Independent Research & further reading

Guest: Dr Roger Seheult

Disclaimer 1: The sources presented here, directly (or as closely as possible), look at statements made by the guest in this episode. In order to report each topic thoroughly, an extensive search and review (beyond the scope of this document) would be required.

Disclaimer 2: The information provided in this podcast and any associated materials is not intended to replace professional medical advice. For any medical concerns, it is essential to consult a qualified health professional.

Contents

Nutrition’s impact on wellbeing

> *“there are studies that have done that, show that, that depending on what we put into our bodies as food can have a dramatic impact in terms of our wellbeing”*

Nutrition is a fundamental pillar of overall wellbeing, influencing physical health, mental health, disease prevention, and quality of life. A balanced, nutrient-rich diet is essential for optimal functioning, healthy development, and the prevention of both physical and mental health problems.

References 1-6.

Health benefits of exercise

> *“So exercise obviously is gonna make you more fit. It's gonna make you have better endurance. But did you know that it reduces stroke? Did you know that it improves, uh, um, uh, wellbeing? It reduces depression. There's so many benefits. ”*

- Large meta-analyses and cohort studies show that people who are physically active have a 17–27% lower risk of stroke compared to inactive individuals, with benefits seen for both ischaemic and haemorrhagic stroke types.
- Exercise is a safe, accessible, and effective way to reduce the risk of depression and improve mental health. Benefits are seen across all ages and with various types and intensities of activity, making it a valuable tool for both prevention and treatment.

References 7-17.

Drinking water

> *“you need to drink enough water to make sure that you can flush your system, all these toxins.”*

Drinking water is crucial for survival and optimal functioning. It supports every major system in the body, prevents dehydration, and helps maintain health and well-being. Regular water intake is necessary because the body cannot store excess water and loses it continuously.

References 18-21.

Specific heat

> *"it's called the specific heat. So what does this, what do I mean by this? As you start to heat up water, it takes a tremendous amount of energy to raise the temperature of water. Just a few degrees. What does that mean? That means going the other direction. As you put water onto a body, it will draw out much heat and only lower the temperature of that water by a small amount. What does that mean? That means that you can affect the temperature of somebody very well using something like water."*

Specific heat is a property that describes how much heat energy a substance must absorb to increase its temperature. Water has a high specific heat, which means it can absorb or release a lot of heat with only a small change in its temperature. This property plays a crucial role in regulating body temperature. Water immersion studies show that water's thermal properties influence how the body senses and responds to temperature changes. Immersion in water can quickly transfer heat to or from the body, affecting core and skin temperatures and triggering thermoregulatory responses like sweating or shivering.

References 22-25.

Sauna bathing

> *"We also have pretty good data from Finland where they have more saunas than almost than people, uh, where they've actually done the research and, and shown with dose response curves that this is actually very beneficial."*

Sauna bathing is a traditional practice in Finland, and recent research has explored how the frequency and duration of sauna use relate to health outcomes. There is strong evidence from Finnish studies that the health benefits of sauna use show a dose-response relationship: more frequent and longer sauna sessions are linked to greater reductions in disease risk and mortality.

In a controlled study (26), two 10-minute sauna sessions (compared to one 10-minute session) led to a greater increase in the anti-inflammatory marker IL-6, suggesting a dose-dependent physiological response even in a single session. Both one and two 10-minute sessions increased IL-1RA, another anti-inflammatory marker, but C-reactive protein (CRP) did not change acutely.

References 26-30.

Airborne bacteria

> *"early on I used to think that, that what this meant was getting pure air with absolutely nothing in it except for just nitrogen at oxygen. That's not true anymore. We now understand that for you to have the best type of air. It actually has to come with some things in it. And we'll talk about those things. Things that are very beneficial, things that, that come from trees, things that are actually, there's bacteria. Sometimes, uh, bacteria that is floating in the air can actually help. Um, just like our, our gut has a microflora that you may have heard about. So too does the air that we breathe also must have that. And, um, the best type of air that you can have is actually outside."*

Exposure to a diverse range of airborne bacteria may help maintain healthy microbiotas in the respiratory and gastrointestinal tracts, potentially supporting immune function and overall health. Limited access to diverse aeromicrobes, such as in highly filtered environments, could reduce these benefits. However, while some airborne bacteria can be beneficial, others may be linked to allergies or infections, depending on the context and individual susceptibility.

References 31-35.

7-day rhythm

> *“The other interesting thing about this is that they've actually shown that we have a, a bio rhythm that is about seven days long.”*

Seven-day (circaseptan) infradian rhythms have been observed in various human physiological processes. These weekly rhythms appear to be endogenous—originating within the body—and are seen across multiple biological systems, though their functional significance remains under investigation. Weekly rhythms have been documented in parameters such as blood pressure, heart rate, immune function, and hormone levels. These rhythms are present at different organisational levels, from cellular to systemic. While the origin appears endogenous, social factors, like the seven-day week and rest days, may help synchronize or amplify these rhythms in humans. Unlike circadian or annual rhythms, the evolutionary or functional advantage of seven-day rhythms is not well established. Some hypotheses suggest a link to periodic rest and repair needs, but this remains speculative.

References 36, 37.

Cortisol daily cycle

> *“for instance, cortisol is at a peak in the morning, and then, you know, 12 hours later it's at a, it's at a low and then it comes back at a peak. So that's a cycle of 24 hours.”*

Cortisol rises rapidly in the early morning, peaking within 30–45 minutes after awakening (known as the cortisol awakening response, or CAR). After the morning peak, levels steadily decrease throughout the day, reaching their lowest point late in the evening and during the first half of the night. Cortisol remains low during sleep, with a new rise beginning in the early morning hours before waking.

References 38-40.

Faith, forgiveness, CBT and mental health

“what we can't ignore is the growing body of evidence from the scientific world that's peeking over and looking at faith that people who have faith and people who have faith in God, uh, whether that is their God in, in that particular denomination are better apt and able to deal with stress and depression and anxiety. So this is something scientifically that has been shown.”

…

“number of studies that have looked at trust in God and how that relates to anxiety. So a number of studies have shown that people who have a good faith and trust in a God that is, uh, or in a religion that is supportive and not non-supportive, can they have less anxiety, less depression.”

Research indicates that individuals who participate in religious activities tend to report higher levels of happiness compared to those who do not. This positive association is influenced by various factors, including social support, community involvement, and personal belief systems. Faith and spirituality can provide emotional resilience, reduce anxiety and depression, and increase life satisfaction by offering hope, meaning, and coping mechanisms during stress or illness. Additionally, practices such as prayer, meditation, and participation in spiritual communities are linked to lower rates of depression and greater happiness. However, faith can also create barriers to seeking professional mental health care due to stigma or spiritual interpretations of illness, highlighting the need for faith-sensitive approaches in healthcare. Also, negative religious coping (e.g., feeling abandoned by God) is linked to worse mental health outcomes. Overall, the association is generally modest but consistent. Some of prospective studies find a significant, though small, reduction in depression with higher religious or spiritual involvement.

References 41-55.

“there was a study that was published. This is Krause and, uh, out of, I believe University of Texas where he did a survey and he asked people, um, how they forgive.
And he he basically divided 'em to two different groups. There were people that would forgive conditionally and people that would forgive unconditionally.

…

What they found in this study when they divided that, is that the people that forgave unconditionally had less depression. They had less feelings of inadequacy, they had less anxiety regarding, uh, end of life. They had all, they had all of these, uh, they had more, the people that forgave conditionally had more somatization of depression. So these were real medical, uh, you know, things that they could actually diagnose with surveys and, and, and tests that are well validated and, and what, what would decide between these two was how they forgave.

…

So they looked at a bunch of factors and none of them stood out except for one. And, and the odds ratio on this was like 2.5. And, and it boiled down to this one question, do you believe that God has forgiven you? That was, that was the major thing. If, somebody believed that the God that they had faith in had forgiven them, they were two and a half times more likely. To, to forgive somebody unconditionally, which then was associated with all of these other things being low, like less depression, less anxiety. ”

The research paper mentioned:

Krause, N., & Ellison, C. G. (2003). Forgiveness by God, Forgiveness of Others, and Psychological Well-Being in Late Life. Journal for the scientific study of religion, 42(1), 77–94. https://doi.org/10.1111/1468-5906.00162

- Unconditional forgiveness involves letting go of resentment without requiring the offender to meet specific conditions. This approach is linked to lower stress, improved psychological well-being, and better perceived health, especially in people facing chronic stress or illness.
- Conditional forgiveness is granted only if the offender meets certain requirements (e.g., apologising or making amends). Research shows that holding onto conditional forgiveness is associated with higher mortality risk, likely due to its negative impact on physical health.

