How inflammation causes fatigue

Guest: Dr. Gabi Macaulay

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Kirsty Cullen - [00:00:15]

Hi, I'm Kirsty Cullen, CEO at the Optimum Health Clinic. Welcome to the Fatigue Super Conference. Today I am so pleased to introduce you to Dr. Gabi Macaulay.

Dr. Macaulay is a family medicine doctor with over 10 years' experience. She holds an MBBS and a first class honors degree in diabetes and endocrinology. In addition, two diplomas from the Royal College of Obstetricians and Gynecologists and the Faculty of Sexual and Reproductive Medicine.

She has undergone further training with the College of Naturopathic Medicine and the American LP3 Network, and she has worked previously in the endocrinology department at Mount Sinai Hospital, along with Imperial College and Chelsea and Westminster NHS trusts.

Dr. Gabi's approach to wellbeing focuses on addressing physical, mental and spiritual health in order to develop holistic treatment plans that combine traditional and lifestyle medicine.

Dr. Gabi, welcome.

Dr. Gabi Macaulay

Oh, thank you so much for having me Kirsty. It's a pleasure to be here today.

Kirsty Cullen

So you and I are going to discuss really today how inflammation causes fatigue. And that being said, why inflammation is so impactful and how we can assess that inflammatory load, look at practical strategies to reduce it, and also consider some of the testing options.

So, let's start by talking about chronic inflammation first and foremost. Can you explain what chronic inflammation is and what happens in the body in response to it?

Dr. Gabi Macaulay

OK, so chronic inflammation is basically when the body responds to something that it doesn't like, so this could be an infection, it could be when the body is stressed, it could be when the body is attacking itself. And when the body is in this state, it actually starts to release something called cytokines. And cytokines are basically a group of very small proteins that communicate with cells in the body and make them do different things.

And some of the cytokines that really cause a lot of trouble in chronic inflammation, these are long words, but they're important to be aware of because I'll refer back to them later on in the talk, are, interleukin-1, interleukin 6, interleukin 8 and tumor necrosis factors. So these cytokines, these messages in the body cause havoc in chronic inflammation.
Now, when people get acute inflammation, which is a very fast response to an infection, they can be

good because they make the blood vessels dilate and they mean that the body can heal. But when they're present for a long period of time at low levels, they can cause some serious problems. And it's a big problem that many of my patients suffer with.

Kirsty Cullen - [00:03:12]

So let's jump from that really useful explanation to, how does inflammation actually cause fatigue in the body then?

Dr. Gabi Macaulay

OK, so how does inflammation cause fatigue in the body? It's actually because there is an imbalance between the amount of energy that the body is able to make and the amount of energy that the body demands. So we need to actually do a deep dive into energy within the body. And the communicating, sort of backed up energy or currency for energy in the body, something called ATP, which is adenosine triphosphate.

And the body usually produces ATP by a process called oxidative phosphorylation. We're really going back to medical school chemistry here, but it's so important to understand. So when we eat, we eat macronutrients which are things like carbohydrates, proteins and fats. And these substances enter our cells and then within the cells, they are used by an organelle, which is a tiny component inside the cell called a mitochondria. And the mitochondria use these nutrients to produce ATP via a process called oxidative phosphorylation.

But in inflammation, the white blood cells, which kind of do things in the body with inflammation like leukocytes or lymphocytes, they want to get energy really really quickly. So they want a lot of ATP very quickly. And so they switch from making it via oxidative phosphorylation to a process called glycolysis. Glycolysis means that they can get ATP more quickly, but it's actually not a good process in the long term because it's not efficient. And it also produces something called reactive oxygen species and reactive oxygen species are bad because they can actually damage mitochondria, which affects energy production in the long term, and they also can damage DNA, which leads to aging.

So this is how energy production is affected by long term inflammation. But also researchers found that energy demands in chronic inflammation can actually be increased. So, for example, in acute inflammation the immune system needs more energy because it needs to respond, so it's using up more energy. And people actually have the sickness behavior where they just want to lie in bed. They want to avoid other people because the body's trying to reduce extra stress on the body.

But what studies have found is that in chronic inflammation, there's actually, the body actually has a slightly increased drive to put effort into things where the sort of benefits of doing that thing are increased. It's a very interesting thing that a study actually found.

Kirsty Cullen

So essentially what we're saying, Dr. Gabi, is when we're inflamed, it's an energy cost to the body over somebody who's not inflamed?

