factors or did any of those come forward?

Bruce Bekkar
Yeah, it's a good question and it's not often about the absolute temperature. Part of what we're learning as we look at the studies that have come out since then is it's relative to what people are used to. It might be a lot hotter in the southeast or in the southwest where we are, but when people experience elevated temperatures, it's almost more significant how much it deviates from what they're used to. We also do see evidence that early in the warm season is when the impacts tend to be greatest because the body hasn't acclimated to these warmer temperatures. So, for instance, right now we are seeing almost a bit of a heat wave in Southern California. I'm on the coast here in San Diego and we're going to have temperatures in the mid to upper 70s and we're not used to that. It's getting down to the mid to high 40s overnight and so

the temperature is going up more than 20 degrees over the course of the day. I wouldn't be surprised at all if we're going to see more patients, more pregnant women coming into the hospital with contractions just because this is a sudden shift and an increase in temperature that particularly at this time of year we're not used to. All the evidence seems to suggest that these impacts are happening everywhere and it's the relative increase due to this massive amount of heat we've trapped in the atmosphere and the way that it's playing out.

Ellen Kelsay
You had mentioned that for you the lightbulb moment was when you were reading this article and I believe you said Scripps article. I'm curious if you now kind of look back on all your years practicing and you can see situations of patients you had where now you understand why maybe they went into preterm labor or anything now that you have the hindsight and the benefit of your experience and knowledge that you look back on your years practicing to say, okay, that makes sense now. I understand why that happened to that patient or that group of patients or in that situation.

Bruce Bekkar
The answer is yes and no. I mean, certainly I think that that's true. But one of things I talk about in the presentations that I give is I think we have a waiting room problem, which is we think all patients come from the waiting room, but they don't. They come from different parts of a city and with even a few blocks difference. Somebody might be living right up next to a freeway and somebody else might be working in a dry cleaner where they're exposed to heat all day long. So our exposures are highly individual and quite variable, and we have never really made the effort, I think it's slowly starting to happen now, where we actually determine what sort of exposures patients have on a regular basis, because as our evidence shows and a whole lot of other studies now are agreeing, those exposures matter and we shouldn't just assume that everybody comes from the same place and goes back to the same place. This greatly affects their risk and their likelihood of developing problems.

Ellen Kelsay
Really insightful. I appreciate you sharing that. Curious where if you and your co-authors are doing other further literature scanning or if there's other research that others are doing, kind of where do you see the next wave of literature review or research being conducted in this space going?

Bruce Bekkar
There have been over 500 citations of our paper since it's come out. It's kind of apparently become part of a growing mountain of evidence around these impacts and we're starting to see more clarification about critical windows of exposure, you know what time in pregnancy matter the most for low birth weight or for premature birth. So we're starting to see more evidence around there. We also have a number of gaps in our knowledge. It's enough to say that there's so much evidence out there now, not only from the domestic U.S., but really around the world, that these impacts are real and significant and need to be paid attention to. But we don't know nearly enough about things like what individual exposures are. For instance, we assume if somebody lives in this small area where there's a temperature monitor, that that's the temperature exposure. But someone may not have air conditioning or somebody may work in a place where air pollution is a big problem. What I think a lot of us are waiting to see are more wearable monitors that actually measure someone's daily exposure over the course of a week or something like that. There have been some preliminary studies. There was an interesting study of women wearing monitors in Africa who do outdoor work, who work in agriculture. Very, very strong evidence that those women, of course, they're exerting themselves and they're being exposed to high levels of heat and there's absolutely no relief for them, and these impacts are really substantial. That's another part of it is that I think we're not seeing how bad this really is because there's so many populations that have not been well studied that have very high levels of exposure. So that's another part of this that we're waiting to see evolve. I do expect wearables will come along and more of this literature is coming. I'm on an editorial board of the Journal of Climate Change and Health, and we are in particular looking for research being done in areas that are not well studied, because I think we'll learn more about the impact of these exposures and things we can do to reduce them from the people that are being hurt the worst by these. But you also asked about our own research and we're getting the band back together. It looks like we're getting three of the

four researchers back together and we're actually working, beginning to work on what's ultimately going to be a thought piece. It's a follow on to our study. It's been five years where we will do some kind of summarizing of what other literature has shown us since our study came out, but also talking about ways that we can think about responding to this, because it's one thing to point it out. I think we know enough to say that this is really a cause and effect relationship. It's not just a random association. Now, where do we go from here?

Ellen Kelsay
Let's pivot to that. What are some of the interventions? What should people be thinking about just generally with their own individual health? But then, as you know, our audience are many of them employers who are providing health care and well-being services to people who work for them. Many of them may be pregnant themselves or have a family member who is planning to be pregnant. What types of things should employers and should individuals be thinking about in terms of interventions and protective factors here?