People who believe forgiveness should be conditional tend to report lower psychological well-being.

References 56-62.

> *"what has been shown in a randomized placebo controlled fashion is that if somebody is of a faith and you inject into that cognitive behavioral therapy aspects of that faith, the cognitive behavioral therapy is even more effective."*

Studies show that religiously adapted Cognitive Behavioural Therapy (R-CBT) is as effective, and sometimes more effective, than conventional CBT for reducing depression in religious individuals, particularly those with chronic medical illness or strong religious beliefs.

References 63-65.

> *"People who have a healthy relationship with their church, who have a healthy relationship in God are associated with less disease."*

Large-scale studies find no significant difference in physical health or disease rates between people who believe in God and those who do not. Atheists and religious individuals generally report similar levels of physical and mental well-being, stress, and life satisfaction. Belief in a benevolent or loving God is, however, linked to lower anxiety, depression, and higher life satisfaction. It important to note, though, that the type of belief matters: belief in a punitive God is associated with more psychiatric symptoms, while belief in a loving God is associated with fewer.

References 66-71.

NEWSTART: health improvement program

> *"if you go through them, um, you've got nutrition. You've got exercise, you've got water, you've got sunlight, you've got temperance, you have air, you have rest, and finally you have trust. You put that together and it spells out new start. So interestingly, these, these particular topics are not copyrighted, but there is a, um, there is a university in Northern California called Weimar University that has actually put these together in that very pattern, as called it New Start."*

Reference 72.

Decline in mitochondrial function with increasing age

> *"What we didn't know at the time is that as we get older, the output from these batteries in our cells drops by about 70%."*

The degree of decline in mitochondrial function varies by tissue type and individual, with most studies reporting a reduction in the range of 30–50% in specific tissues such as heart and skeletal muscle. However, in the eye, studies show a ~70% reduction in ATP levels in the retina from youth to old age, indicating a substantial decline in mitochondrial energy output.

The decline is linked to reduced mitochondrial DNA, increased mutations, impaired oxidative phosphorylation, and increased oxidative stress. This reduction contributes to decreased energy production, muscle weakness, and increased vulnerability to age-related diseases.

References 73-78.

Infrared light, mitochondria, oxidative stress and melatonin

"So there was a paper that came out in 2019 that fundamentally changed the way I saw this. It was written by, um, Russell Ryder, who is the, uh, executive, uh, editor of Melatonin Research. It's a, he's out of, uh, university of Texas and Scott Zimmerman, who's a light engineer.

And what they set forth was to show that basically sunlight is made up of so many different types of wavelengths. You've got ultraviolet on one end, which of course makes vitamin D. Uh, and it's very beneficial. It, it, it's the type of light from the, from the sun that is very short wave and but cannot penetrate very deeply.

And so when the sun is, is shining, there's very short wavelengths, ultraviolet B involving vitamin D, but at the other end, there's this infrared light, which we'll talk about, or red light. It's very long wavelength and it can penetrate very, very deeply. That's very important because what we're talking about is the human body, and if the sun is gonna have an effect on the human body, it's gotta be more than just the skin. So that's exactly what what this paper showed is that basically infrared lights from the sun is able to penetrate probably up to about eight centimetres, according to Scott Zimmerman in this article.

They have a water pump, and that's exactly what the cell has to have for the mitochondria. It's not heat in the mitochondria. It's called oxidative stress. And it's specifically oxidative stress that causes destruction and uh, and, and, um, yeah, destruction of the mitochondria and leads to these types of diseases."

The research paper mentioned is currently unavailable; thus, the statements cannot be fact-checked.

http://www.melatonin-research.net/index.php/MR/article/view/19

References 79-81.

“So oxidative stress causes the mitochondria not to work well, this leads to diabetes. Oxidative stress makes the mitochondria not work so well. This leads to dementia. So there's an, this has already been laid out. This is not that controversial.”

- Mitochondria are both a source and a target of reactive oxygen species (ROS). When ROS levels exceed the cell’s antioxidant defences, oxidative stress occurs, damaging mitochondrial DNA, proteins, and lipids, and impairing mitochondrial function.
- Mitochondrial dysfunction impairs energy production, disrupts insulin secretion, and contributes to insulin resistance, making it a key factor in diabetes pathophysiology.
- Mitochondrial dysfunction is an early and critical factor in neuronal damage, leading to impaired energy production, increased oxidative stress, and the accumulation of toxic proteins that drive cognitive decline.

References 82-94.

“The controversial part is what do we do about it? So what these guys in this paper showed was that, and, and not just them, but look, reviewing the literature, is that the mitochondria makes its own cooling system and that cooling system is melatonin. Now you might be thinking, wait a minute, melatonin. Isn't that the, isn't that the stuff that we take, that our brain makes right before we go to sleep? Yeah. That you're, it's absolutely correct. That's what happens. The problem is, is that this is not melatonin that's made in the brain. This is not melatonin that goes through the blood supply and goes, goes through our blood and, and tells us it's time to go to sleep.

This is melatonin that's made in the cell, in the mitochondria, and it's a powerful antioxidant that basically prevents the oxidative stress from occurring. What Scott Zimmerman, Russell Ryder showed in a proposed in this was that basically the infrared radiation that's coming in to the body is able to stimulate and upregulate melatonin and a number of other factors that keep the mitochondria cool and can actually improve the energy output of the mitochondria.”

Melatonin plays a crucial role in mitochondrial health and function. It acts as a powerful antioxidant within mitochondria, is synthesised locally in these organelles, and helps regulate mitochondrial quality control, energy production, and cell survival. This positions melatonin as a key protector against cellular ageing and disease.

There is evidence that near-infrared light can stimulate melatonin production outside the pineal gland (extrapineal melatonin), such as in skin and other tissues. This local melatonin may help protect cells from oxidative stress and contribute to overall well-being. The increase in extrapineal melatonin from NIR exposure could even raise circulating melatonin levels if exposure is sustained.

References 95-100.

ACE2 receptor

“You may have heard about the ACE two receptor. Okay? This is where the, the virus actually latches on. To the cell and gets internalized. So what is this ACE two receptor? Is this, was this there for all of humanity just to be a receptor? Or does it actually have a role? It turns out it actually has a role and mind blowingly, the ACE two receptor is involved in mitigating oxidative stress. ”

ACE2 helps protect cells from oxidative damage by balancing the renin-angiotensin system, promoting antioxidant pathways, and reducing inflammation. Loss or dysfunction of ACE2 increases oxidative stress and related tissue injury.

References 101-105.

Vitamin D, infrared light and COVID-19

“We knew early on in the pandemic that people who came into the hospital and had higher levels of vitamin D did really well. They didn't die. They, they didn't have the same chances of dying.

People who had low vitamin D levels, they had much higher levels, uh, chances of dying. So we would check these vitamin D levels. And so think about this. You're, you're there at ground zero and you're taking care of these patients and you see this data over and over and over again. That vitamin D is very predictive of who's gonna die.

Obviously, what are you gonna do? Even though this is an associative study, that association doesn't mean causation. You're gonna be giving people vitamin D and try to get those levels up. The problem is, is that we gave vitamin D and it really didn't have much of an effect. So you gave it in supplement topic?”

Multiple studies and meta-analyses show that low serum vitamin D levels are associated with increased risk of severe COVID-19 and higher mortality rates. Patients with vitamin D deficiency had

significantly higher odds of death and severe disease, even after adjusting for age and comorbidities. Regular or timely vitamin D supplementation, especially in frail elderly or those with deficiency, has been associated with better survival rates and less severe COVID-19 in some studies. However, while supplementation may reduce severity, its effect on mortality is less clear and may depend on baseline vitamin D status and dosing regimen.

References 106-118.