Dr. Gabi Macaulay

Yeah, so it's kind of an energy demand and supply imbalance, and that's why people feel fatigued within the body.

Kirsty Cullen

So as I would often say in clinic, it's like kicking a hole in the energy bucket, essentially, because there's a sort of a source of energy expenditure there.

Dr. Gabi Macaulay - [00:06:46]

Yeah, you're kicking a hole into it. And another really important thing I didn't mention is that inflammation causes the body to become insulin resistant, which means that it's difficult for your glucose, which is like sugar, to enter the cell. So this kind of forces the body to produce energy from fat, and that is a longer process, so the body can't make energy quickly.

I think that was one other thing I was going to say on that point, which is, I've remembered it, is that the body also is forced to use more protein. And if you're using protein to make energy, then the protein is not available to be used for muscle production, healing, things like that. So insulin resistance is terrible in the body.

Kirsty Cullen

So another interesting question to ask is, how does inflammation cause fatigue within the brain specifically?

Dr. Gabi Macaulay

Yes, so neuroscience is a very complicated topic, but the main thing that you need to know is that we have cells called astrocytes in the brain and the astrocytes are involved in making energy for our neurons in our brain so energy, sorry, so our neurons use something called lactate. But when we are inflamed this process doesn't work properly.

Also, it's known that some cytokines, some interleukins can actually go into the brain, so cross the blood brain barrier, and this causes our body to kind of have a sickness response where we're feeling more tired and fatigued within our brain it can affect our cognition.

Kirsty Cullen

So essentially, we'd expect to see some changes in cognitive function. What might they look like in real terms?

Dr. Gabi Macaulay

So this can be explained as kind of brain fog, so just not being able to think as quickly or as efficiently. People may begin to withdraw more, so social interactions might be quite difficult for them, it might take a lot of energy out of their brain.

Kirsty Cullen

So that's the inflammatory picture and we'll come back again to more acute inflammation in a moment, but when we're thinking about fatigue generally, Dr. Gabi, is inflammation the only thing that causes fatigue and disease?

Dr. Gabi Macaulay

No so, fatigue is a subjective symptom. It's not something that can be measured with a blood test. But there are lots of different components when we think about fatigue. So one of those things would be illness. So illness would include things like pain, it would include things like arthritis, it would include things like disease burden on the body.

There are also psychological things that contribute to fatigue. So that would be disturbances like anxiety or depression.

And then also personal factors are very important. So age, sex of the individual and their social circumstance, that would affect fatigue. And even though we're focusing on inflammation today, it's important to know that some people who have a disease such as rheumatoid arthritis, a study actually showed that in people who had rheumatoid arthritis, even though disease was well

controlled, the inflammation was controlled, that didn't necessarily correlate with the extent of fatigue. So I hope that sort of provides some people who are experiencing fatigue, some sort of comfort to know that it is recognized, there were other things that can contribute. And just because your inflammation is under control doesn't mean that your fatigue should be not recognized or not addressed. It's still a very important thing where other factors can contribute to it.

Kirsty Cullen - [00:10:41]

In our experience, fatigue is extremely complex, isn't it? It's often sort of a plethora of different factors.

So, we've spoken about chronic inflammation then and you mentioned acute inflammation, can you just explain a little bit more about the difference between the two and how acute inflammation might affect us so dramatically?

Dr. Gabi Macaulay

So acute inflammation is a response to a trigger to the body. So something that the body doesn't like, like an infection. It's actually a good thing if your skin gets cut, it's a good thing because these cytokines mean that our blood vessels become very leaky. It means that our white blood cells, which promote healing, can get to the right place. And it happens very quickly over a matter of days or couple of weeks max.

Now, when this happens, we get something called the acute sickness response or sickness behavior. As I said before, the body doesn't want to add extra stress because it's already trying to heal itself. So people tend to withdraw. They might sleep more. It also benefits us. So in COVID-19 people get very fatigued and it means that they stay at home, which actually benefits the human species because it stops people from spreading an infection. So this is something that we've adapted to do.

Now with chronic fatigue, sorry, with chronic inflammation, it's different. So it's when the body kind of has a response, as it would do to an infection, but there is no infection and it's low grade for a long period of time. So this can happen if the body is irritated by toxins that it can't clear, if the body has an infection to a fungus or a parasite that it can't clear, you can get chronic inflammation. In conditions like diabetes we see chronic inflammation or even chronic kidney disease.