Bruce Bekkar
Yeah, it's very important to get to this. Frankly, we don't have all the evidence and answers that we need right now, but we know enough to do something about this. First of all, on an individual level, understanding that these exposures are significant risks to having a healthy birth, reducing those exposures as best you can. There is growing evidence that having air conditioning and using air conditioning actually does reduce the risk of not only pregnancy complications, but other sorts of complications as well and that makes all kinds of sense, but it's important that we do things about that. You may be aware that there are some cities around the country that have established these networks of cooling centers where they make this information available to the public, you know, free of cost. Almost no matter where you are, you're not very many minutes away from a public space you can go that's air conditioned, and during a heat wave, it's important to maybe figure out ways to reduce your exposure by spending time in a place like that or just avoiding being outdoors during the hottest part of the day. At one level, it's kind of common sense, but it only is going to be utilized if people are aware that these are risks. So sharing this information, letting pregnant moms know that this is something that they ought to avoid. On the institutional side, as far as health care is concerned, we very much are an educational type of an industry. I think an awful lot of what we do that's a win-win is to reduce people's risk of various things by encouraging certain behaviors and that not only prevents them from having these kinds of bad birth outcomes, but it also saves us the time and money it takes to take care of them if they came in without that awareness. So doing more work to educate patients, to make them aware if there's one little silver lining to a heat wave, it never arrives without any advance notice. We usually know a few days, maybe even a week or two in advance, and people can prepare and alter their plans so that they have as little exposure to that as possible, make sure that they have lots of fluids, that they're not getting dehydrated otherwise during those times. The third part of this answer really has to be policy, and policy is really important at every level of government. We're making real significant progress on the local level and the state level now. But in those places where it's possible, certainly at least at the local level, we can recommend as health professionals that based upon this information, the best thing to do for that community, not only just because it's the right thing to do and everybody seems to want to protect pregnancy and protect babies, but also economically it's really important.

Ellen Kelsay
Well, and I think all the things that you just mentioned are certainly directly applicable to pregnancy and maternal and infant health, but also more broadly to women's health, broader population health, more expansively. While we're speaking through a lens of pregnancy related impacts of climate change, many of the things you just mentioned are broadly applicable for health and well-being overall at the macro level.

Bruce Bekkar
Absolutely and it's a very important point to make. The vulnerable groups that we've known about for over 10 years now are the elderly, people that are poor or who don't have health insurance, people with chronic illnesses and people that are excessively overweight, and unfortunately, children and pregnant moms and their babies. All of these subpopulations are important for us to protect in health care.

Ellen Kelsay
That's for sure. Looking forward to your future research and studies that either you and your band will do together or that others will do. Certainly we know that the climate crisis is getting worse, not better. So in some senses, we're just scratching the surface of even understanding the acuity and the trajectory of the challenges. It means that we need to move with even more haste to get this word out. I'm so grateful for you joining us today. I would love to just close with, as you think about the entirety of the work, what gives you hope for the future?

Bruce Bekkar
I don't want to minimize it. I think it's so important right now. We have a big job to do. We need to make a rapid transition from the way we have created energy and used it in the past to something far better on multiple levels. But what gives me hope is that these changes that we need to make are not some sacrifice to our well-being nor to our quality of life. They are things that improve how we live and how we get around and the air that we breathe and the water that we drink. This is win-win stuff, which are the kinds of games that I always love to be involved with. I'm really looking forward to that. I'm also very buoyed by the docs and the nurses that I talk to on a regular basis, working with various nonprofits and doing speaking engagements and things with people. I think those of us in health care kind of fundamentally understand biology. We understand the risks that we're running and it really empowers people and makes them feel better about this crisis to start connecting to solutions. We can all make this better. We all have a role to play. The more that we do that, the better our own lives get and the less anxious we feel when we feel like we're part of the solution. On the one hand, it's an overwhelming problem. How in the world can you engage with it? I'm way too busy. I don't have enough time. As soon as people plug into this and begin to work on it and find other people doing the same thing, this is, again, win-win. This is the kind of thing that makes people feel a little less anxious about their lives and a little better about the world. It certainly has kept me going since 2007 and I think the people that I know feel the same way about it.

Ellen Kelsay
I've been speaking with Dr. Bruce Bekkar about the way climate impacts the health of some of the most vulnerable in our communities. Dr. Bekkar's research highlights the urgent need for action from individual choices to systemic change.

I'm Ellen Kelsay, and this podcast is produced by Business Group on Health, with Connected Social Media. If you like this episode, please rate us and leave a review.