> *"I would propose, and Scott Zimmerman and Russell Ryder would propose, and I, I can tell you a number of other scientists that would agree with me on this, is that infrared radiation from the sun is causing an effect at the mitochondrial level in terms of oxidative stress. And that vitamin D was just the marker of who was getting the infrared light and who was not, who was going outside and who was not going outside. "*

- Vitamin D supports both innate and adaptive immune responses, enhances production of antimicrobial peptides, and may reduce excessive inflammation (cytokine storm) associated with severe COVID-19.
- Exposure to red or infrared light may reduce hyper-inflammation and cytokine storms associated with severe COVID-19 by downregulating inflammatory pathways (e.g., TLR-4, NFkB, AP1) and decreasing cytokine production in cell studies. Theoretical mechanisms include improved mitochondrial function and immune modulation, but clinical evidence in humans is still limited.

References 119-124.

670nm red light studies

> *“people like Glenn Jeffrey out of UCL, uh, is actually doing research at 670 nanometers of red light and has shown, uh, in randomized controlled trials that, that type of light right there at six 70, the type that you can even see. Actually does improve mitochondrial efficiency. He's shown this in a number of randomized controlled trials. It improves eyesight and, and you have to realize that the retina at the back of your eye is very rich in mitochondria. He's shown this in terms of, uh, managing glucose and, and output from mitochondria.”*

The study mentioned, titled "Weeklong improved color contrast sensitivity after single 670 nm exposures associated with enhanced mitochondrial function" (125) investigates the effects of single short-term exposure to 670 nm light on colour contrast sensitivity and how these effects correlate with enhancements in mitochondrial function. The central finding of the research indicates a significant increase in colour contrast sensitivity lasting up to one week post-exposure, coupled with measurable improvements in mitochondrial function.

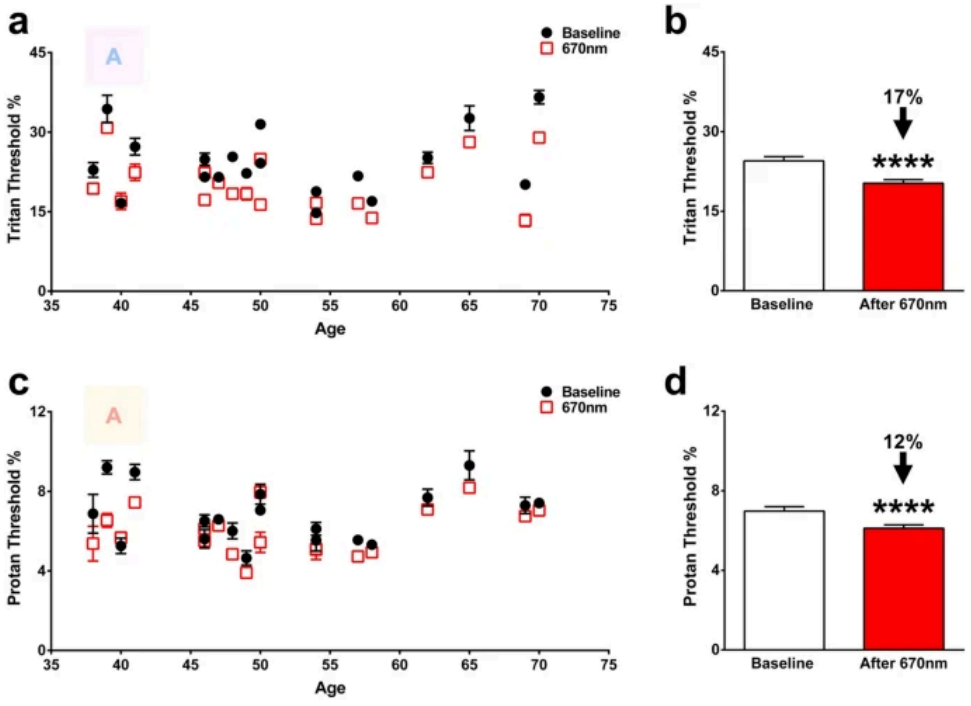

Figure – “Colour contrast sensitivities (CCS) measured 3 h following a morning exposure (8-9AM) of 670 nm. CCS of tritan (a) and protan (c) axes measured in 20 healthy subjects and their response to 670 nm exposure. Black closed circles represent

baseline measurements and red open boxes are those in the same individuals measured 3 h following a single 3 min 670 nm exposure delivered in the morning. The colour letter A in both graphs is an example of the target to be identified as it appeared on the screen. (b) Thresholds for tritan function in individuals 38–70 years. Most subjects displayed a significant decrease to their tritan thresholds following light exposure. Overall, there was a 17% reduction to thresholds across the population. (d) Thresholds for protan function in individuals 38–70 years, with half the population displaying a significant decrease to their protan thresholds after 670 nm exposure. Total protan thresholds were reduced by 12% across all subjects. Wilcoxon matched-pairs signed rank test was used for statistical analysis. Data are presented as means ± SEM. ****$p < 0.0001$." from Shinhmar, H., Hogg, C., Neveu, M. et al., 2021 (ref 125).

The other study mentioned, titled "Light stimulation of mitochondria reduces blood glucose levels" (126) investigates the effect of photobiomodulation (PBM) at a wavelength of 670 nm on blood glucose levels and the underlying mechanisms of this phenomenon. The researchers conducted an intervention using local light exposure on participants and measured its effects before and after glucose consumption.

One of the pivotal findings is that exposure to 670 nm light significantly reduced blood glucose concentrations approximately 45 minutes after administration of the glucose load, suggesting a rapid onset of action from the light stimulus. This is indicative of an acute regulatory mechanism that efficiently modulates blood glucose levels. The underlying mechanism proposed by the authors includes enhanced mitochondrial oxidative phosphorylation, which subsequently elevates ATP production in the cells. This increase in ATP correlates with a more efficient influx of glucose into cells, facilitated by a higher facilitated diffusion rate, thus lowering blood glucose levels.

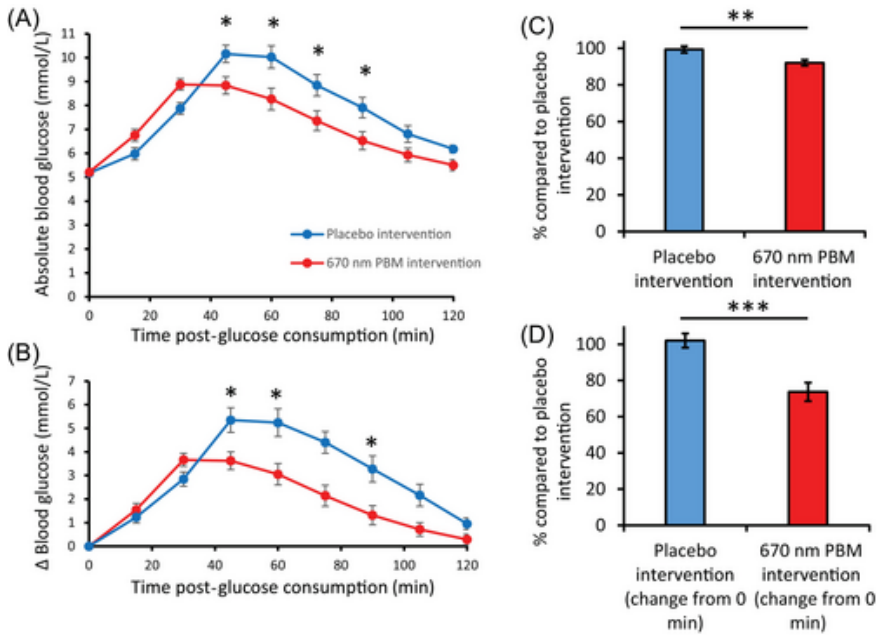

Figure – "A 670 nm photobiomodulation (PBM) reduces blood glucose levels. Exposure to 15 min of 670 nm light (n = 15), starting 45 min prior to oral glucose tolerance test (OGTT), significantly reduced blood glucose levels, from time point +45 min, compared with a placebo intervention (no light, n = 15). This was observed when the absolute blood glucose concentrations were compared (A) and confirmed by analysing each participants change in blood glucose from time point 0 min (B). Area under the curve analysis shows a 7.3% reduction in total circulating glucose concentration (C, p = 0.0061), and a 27.7% reduction in the post-glucose consumption rise in glucose levels (D, p = 0.0002) *p < 0.05, **p < 0.01, ***p < 0.005. Error bars are standard error of the mean." from Power and Jeffrey, 2024 (ref 126).