And people who have all of these diseases they're actually at increased risk of cardiovascular disease because it causes our blood vessels to become quite fiery and this can affect blood flow to the heart or blood flow to the brain. So anyone who's experiencing chronic fatigue, sorry, chronic inflammation, it's important that their doctors are very aware and supportive of their cardiovascular health because we want to prevent people from developing heart attacks or strokes.

Kirsty Cullen

So all that being said, Dr. Gabi, let's introduce some of the strategies around reducing inflammatory load, because obviously that's something that we want to achieve in clinical practice. Let's start by discussing why a healthy sleep pattern is so important when we're thinking about reducing inflammation.

Dr. Gabi Macaulay

So, studies have actually found that people who have disturbed circadian rhythm or people who have poor sleep are at increased risk of having things like anxiety and depression. We also know that having a disturbed sleep cycle affects our adrenal axis. So this is the hypothalamic adrenal axis is how the brain communicates stress to the body, and that affects our stress hormone, our cortisol levels are involved in inflammation as well. They are sort of the two main things I would mention.

Kirsty Cullen - [00:14:09]

And why is it that that adrenal axis is so important when it comes to reducing inflammation? Because obviously it's hugely impacted by sleep, isn't it, in terms of cortisol and sort of melatonin production and that balance. But what is the specific role of cortisol and that adrenal axis in helping to kind of dampen inflammation?

Dr. Gabi Macaulay

So when our adrenal axis is working properly, cortisol helps to suppress inflammation. But when it's not working properly, if we're very stressed over a long period of time or we're not sleeping, the adrenal glands produce too much cortisol. And then over time, the body becomes resistant to it. And then once you're at the very end, if you've been stressed for a really, really, really long time, people can actually develop a problem where the adrenal glands are not making enough cortisol. So, you know, having a really healthy adrenal gland is quite important when we're thinking about inflammation.

Kirsty Cullen

And of course, encouraging a really healthy sleep pattern, therefore, to get back into that sort of circadian rhythm is important to that overall inflammatory burden then?

Dr. Gabi Macaulay

Definitely. I mean, even a study found that in people who were forced to be sleep deprived, they actually had increased levels of cytokines in their blood.

Kirsty Cullen

It's huge, isn't it? I know we spend a long time looking at how to encourage, you know, the more ideal sleep pattern, and it can be quite interesting, certainly in chronic fatigue, because quite often that sleep patterns is reversed and we'll tend to see sort of night owl activity. So shifting that back towards a normal and natural sleep pattern can be one of the first challenges clinically.

It also seems really appropriate on a beautiful spring day like this to talk about why getting outside into nature might be recommended within this discussion?

Dr. Gabi Macaulay

Yes. So getting out in nature is so beneficial in lots of different ways. And the first way I would mention is that people who go out in nature or even people who look at pictures of nature have been found to, it stimulates a relaxation response in the body.

Getting out in nature promotes, you know, breathing in fresh air, which is going to refresh the body. It means that you're going to actually be exercising. And exercise has been found to reduce fatigue, above that of weight loss by just changing nutrition. So exercise is really important. It's going to help build up your muscle mass.

And then also going out in nature means that you get access to sunlight. And natural sunlight is so important, especially in the morning for kind of regulating that circadian rhythm and encouraging the body to release melatonin at nighttime, which is the substance that makes us want to sleep.

And then finally, vitamin D. I'm so happy today because it's sunny, so I'm getting some sunlight and some vitamin D, which I've been starved of all winter. But vitamin D is really important when it comes to our immune system. It affects almost every cell in the body and it helps to modulate the immune system. Low vitamin D levels can actually make people feel very low in mood and also, low vitamin D levels can lead to problems with our bones and our muscles. So it can lead to thin bones or osteoporosis. It can lead to really achy muscles and these things can contribute to fatigue.

Kirsty Cullen - [00:17:39]

And it's also important to say, isn't it, where we're at the beginning of that journey with chronic fatigue and our energy capacity is really low that actually even just having a chair outside the back door or by a bright window is also a good place to start to get that light access initially if we're still housebound. But then also to kind of step out into the garden, but just sit and be outside in nature and take that in and all the sounds and everything that comes with it, before we get that, building capacity to go on a walk and increase that energy ability.

Dr. Gabi Macaulay

Yes. So it's really difficult for people to go from 0 to 100, especially if people are suffering from depression because that really affects their motivation. So the actual drive to get up and go and do something, it's very difficult to get started. But people find once they're doing something, it's easier. So, as you said, even just sitting by a window, letting that sunlight come in, it's going to enter your pupils. It's going to directly affect your brain and all the sorts of neurotransmitters that are produced in the brain.

Kirsty Cullen

And certainly in the U.K, Dr. Gabi, how important would you say it is for people to be aware of their vitamin D levels, to check them on an annual basis and possibly to supplement around that?

Dr. Gabi Macaulay

Yes. What I would say is that getting enough vitamin D is very difficult in the U.K. because we don't get much sunlight and a lot of the year it's quite cloudy. So it's really important for people to know what their vitamin D levels are because low vitamin D can increase the risk of depression. As I said, thin bones, it can even sort of, vitamin D helps to prevent against unregulated cell proliferation, which can lead to cancer. So it's such an important vitamin to make sure we have good levels of.

Now in the U.K, the government actually recommend that it's safe for everyone to take a vitamin D supplement during the winter months and the government recommendation is 400 units a day. However, some people who, you know they've measured their vitamin D levels and they found it to be low, they may actually need more supplementation than the 400 units in the winter. Some people need supplementation throughout the whole year. Some people need a boost of very high supplementation.

The important thing is that when it comes to supplements, if you're taking a good quality one it is going to affect your body and it is possible for people to overdo it. So this is something that should be done safely with the support of your doctor, with blood testing, if you're going to be, you may need high levels or your deficient. And also nutritionists can support with nutritional supplementation or speaking to your community pharmacist.

I advise people don't just wing it, get the support of the professionals who are there to help you. And we can also get vitamin D from some of our food. So I won't go into that today. But it's a multifactorial thing.

Kirsty Cullen

I always say I think it's one of those figures like your blood pressure or your cholesterol level that you should be aware of. And I know I always like my clients to test October time to see where they are as we head into winter and then test again in the spring. So that they're really informed about the level of supplementation they're using, as you say, so we can avoid going above that to the safe upper level. But equally, we know if there's a serious deficiency there, what type of dosage that we need to be looking at. So knowing those figures is really important, as you say, rather than just guessing and throwing supplementation at it.

Dr. Gabi Macaulay - [00:21:27]

Yeah, I was going to say that it's important for people to know that there are different forms that they can take. So, for example, I don't really like taking capsules or tablets. So I find that switching to a spray was very helpful for me. And it's absorbed quite well because you just spray under your tongue on your cheek and it goes straight into your system.

Kirsty Cullen

So on the subject of testing, let's talk a little bit about how we would go about assessing inflammation through testing in the body. What type of tests would you use for that?

Dr. Gabi Macaulay

OK, so blood tests can be quite helpful for assessing levels of inflammation. I'll go through them one by one. So there's something called a full blood count. This looks at our red blood cells, our white blood cells and white blood cells are the ones that can be raised in inflammation.

Now, it's not just the overall number of white blood cells that are important. It's the breakdown of white blood cells. So things like leukocytes, these are white blood cells that often go high in infection that's causing inflammation. Often there's different types of leukocytes, actually.

So you've got neutrophils which go high if it's a bacteria causing inflammation usually, we've got lymphocytes which usually go high if there is an infection causing inflammation, we have eosinophils which is a blood cell that can get high if there's some sort of allergy or irritant causing inflammation.

So looking at the white blood cell count and the actual type of cells that are high gives us a further indication as to what's going on.

Also, platelets which are involved in wound healing, they can be dysregulated in inflammation.

We also find that people who have chronic inflammation can actually become anaemic so they can have lower red blood cells. Lots of different things can cause anaemia, but it's important to look at the whole picture for the patient. And also, anaemia can lead to reduced oxygen in our muscles, which can make us feel more fatigued in inflammation.

Moving on to another blood test called C-reactive protein. This is something that we test for that often goes high when people have acute inflammation, so if they're responding to an insult very quickly. But there is a sort of newer test called highly sensitive CRP. And sometimes we look at this in regards to longer term inflammation or sort of inflammation when it comes to risk of cardiovascular disease.

Next on the list is something called ESR, which is erythrocytes sedimentation rate. This is something that represents more sort of long term inflammation in the body, it can be caused by an infection or by something else causing inflammation.