References 125-126.

Infrared light and skin

> *"what's going on right now is that red light, which can penetrate very deeply down, is going into the skin, and it is activating the mitochondria in your fibroblast to produce more energy, which those cells need to deposit collagen.And so when you deposit collagen, that's gonna give the skin a more tight, uh, feel because as you get older, that collagen deposition is gonna get less and less and less. So this is gonna help keep me looking young."*

Infrared light (IR) penetrates the skin and is absorbed by mitochondria, especially by the enzyme cytochrome c oxidase. This absorption increases ATP (energy) production in skin cells, which is essential for cell repair and regeneration. Enhanced mitochondrial activity leads to increased

fibroblast proliferation and greater production of collagen and procollagen. Collagen is a key protein that gives skin its firmness and elasticity, so its increased synthesis helps tighten and rejuvenate the skin. Infrared light alters the expression of hundreds of genes in skin fibroblasts, many of which are involved in skin ageing and repair. These changes are largely driven by mitochondrial signalling pathways, which coordinate the skin's response to infrared exposure. Infrared-induced mitochondrial activity also boosts the production of growth factors and cytokines, such as keratinocyte growth factor, which support wound healing and skin renewal.

While UV light's effects on skin are well-documented, IR light has not been studied as thoroughly. Recent reviews highlight that available research is growing, but significant gaps remain, especially regarding long-term effects and real-world exposure scenarios. The biological effects of IR light depend heavily on the intensity and duration of exposure. High-intensity artificial IR sources can cause skin damage, while natural sunlight-level IR may have protective or beneficial effects, such as preconditioning the skin against UV damage. IR exposure can induce oxidative stress, alter collagen, and accelerate skin ageing, but it can also trigger beneficial cell signalling pathways that promote repair and resilience, especially at lower, physiologically relevant doses. Some studies suggest IR light, particularly in the near-infrared range, may enhance skin repair, support wound healing, and release nitric oxide, which has systemic health benefits.

References 127-135.

Penetration depth from infrared light

> *"Infrared does about eight centimeters. (can penetrate the skin)"*

Near-infrared (NIR) light (700–1400 nm) penetrates skin more deeply than visible or ultraviolet light, often reaching several millimetres below the surface. The exact depth depends on factors like wavelength, beam width, and tissue properties. Typically, it penetrates 2–8 mm into skin and soft tissue, with deeper penetration at longer wavelengths within this range.

References 136-139.

Glenn Jeffrey's glucose study

"the study that I'm referring to with Glenn Jeffrey out of University College London, he took, uh, young people in, in this study and he gave them a glucose tolerance test. What that means is he gave them a, a bunch of glucose and everybody who gets a bunch of glucose should have a spike in their blood sugar, and he randomized them on their backs.

To see what would happen when he shined red lights, uh, on their backs. And the people that got the red light had lower spikes. In other words, it seemed as though the mitochondria were metabolizing faster, which caused a lower, uh, sorry, a, um, uh, less of a spike of the glucose in their blood. The way he confirmed that is looking for the byproducts of the mitochondrial metabolism, which is carbon dioxide.

So when we breathe, when we metabolize, we're breathing out carbon dioxide, which is the result of, of, uh, mitochondrial um, metabolism. And in fact, in those people that had the light on, it showed a higher level of carbon dioxide in the exhaled, uh, breath. The whole point of that is to get back to your question, is whether we should putting this all over your body, he was able to get that effect systemically with just putting the light on the back."

The results of the mentioned study have been presented above, under the title "670nm red light studies". The researchers employed a controlled experimental setup, initiating the study by exposing participants to 670 nm light prior to administering a glucose load. The key measurements taken included:

- Blood glucose concentrations: Levels were recorded before and after the glucose intake at specific intervals, particularly focusing on a 45-minute post-glucose measurement to ascertain the immediate effects of light exposure.
- Mitochondrial activity: While the study primarily focused on blood glucose, it indirectly assessed mitochondrial functionality through the outcomes of ATP production, speculating that light exposure would enhance ATP synthesis. However, direct measurement of metabolic byproducts or mitochondrial reactive oxygen species (ROS) was not specified in the detailed description of their methods. It is noteworthy that mitochondria use oxygen to convert nutrients into ATP, releasing carbon dioxide as a byproduct, though this was not discussed in the paper.

The mechanism proposed in this study centres around the activation of mitochondrial function due to light, leading to improved ATP production and increased glucose uptake in peripheral tissues, effectively lowering blood glucose levels. The authors primarily emphasises the glucose regulation effects of this process. However, the intricate relationship between ROS generation and mitochondrial activity requires careful analysis and further investigation, given its implications for cellular metabolism and the signalling pathways involved in glucose homeostasis.

Reference 126.

Length of time needed to see effects of infrared light exposure

"How long did it take in those studies to see the effect of red light therapy like this?
Roger: It was almost, uh, well, that's a very good question. So, uh, when, if you talk to Glenn Jeffrey, which I have, he noticed a, an improvement in 15 minutes.

Roger: He said he has studied the mitochondria in fruit flies and in mosquitoes and bees and in human beings, and it's the same every time.

He says after about 15 to 20 minutes of this type of light, in that type of setting, there is a switch that turns on and it, and you, and you don't need further stimulation. Further stimulation doesn't do anything more. It's a, it's a very bizarre thing. You would think that the more light that you gave, the more the effect would be. It's not after about 15 minutes. It, it, there's something that changes in the mitochondria. There are certain theories about where this might be. This might be in the electron transport chain. Uh, uh, complex four. Uh, these are very technical things. There's a lot of studies that are actually, there's a number of groups that are actually looking at this. Uh, there's a whole area of science called photobiomodulation, which is looking at this. But 15 minutes is really what it takes. So we're not, we're not talking about a long period of time. This is really, really interesting."

In a cell study (140), 30 minutes of near-infrared exposure at 1.6 mW/cm² increased mitochondrial activity, suggesting short exposures can have measurable biological effects. In Kaynezhad et al. (143), changes in mitochondrial activity were measured after exposing retinal tissue to 670 nm light for just 5 minutes. The increases in oxidation of cytochrome c oxidase (COX)

post-exposure confirmed that even brief exposures could significantly impact mitochondrial function, supporting the effectiveness of short-duration photobiomodulation.

The magnitude and nature of mitochondrial responses depend on the total energy delivered (power × time), not just the duration. Both under- and over-exposure can lead to reduced or inhibitory effects, highlighting the importance of optimising parameters. More research is needed to elucidate what those parameters are.

References 140-143.

Infrared LED vest therapy

"The highest level of evidence that we have in medicine is something called the randomized placebo controlled trial. And that's where it, it gets rid of a lot of the confounders, and that's exactly what they did in Brazil. They took COVID patients that were, that were sick enough to be admitted to the hospital, but not too sick to be intubated in an intensive care unit.
And they did something tremendous. They actually manufactured a jacket that they could put on patients and on the inside of this jacket were these LED bulbs that gave off infrared radiation at exactly 940 nanometers. They put the jackets on and they randomly randomized the sign which jacket was turned on and which jacket was turned off.
It was blinded because the light coming from this jacket could not be seen by the human eye. It wasn't even enough to bruise enough heat. And so they, they did this on 30 subjects and they randomized 'em. 15, did it 50 15, all 15 or all 30, had the jackets on, 15, had it turned on, 15 did not have it turned on and they watched them.

What happens to these patients? Every single endpoint that they looked at was statistically significant. And what does that mean? It means that. The, the differences between these two groups could not have been from chance. There was a real difference. The group that had the jacket turned on, had improvement in their oxygen saturation, had, could take breaths in more deeply and stronger, um, had improvements in their blood, white blood cells.

Um, and not only that had improvements in their heart rate, their respiratory rate, all of these statistically significant. But the most important and mind blowing statistic was the length of stay in the hospital. So they had these jackets on for 15 minutes, once a day for seven days in the group that did not have the jacket turned on, their average length of stay was 12 days in the hospital. For those that had the jacket turned on, it was eight days. That was four day difference."