And then also further tests. Liver function test is something that people commonly have done. And part of a liver function test, we measure something called globulin, and this is a measure of protein in the blood. And sometimes if the globulin level is high, I actually further investigate in my patients and I go digging like an investigator to find out what is causing this.

And I have actually picked up conditions that people had, but they didn't really tell me about their symptoms because I said, look, your globulin is high, there's something up, something going on. One of the ways we look at, we further investigate high globulin is looking at immunoglobulin, which is a breakdown of the globulin to see if it's just one type of immunoglobulin high or if it's a polyclonal, which is lots of different ones are high, which says that there's something generalized going on.

And I've spoken a lot about this so I'll wrap it up. We also look at, we can test levels of gut inflammation by doing a stool sample test. So fecal calprotectin is a stool sample test that I really love doing. It tells me about inflammation, which could be due to an infection or something else, but it

tells me that there's something going on in the gut that we need to investigate further in regards to inflammation.

Kirsty Cullen - [00:25:55]

The playing health detective is so important in thinking about the causes of inflammation, you've mentioned a few already, Dr. Gabi, but what are some of the key causes of inflammation that you would list off? And those being said then we can kind of align those to some of the strategies that we might use to reduce inflammation in the body. So let's just start with some of the key causes. If you could list those, what would they look like?

Dr. Gabi Macaulay

OK, so inflammation, we've already talked about infection that can cause it. We actually know that cancer can cause a lot of inflammation in the body. This is because tumors often secrete those cytokines that I was talking about. But studies have actually found that people who have cancer can suffer from cancer fatigue syndrome up to 10 years after they've had treatment with chemotherapy or radiotherapy, because these cytokines are still actually quite high in the blood, OK.

Now autoimmune conditions are really big cause of inflammation and fatigue in the body. So these would be things like rheumatoid arthritis, Sjogren's syndrome, lupus, vasculitis. These all cause inflammation. Psoriasis, psoriatic arthritis, type 1 diabetes is another autoimmune condition that causes inflammation. Multiple sclerosis is on the list.

And then also a really big one is chronic fatigue syndrome. So chronic fatigue syndrome is when people feel extremely fatigued in the absence of a diagnosed disease. And studies have actually shown that people with chronic fatigue syndrome can actually have raised cytokines in the body.

Kirsty Cullen

So with that list and that list can go on and on, can't it, we could probably stay on that another ten minutes, but with that list in mind, what are some of the key strategies that you have, to reduce the inflammatory load within the body?

Dr. Gabi Macaulay

OK, so I think that this is a very big topic, but I'll try and break it down and in a way that people can find helpful.

So one of the key things is if people do have excess body fat, it's important to try to reduce this with different strategies. But body fat is actually an endocrine organ, it actually releases hormones in the body. It actually causes the body to become more insulin resistant. So losing body fat can help reduce the inflammation in the body.

Now, looking at nutrients is really important. There are so many different nutrients that we have, but a lot of people don't think of water as a nutrient. Now, our brain cells need a lot of water. A lot of our brain is actually made up of water. So, if we're not drinking enough water, nothing is going to work right. And we're going to feel fatigued in the brain and our metabolism is going to be messed up if we don't have enough water.

Nutrients that we should be avoiding, so things like trans fats or saturated fats, these increase inflammation. So we want to be avoiding these kind of things. So processed vegetable oils or processed packaged foods. They contain a lot of trans fats. Instead, we want to be consuming healthy fats like omega-3 fatty acid, which has been found to be very beneficial, it's got anti inflammatory properties. But we want to be getting it from good food sources like fatty fishes, like salmon. Wild salmon is really good for increasing omega-3. For people who are plant based there are other ways to omega-3. I would recommend speaking to nutritionists about healthy plant based sources of omega-3. It's an essential component.

Eating more antioxidant containing foods is very important because antioxidants fight against the free radicals in the body. Reactive oxygen species that cause damage to DNA and mitochondria. So things like berries or apples. They contain a lot of antioxidants. This is very important. Even things like green tea or black tea, they contain polyphenols, which are really important in fighting inflammation in the body.

I've given you quite a lot of things to work with on that list.

Kirsty Cullen - [00:30:50]

And Dr. Gabi you also mentioned toxins briefly, previously. Would there be a recommendation to try and reduce their exposure to toxins?