The study mentioned is Pereira et al, 2023 (ref 144).

Figure – “Photographs showing the LED-therapy protocol (Left) view of the open vest showing the array of LEDs emitting infrared radiation.” from Pereira et al, 2023 (ref 144).

References 144.

Latitude-COVID-19 link

“there was a study actually that was done in, in Europe where they looked, they said, okay, here's COVID COVID ISS going up. When does COVID go up? Is it because of temperature that changes? Is it because of humidity? And the answers to both of those were no.

Do you know what predicted when countries were to have their first surge in the autumn of 2020? There was a study that was actually done on this. It was latitude. It started in Finland and thenreal went down the entire continent. The last country in the, in the autumn of 2020 to have a COVID surge was Greece.

So a, as the sun is literally pulling down into the southern hemisphere, as the shadow starts to go over Europe, that's when we start to see COVID surges one by one by one.”

There is strong evidence that COVID-19 surges and mortality rates are higher at higher latitudes, particularly during periods of reduced sunlight, but this relationship is influenced by many factors and is not universal. Multiple studies in Europe and globally found a clear correlation: countries at higher latitudes experienced COVID-19 surges and higher mortality rates, especially in autumn and winter, when sunlight and UV exposure decrease, potentially leading to lower vitamin D levels. The latitude effect is not consistent everywhere. For example, within China, no significant correlation was found between latitude and COVID-19 mortality, suggesting other factors (public health measures, healthcare access, demographics) play major roles. In the US, latitude was not correlated with COVID-19 outcomes, while other geographic factors (like longitude) sometimes showed associations.

References 145-151.

Sunlight and COVID-19: study from the University of Edinburgh

“there was a, a study that was done out of the University of Edinburgh and they looked at this very question that we had talked about earlier about vitamin D. They looked at the United States in the, in the wintertime. So, and they eliminated the southern part of the United States because in the southern part of the United States, you can actually get some vitamin D in the wintertime.

So they just looked at the, sort of the northern portion of the United States, and they were able to show that the more sunlight there was in particular areas, the lower the mortality from COVID-19. So they said, oh, this is interesting. What about in England? So they, they did the exact same study in England, and, and sure enough, of course, they didn't have to eliminate any part of England because the whole country doesn't get in any vitamin D in the wintertime.

What they showed was that, again, certain parts of the country in England, as you know, get more sunlight than other parts. Well, those areas that got more sunlight had lower mortality from COVID-19 than they took the same. They predicated the same, uh, study and they looked in Italy exactly the same finding, and they published this and they said in their study, and this is what really, uh, amazed me, they said the fact if this is causal, they say, they said that, um, this might actually show a possible public health intervention.

The fact that it is completely independent of vitamin D means that there's something else going on. ”

The study being mentioned is Cerrie et al. 2021 (red 152). It is important to note that this is a correlation study, not a randomised trial, so it shows associations, not proof of cause and effect.

Reference 152.

Swedish study on sunlight exposure

"So the Swedish study is, is, is groundbreaking. Um, this was a study where they asked 20,000, 20 to 30,000 Swedish women about their habits in sunlight.

And they divided these women into three categories. Those women that did not get a lot of sun, those that got a moderate amount of sun, and those that got a lot of sun. And they followed them for 20 years and they, they kept a track of each one that died and what they died of. And when they were done with that, they were astonished because what they found was that the women who had spent most, spent the large amount of their time outside, or that spent the most amount of time outside, had the least amount of mortality from cancer.

From cardiovascular disease and non-cardiovascular disease, and those that spent the least amount of time outside had the highest levels of that. The magnitude difference between those two was so much that they were able to show that women who in Sweden, who spent the most amount of time outside and smoked, had the same mortality as those women that did not spend as much time outside and did not smoke.

They were equal. They were equal. In other words, being in that category of not spending much time outside in the sun was the same risk factor for death as smoking. "

The study titled "Avoidance of sun exposure as a risk factor for major causes of death: a competing risk analysis of the Melanoma in Southern Sweden cohort" conducted by Lindqvist et al. (153) presents important findings regarding the impact of sun avoidance on mortality. The research identifies avoidance of sun exposure as a significant risk factor, comparable to smoking concerning its implications for all-cause mortality. The study analysed data from the Melanoma in Southern Sweden cohort, encompassing 29,518 women over a period of 20 years.

One of the key findings indicates that the risk of mortality due to cardiovascular diseases (CVD) and non-cancer/non-CVD conditions decreased with increased sun exposure. This suggests that higher levels of sun exposure contribute positively to overall health, likely through mechanisms such as increased vitamin D synthesis, which is essential for numerous physiological functions, including bone health and immune regulation. The authors specifically noted that for women who

habitually avoided sun exposure, the all-cause mortality rate was approximately double that of those with high sun exposure.

Moreover, the study highlights differential impacts of sun exposure according to demographic factors such as age. It suggests that younger women may experience longer life expectancy when exposed to sunlight, supporting the idea that moderate sun exposure contributes to a longer lifespan. This establishes a complex relationship wherein sun exposure can reduce the risk of dying from certain causes while simultaneously increasing skin cancer risk, introducing a competing risk scenario.

The overall population attributable risk for all-cause mortality linked to sun avoidance was found to be significant at 3%. Such statistics reveal broader public health implications of sun avoidance behaviours, particularly in climates or cultures where sun exposure is often stigmatised due to skin cancer fears. Furthermore, these findings align with previous research emphasising the importance of balancing sun protection measures with adequate UV exposure to maintain optimal vitamin D levels, which have been shown to play a protective role against various diseases, including CVD.

References 153 154.

Rethinking sunlight exposure

> *"Richard Weller, who's a dermatologist in England, did just last year a very similar study as to the Swedish study, except it was 10 times bigger and he did it with both men and women … He discovered that either from solariums or from being outside using solar radiation data, he was able to show both on their questionnaire and also where they lived, that the more light that they had, the lower their risk of mortality and cancer mortality. So the question was, does it increase melanoma? (...) That's the big risk that everybody's concerned about. You go out into the sun and you're gonna get skin cancer. And he was able to show in that study that there was no statistical increased risk of melanoma incidents, but there was a reduction in non-skin cancer mortality (…) That caused him to write an op-ep and publish it in (…) The Journal of Investigative Dermatology called Sunlight: Time for a Rethink … public health organizations that are saying now, before we have said that the sun is a deadly laser and you should avoid it at all costs. We may need to rethink that."*

A large prospective cohort study using UK Biobank data investigated the relationship between ultraviolet (UV) exposure and mortality among over 395,000 participants of white European ancestry. The study assessed UV exposure using two validated proxies: solarium use and residential shortwave solar radiation (SWR). Both measures were associated with lower all-cause, cardiovascular, and cancer mortality, even after adjusting for a wide range of demographic, behavioral, and socioeconomic confounders. Specifically, solarium users had a 15% lower risk of all-cause mortality and a 14% lower risk of cancer mortality compared to non-users. Similarly, higher residential SWR was associated with a 12% reduction in all-cause and cancer mortality per 2000 kJ/m² increase. Notably, while there was some indication of a higher incidence of melanoma with greater UV exposure, there was no statistically significant increase in melanoma mortality, suggesting the benefits of UV exposure may outweigh the risks in low-sunlight regions such as the UK.

Sunlight: Time for a Rethink?

In the editorial "Sunlight: Time for a Rethink?", Richard Weller argues that prevailing public health advice emphasizing sun avoidance may warrant revision. Drawing on epidemiological evidence—including recent findings from the UK Biobank study—Weller notes that greater sunlight exposure is associated with reduced all-cause and cardiovascular mortality, despite modest increases in melanoma incidence. He highlights the health benefits of ultraviolet radiation beyond vitamin D

synthesis, such as blood pressure reduction via nitric oxide mobilization in the skin. Weller suggests that current public health messaging may overstate the risks of sunlight exposure while underappreciating its potential benefits, particularly in high-latitude regions where sunlight is scarce. He calls for a more balanced and evidence-based approach to sunlight recommendations, particularly given emerging data linking UV exposure to lower mortality risk.

References 155, 156.

Time spent indoors

> *"How long does the average American spend indoors, the average Brit spend indoors? Roger: Good question. They're almost identical. I think the Brits spend a little bit more time outside than Americans. The last number for Americans was 93%, and Brits was 92%. "*

Research consistently indicates that individuals in the United States spend approximately 90% of their time indoors, amounting to nearly 22 hours per day. This time is primarily spent at home, but also includes workplaces, schools, and other indoor environments. While specific figures for the United Kingdom are less frequently cited in the academic literature, similar patterns are observed across other developed nations, including the UK. The trend toward indoor living has remained stable over decades and may have intensified due to the rise of digital technology and the COVID-19 pandemic. Notably, U.S. adults now spend over an hour and a half more at home each day compared to 2003, and elderly populations may spend as much as 95% of their time indoors. This widespread indoor lifestyle carries significant health implications, including increased exposure to poor indoor air quality, reduced physical activity, and diminished contact with natural environments.

Reference 157.

Health benefits of living near green spaces

> *"we've known for decades that people who live in green spaces do much better in terms of diabetes, do much better in terms of hypertension, mortality, all of these things. Depression."*

A substantial body of research shows that living in greener environments is linked to better physical and mental health. People who reside near green spaces have lower rates of type 2 diabetes, high blood pressure, and early death, even when differences in income or neighbourhood conditions are taken into account. Mental health also appears to benefit, with access to green or garden spaces associated with reduced levels of depression and anxiety, particularly for individuals with chronic conditions like diabetes. Exposure to green space has additionally been linked to better heart health and lower rates of cardiovascular-related illness. Although some studies suggest the benefits may vary depending on age or how greenery is perceived, the overall evidence strongly supports the role of natural environments in improving health and increasing life expectancy.

References 158-161.

The Green Heart Study: health impacts of urban reforestation

> *"I just have to tell you this study, there was something called the Greenheart study in South Louisville, Kentucky. They did an amazing thing. They took this four square mile area in South Louisville, Kentucky, urbanized, uh, area, and they measured everybody's, uh, H-S-C-R-P (Highly sensitive C reactive protein). It's a marker of inflammation and it's been correlated to bad things like stroke and heart attack (...) So they measured about 700 people and then they did something extraordinary. They purchased 8,000 mature trees, dug holes, and planted 8,000 trees into four square mile area (...) Two years later, they come back and they measure all 700 people in their study (...) the H-R-C-R-P dropped by 13 to 20%, which correlated to about a 10 to 15% reduction in strokes."*

In a controlled intervention study conducted in South Louisville, Kentucky, the Green Heart Project assessed the impact of urban greening on inflammation among 745 residents. After planting over 8,000 trees and shrubs across a four-square-mile area, researchers observed a 13–20% reduction in high-sensitivity C-reactive protein (hsCRP) levels, a marker associated with systemic inflammation and elevated risk of cardiovascular disease, among participants living in the greened neighbourhoods compared to control areas. According to the project's investigators, this decline in hsCRP may correspond to a 10–15% reduction in risk for heart attack, cancer, or all-cause mortality.

References 162, 163.

Infrared light exposure: clouds vs. indoors

“clouds, because they are water molecules will absorb a lot of the infrared lights. And the problem is that that's the exactly the type of light that you want to get. However, even on a cloudy day being outside, you're gonna get more infrared lights than if you were inside.”

Cloud cover substantially reduces exposure to natural infrared light at the Earth’s surface. Under clear skies, shortwave infrared irradiance can reach levels as high as 600 microwatts per square meter (μW/m²) but during full cloud cover or rainfall, it may drop dramatically to as low as 0.5 μW/m², a reduction by several orders of magnitude. The decrease occurs because clouds absorb and scatter infrared radiation, especially when they are thick and low in altitude. Despite this, indoor environments typically block even more infrared light due to the absorptive properties of walls, windows, and roofing materials. As such, while clouds diminish infrared exposure outdoors, being outside, even on a cloudy day, still generally offers more natural infrared light than staying indoors.

Reference 164.

Incandescent light and colour vision

“So, Glenn Jeffery (...) took people that were working in this environment with LED bulbs (...) And what he did with 22 people is he switched out these LED bulbs and put in incandescent bulbs and there was a 25% improvement in color differentiation in his study (...) They were able to distinguish colors 25% better than they were when they were exposed to LED bulbs (...) So think about what's going on with this. The retina, which is the back of your eye, where in the light is coming in, there's these cones that are tremendously metabolically active. They're constantly updating, sending neuro signals to the brain (...) it's the one tissue in your body with the most amount of mitochondria, and it's because they have to supply a lot of energy. As somebody gets older, that mitochondria is not producing the same amount of energy (...) If you can perhaps increase the amount of output of energy from those mitochondria, you could improve the ability to visually perceive (...) Glen Jeffery’s done this study already where he, for just three minutes, 670 nanometer light in the eye, only in the morning, improved those people's ability to visualize and actually see.”

A recent study by Glen Jeffery and colleagues examined the impact of lighting type on visual performance among individuals working under LED illumination. In a controlled trial involving 22 participants, those exposed to incandescent lighting for two weeks experienced a 25% improvement in colour contrast sensitivity across both red-green and blue-yellow axes compared to those who remained under LED lights. The researchers attribute this effect to the spectral properties of incandescent bulbs, which emit more long-wavelength light known to support mitochondrial function. The retina, among the most metabolically active tissues in the body, contains a high concentration of mitochondria, particularly in the photoreceptor cells responsible for colour vision. Prior research by the same group has shown that brief exposure to 670 nm light, especially in the morning, can enhance mitochondrial efficiency and improve visual performance. These findings suggest that both the spectrum and timing of light exposure may influence visual health, particularly as mitochondrial function declines with age. ***It should be noted that this study is a preprint and has not yet undergone peer review***.

References 165, 166.

Mitochondrial function and visual perception

> *"what is the effect of low energy output from the mitochondria? Roger: Well, it depends on what tissue the mitochondria is in. And so if it's in the eye, then it's gonna be a better visual perception"*

Mitochondrial function plays a critical role in visual perception due to the exceptionally high energy demands of retinal cells and the optic nerve. When mitochondrial energy output is impaired—whether through genetic disorders, aging, or acquired dysfunction—it can lead to vision-related conditions such as optic neuropathy, retinal degeneration, and age-related macular decline. This disruption arises from decreased ATP production and increased oxidative stress, which collectively damage visual pathways. Conditions like Leber's hereditary optic neuropathy and glaucoma are linked to mitochondrial deficits, and emerging therapies that support mitochondrial health, such as Elamipretide, have shown promise in mitigating visual impairment in preclinical studies.

References 167-169.

Seasonal patterns in mortality

> *"The maximum amount of deaths every year occurs within a month after the shortest day of the year. So we're talking December, January, we see the most amount of influenza deaths at that time. We see the most amount of cardiac deaths at that time. We see the most amount of kidney deaths at that time. What is the time of year that we see the least amount of deaths? It's within a month after the longest day of the year (...) The most amount of deaths occur in Australia in the Southern Hemisphere in June to July. That's their winter. And so what you see is deaths are correlated to the length of the day."*

Seasonal variations exert a significant influence on mortality rates, particularly from cardiovascular, renal, and infectious diseases. Numerous studies show that deaths from acute heart failure, myocardial infarction, aortic dissection, and influenza peak during colder months, especially in temperate and continental climates. Cold weather increases physiological stress and susceptibility to respiratory infections, which in turn elevate cardiovascular risk. In patients with end-stage renal disease, winter months are associated with higher rates of all-cause and cardiovascular mortality, as well as infection-related deaths such as pneumonia. These patterns are mirrored across hemispheres, winter months in each region see the highest mortality, while the summer months generally correspond with the lowest. Although some causes of death, such as cancer or septicemia, show less seasonal fluctuation, the consistent winter peak in mortality across multiple conditions highlights the role of day length and ambient temperature as significant environmental factors.

References 170-172.