Dr. Gabi Macaulay

Yeah. So I think toxin build up or toxic burden on the body is something that is really difficult for us to avoid in 2021, in modern life. There's the really key toxin that a lot of people will be aware of, so cigarette smoking is just pouring so many different toxins in the body. That's one of the best things that people can do, is to quit smoking if they're suffering with inflammation, even if they're not, it just reduces symptoms. It reduces toxins in the body.

But we're also exposed to so many other toxins around us. So there's pollution in the air, were exposed to microplastics all the time, eating foods that are covered in plastics, warming food in the microwave in plastic containers. It's terrible for the body. And these plastics can actually, the body can actually recognize them as like pseudo-oestrogens and that can cause a lot of issues in the body.

And things like makeup. A lot of makeup products actually contain toxic ingredients that affect the body. A lot of chemical sunscreens are actually toxic, not if you use them once, but if you're applying that on your face every day for 50 years, that's going to build up in the body.

And then, cleaning products. People, sometimes I have patients with cleaners and they are actually experiencing lung problems due to the amount of toxins that they're inhaling on a daily basis.

So it's not one of these things that are going to cause a problem, but it's the overall burden on the body when it's just coming, it's when you're getting this from all these different angles, it builds up in the body.

Kirsty Cullen

Can we support detoxification pathways to help with that? Is that something that you would look at?

Dr. Gabi Macaulay

Yes, I think one of the key things when it comes detoxification is making sure that your liver is really healthy. Because the liver is very important for getting rid of any toxin in the body. And so, you know, seeing someone who can assist with that in a safe way can be quite helpful.

Kirsty Cullen

And obviously, Dr. Gabi, you mentioned the HPA axis and the importance of the adrenal glands and stress being impactful on inflammation, would you give advice around stress management, anxiety management and sort of supporting the adrenals, for example?

Dr. Gabi Macaulay

Yes. So I think stress management is a very important component when it comes to managing inflammation. And that's why it's so important that we take a mind, body and spirit approach. Because if your nutrition is on point and you're exercising, but you have an immense amount of personal stress,

you're not going to have whole health.

So ways that we can sort of really trigger the relaxation response would be things like doing yoga, things like deep breathing exercises, things like meditation. They are proven to trigger the relaxation response, which is where we kind of push our nervous system towards the parasympathetic nervous system. And this works against the sympathetic nervous system, which is the fight or flight response. It actually works to slow down our heart rate variability.

Now, there's something else which is really helpful, actually, in reducing stress, which is called HeartMath. And this is a very useful technique that turns stress into resilience. And basically, it's a simple technique that can be used to actually make your heart rate variability more like a sine wave. And this is not necessarily a relaxation state, it's more of a doing state, which means that the body is able to respond to the demands of everyday life.

We know that music helps trigger the relaxation response. Going out in nature helps trigger the relaxation response. So these are you know, these are evidence based things that we can do to really help reduce stress and help support our adrenals.

Kirsty Cullen - [00:35:24]

And of course, in doing that and reducing the overall inflammatory burden on the body, then we are essentially supporting energy production systems in the body and therefore hopefully reducing the burden of fatigue. Is that where we're heading?

Dr. Gabi Macaulay

Yeah, that's where we're heading. It's really a multifactorial thing. You know, we can't just look at fatigue as, right inflammation, we're going to give you a really strong drug that's going to get rid of the inflammation and you're going to be cured. That is not a way of approaching health from a holistic point of view. We need to look at people as a whole. We need to make sure we're supporting the brain, make sure we're supporting the gut, the adrenal glands and make sure that we're supporting people psychologically. We've got to achieve whole health by looking at all of these things.

Kirsty Cullen

Superb. Dr. Gabi, thank you so much for sharing your knowledge with us today. If people want to find out more about your work, specifically, where can we direct them to online?

Dr. Gabi Macaulay

Yes, so I would definitely encourage people to check out the website, which is www.mahaah.co.uk, it's a mouthful.

I'm also quite active on Twitter, which is, my Twitter is Dr. Gabrielle Macaulay. I'm quite active on Instagram as well. So it's @mahaahofficial please do check us out.

We do have a blog on the website where we talk about things like this. We kind of look at the latest science and we tell you what you need to know, what's going to be helpful, things that I know you're going to love.

Kirsty Cullen

That's wonderfully helpful. Thank you again for your time today.

Dr. Gabi Macaulay

Thank you very much for having me.