Timing sunlight exposure for health

> *"Optimal time of day to get sunlight would be (...) as we talked about, when the sun is low in the sky, that's gonna be beneficial because the ultraviolet cannot penetrate obliquely through the atmosphere as well as long wavelength radiation. So when the sun is coming up (...) in the mornings and when the sun is going down in the evenings, that's gonna be the time where you're gonna get proportionally more infrared light and the least amount of ultraviolet light. Now, when the sun is directly overhead at noon, you're gonna be getting the most amount of infrared light at that time, but you're also gonna be getting a lot of ultraviolet radiation."*

The time of day significantly influences the type and intensity of solar radiation reaching the Earth's surface, with implications for human health. Ultraviolet (UV) radiation, particularly UVB, peaks when the sun is highest in the sky, typically between 10 a.m. and 2 p.m., increasing the potential for skin damage while also maximising vitamin D synthesis. In contrast, infrared (IR) radiation is more evenly distributed throughout the day and is proportionally more dominant during the early morning and late evening, when UV levels are significantly lower. During these times, the atmosphere filters out more UV radiation due to the oblique angle of the sun's rays, allowing greater relative exposure to long-wavelength infrared light. Morning and evening sunlight may therefore offer health benefits—such as warmth and potential support for mitochondrial or melatonin-related processes—while minimising UV-related harm. Though midday offers the greatest total irradiance, including both UV and IR, it also carries the highest risk for UV-induced damage. As such, timing of sun exposure can modulate its effects on the body, with early and late daylight hours generally posing lower risk and offering distinct physiological advantages.

References 173-176.

Seasonal affective disorder (SAD) light, circadian health, and mood

> *"This type of light is called a SAD (seasonal affective disorder) light (...) light can actually shift [circadian rhythm] one way or the other, depending on when you're shining that light (...) These lights, especially in the morning, have a way of not only setting your circadian rhythm and making sure it's on track, but also reducing depression. There's a portion of your brain that receives light information called the perihabenular nucleus (...) And if it doesn't get stimulated, it can cause depression (...) So what I would recommend (...) getting is about 3000 lux hours (...) You only have to look at it for about 20 minutes, and that should be enough."*

Bright light therapy, often delivered through specialised Seasonal Affective Disorder (SAD) lamps, has been shown to effectively regulate the circadian rhythm and reduce symptoms of depression, particularly when administered in the morning. These lights simulate natural sunlight and help realign delayed or misaligned circadian cycles, which are commonly disrupted during winter months and associated with seasonal mood disturbances. Light acts directly on the brain's circadian pacemaker via retinal pathways, shifting the timing of melatonin release and improving sleep and mood regulation.

Beyond its circadian effects, light also influences mood through a distinct neural circuit involving the perihabenular nucleus (PHb). Research indicates that abnormal or nighttime light exposure activates this pathway, projecting from the retina to the PHb and onwards to limbic regions, contributing to depressive-like behaviours even in the absence of circadian disruption. Chronic irregular light exposure has been shown to alter PHb function, leading to mood disturbances that closely resemble those caused by circadian misalignment. These findings highlight that light affects mood both through circadian entrainment and through direct neural mechanisms, supporting the therapeutic use of timed light exposure for mood disorders.

References 177-181.

Brighter nights, darker days, higher mortality risk

> *“there was a study that was published recently and the title was Dark Days and Bright Nights, and that correlated with increased mortality.”*

A large-scale prospective study involving over 88,000 UK Biobank participants examined the relationship between personal light exposure patterns and all-cause mortality. Using wrist-worn devices to track individual light exposure over seven days, the researchers assessed the effects of brighter night-time light and dimmer daytime light on long-term health outcomes. The findings revealed that individuals exposed to lower daytime light and higher night-time light had a significantly increased risk of mortality. Specifically, the highest quartile of night light exposure was associated with a 21% increase in all-cause mortality compared to the lowest quartile, even after adjusting for age, sex, lifestyle, health status, and socioeconomic factors. Similarly, individuals in the lowest quartile of daytime light exposure had a 19% higher risk of death. These results suggest that disruptions to the natural light-dark cycle, characterised by “darker days and brighter nights”, may adversely affect circadian regulation and overall health, reinforcing the importance of appropriate light exposure patterns for longevity.

References 182.

Nighttime light, melatonin suppression, and circadian disruption

> *“light that's going into our eyes is doing two things at night. Number one, it is shutting down melatonin production from the pineal gland. And as we just talked about, melatonin's a very powerful antioxidant that's very beneficial. The second thing that it's doing is it's confusing your circadian rhythm.”*

Exposure to artificial light at night (ALAN) suppresses the natural production of melatonin—a hormone secreted by the pineal gland that signals the onset of sleep. Light, particularly in the blue wavelength range, inhibits melatonin release and can delay or shift circadian rhythms, leading to later sleep onset and disrupted biological timing. Even low levels of light from streetlights, electronics, or indoor lighting can interfere with this process. Such disruptions are linked to a range

of health concerns, including metabolic, cardiovascular, cognitive, and mood-related disorders. The effect is especially pronounced among night shift workers and others exposed to light during typical sleep hours.

Antioxidant properties of melatonin

Melatonin, best known for regulating the sleep-wake cycle, is also a powerful antioxidant. It directly neutralises harmful molecules like free radicals and supports the body's own defences by increasing the activity of protective enzymes while reducing those that cause oxidative stress. Unlike many other antioxidants, melatonin can reach all parts of the cell, including the mitochondria, where oxidative stress is often highest. It also helps prevent the formation of highly reactive and damaging molecules by stabilising certain metals involved in these chemical reactions. In addition, its breakdown products continue to offer antioxidant protection, creating a lasting chain of defence. These qualities make melatonin a key protector against cell and tissue damage in conditions such as cardiovascular disease, neurodegeneration, cancer, and ageing. In fact, its antioxidant role is thought to have evolved before its function as a hormone.

References 183-185.

Effectiveness of blue light blocking glasses

> *"The next best solution is to have more of a red shift or, put {blue blocker glasses] on at night (...) They're trying to eliminate blue, but I'm still getting light in. And that's enough light to shut down melatonin production (...) [studies] find that it doesn't really affect the timing of the circadian rhythm as much as they would like (...) the best way to do it is to turn off the light. The good news is that this very type of exposure is actually beneficial at five, six o'clock in the morning."*

Blue light blocking glasses are a practical and non-pharmacological intervention designed to reduce melatonin suppression from nighttime exposure to artificial light, particularly from screens and LED sources. Research shows that wearing these glasses in the evening can significantly mitigate melatonin disruption, decrease pre-sleep alertness, and help advance the natural onset of sleep. This effect has been particularly beneficial for individuals with delayed sleep phase disorder, where blue

blockers have helped realign the circadian rhythm by shifting melatonin and sleep onset earlier. However, while these glasses support circadian alignment and ease of sleep initiation, improvements in overall sleep quality appear less consistent in healthy individuals. Effectiveness depends largely on the spectral filtering range of the lenses: red and orange-tinted glasses block nearly 100% of blue light in the circadian-sensitive 440–530 nm range, while yellow and brown lenses are moderately effective, and clear lenses offer minimal protection. Despite variations between brands and marketing claims, red or orange-tinted lenses offer the most reliable defence against melatonin suppression and circadian disruption.

Benefits of morning blue light exposure

Exposure to blue light in the early morning is an important factor in aligning the circadian rhythm and enhancing overall daytime function. Morning blue-enriched light strongly suppresses melatonin at the appropriate time, helping stabilise the body's internal clock and support healthy sleep-wake cycles. This exposure promotes increased alertness, faster cognitive processing, improved mood, and reduced daytime fatigue. It has shown particular benefit in environments with limited natural daylight, such as schools, offices, and clinical settings, and has been linked to better rest-activity rhythm stability and cognitive outcomes in older adults and individuals recovering from neurological injury. As the most effective wavelength for circadian entrainment, early blue light exposure is a powerful and accessible tool for improving mental clarity and physiological regulation.

References 186-191.

How the glymphatic system clears brain toxins during sleep

> *“there's glymphatics in our brain that's supposed to take away toxins, that only happens during sleep. When the brainwaves are moving in a particular way that causes the movement of this glymph, they call it, to move these toxins away from the brain.”*

During sleep, the brain activates a specialised waste clearance mechanism known as the glymphatic system. This system relies on cerebrospinal fluid (CSF) flowing through channels formed by astroglial cells to flush out neurotoxic waste products such as amyloid-beta and tau proteins. Notably, glymphatic activity peaks during slow-wave sleep, when the interstitial space between brain

cells expands, allowing fluid to move more freely. This process is facilitated by aquaporin-4 water channels and is influenced by arterial pulsation, respiration, and circadian rhythms. Because glymphatic function is minimal during wakefulness, adequate and high-quality sleep is vital for clearing toxins from the brain. Disruptions in sleep or this clearance pathway have been linked to an increased risk of neurodegenerative diseases, including Alzheimer's.

References 192-194.

Sleep loss and disruption of metabolic and immune proteins

> *"They actually have done this study where they had these college students stay up the whole night, and then the next day they measured 150 different proteins (...) that were involved with immunity, with cancer fighting, with diabetes, metabolism. They were all outta whack."*

Although not involving college students, an investigation from the University of Colorado Boulder examined the effects of sleep and circadian disruption on the human plasma proteome. In this controlled trial, healthy young men were subjected to a simulated night-shift schedule, involving nighttime wakefulness and daytime sleep. The study identified 127 plasma proteins whose 24-hour rhythms or average levels were significantly altered. These proteins were linked to immune function, cancer-related signalling, glucose regulation, and metabolic processes. Disrupted pathways included interleukin and PI3K signalling, antigen presentations, and hormonal regulators of insulin sensitivity. The findings suggest that even short-term circadian misalignment can produce widespread molecular changes with implications for immunity, metabolism, and disease risk.

Acute sleep loss and biological system disruption

Broader research supports the finding that even a single night of sleep loss can trigger widespread biological changes. Experimental studies have shown that acute sleep deprivation in humans increases pro-inflammatory cytokines like IL-6 and TNF-α, alters STAT protein signalling in immune cells, and creates an immune environment that may elevate the risk of inflammatory diseases and cancer. Animal models further demonstrate that short-term sleep disruption activates genes in the brain associated with tumour progression and immune suppression. In humans, all-night wakefulness has been found to shift the distribution and behavior of immune cells, increase

autoimmune and inflammatory markers, reduce the activity of cancer-fighting cytotoxic cells, and accelerate cellular ageing processes. Metabolic tissues also show rapid molecular responses to sleep loss, including inflammation, altered circadian gene expression, and signatures of muscle breakdown and fat accumulation.

References 195-197.

Light-emitting e-readers suppress melatonin and delay sleep

> *"there was a study that was done where they compared someone reading at night with a book with a light bulb shining on it versus the LED, like a Kindle or whatever (...) What they found was that there was a lot more light coming outta the Kindle than there was just reading the book with the lamp, and it delayed sleep onset (...) enough to delay the circadian rhythm and shut down melatonin production."*

A randomised, controlled crossover trial by Chang et al. (2015) investigated the effects of evening use of light-emitting e-readers compared to printed books on sleep and circadian physiology. Twelve healthy adults read for four hours prior to bedtime over five consecutive evenings, using either a light-emitting e-reader (iPad) or a printed book under controlled dim lighting. Results showed that reading on the e-reader significantly suppressed evening melatonin levels, delayed the onset of endogenous melatonin by over one hour, increased the time taken to fall asleep, and reduced REM sleep in the early part of the night. The following morning, participants who had used the e-reader reported feeling less alert and took longer to become fully awake. These effects were attributed to the short-wavelength (blue) light emitted from the screen, which actively engages melanopsin-containing retinal ganglion cells that influence circadian timing. In contrast, reading from a printed book under dim lighting had no such adverse effects.

Reference 198.

Daily vitamin D reduces risk of respiratory infections

> *"Martineau (...) published in the British Medical Journal (...) a meta-analysis of randomized controlled trials, showed that people who supplement every day with vitamin D had lower risks of acute chest syndrome (...) there was a recent study that came out that showed that people who supplemented with 2000 international units daily of vitamin D had a lower risk of all cause autoimmune conditions (...) we actually reviewed that on our, on our med cramp channel."*

A large-scale meta-analysis by Martineau et al. (2017), published in the BMJ, analysed individual participant data from 25 randomised controlled trials involving over 11,000 participants. The study found that vitamin D supplementation significantly reduced the risk of acute respiratory tract infections (ARTIs), particularly when taken on a daily or weekly basis rather than in large, infrequent bolus doses. Among those receiving daily or weekly supplementation, the protective effect was strongest in individuals with a baseline vitamin D deficiency (<25 nmol/L). While the study did not specifically examine "acute chest syndrome", it provides robust evidence that consistent vitamin D intake lowers the incidence of a wide range of respiratory infections, including colds, flu, bronchitis, and pneumonia.

References 199.

Vitamin D supplementation lowers risk of autoimmune disease

> *"there was a recent study that came out that showed that people who supplemented with 2000 international units daily of vitamin D had a lower risk of all cause autoimmune conditions."*

A 2022 randomised controlled trial by Hahn et al., published in the BMJ, examined the effects of daily vitamin D supplementation (2,000 IU) and marine omega-3 fatty acids on the risk of developing autoimmune diseases. The study analysed data from over 25,000 older adults in the U.S. over a median follow-up period of 5.3 years. Participants who took vitamin D had a 22% lower risk of developing autoimmune diseases, including conditions like rheumatoid arthritis, psoriasis, autoimmune thyroid disease, and polymyalgia rheumatica, compared to those who received a placebo. The protective effect was more pronounced after two years of supplementation, suggesting

a cumulative benefit. The findings indicate that consistent, moderate-dose vitamin D supplementation may help prevent the onset of autoimmune conditions in ageing populations.

Reference 200.

Vitamin D levels and calcium metabolism

> *" here's the concern I have is if you are gonna supplement with vitamin D, make sure that you get your levels checked (...) because it is a fat soluble vitamin and it is possible to take too much (...) if you take too much, it can affect calcium metabolism and you can have issues with calcium, too high levels of calcium."*

Excessive vitamin D intake can lead to hypercalcemia, a condition in which blood calcium levels rise above the normal range. This occurs because vitamin D enhances intestinal calcium absorption; when vitamin D levels become too high, calcium uptake may increase to unsafe levels. Although the overall risk of hypercalcemia from supplementation is relatively low, it becomes more likely with high doses, long-term use, or concurrent calcium supplementation. Elevated calcium levels can cause a range of health issues, including kidney stones, vascular calcification, and reduced kidney function. Additionally, very high vitamin D levels may trigger bone resorption, drawing calcium from bones into the bloodstream, especially in those with low dietary calcium intake. For these reasons, it is advisable to monitor vitamin D status when supplementing regularly, particularly with higher doses or in combination with calcium.

References 201-203.

Vitamin D and muscle growth

> *"I have not seen a connection between vitamin D and muscle growth, though I would imagine it's probably not gonna hurt if you've got adequate vitamin D supplementation (…) studies that have been done show that people with adequate vitamin D levels have better muscle strength, especially in their legs."*

Research shows that vitamin D supplementation can modestly improve muscle strength, especially in individuals who are deficient or older adults. Meta-analyses indicate that supplementation enhances both upper and lower limb strength, with the strongest effects seen in those with low baseline vitamin D levels. However, these gains in strength do not consistently lead to increases in muscle mass or explosive power, and the overall effect size remains small. Among athletes, vitamin D appears to support lower limb strength, particularly in those who train indoors, but does not significantly impact upper body strength or muscle power. Some studies suggest a potential increase in muscle fibre size in older women with low vitamin D, though further evidence is needed. Overall, while maintaining adequate vitamin D is important for neuromuscular health, it is unlikely to drive significant muscle growth in healthy individuals with sufficient levels.

References 204-208.

Dietary sources of Vitamin D

> *"certain foods as well, mushrooms, for instance, certain types of fish, they have vitamin D in them as well."*

Both mushrooms and fish can provide meaningful amounts of vitamin D, though the type and quantity vary by source. UV-exposed mushrooms, such as Agaricus bisporus or Lentinula edodes, produce vitamin D_2 (ergocalciferol) and can supply amounts that meet or exceed daily recommendations, particularly when sun-dried or UV-irradiated. Fatty fish like salmon, mackerel, and sardines contain vitamin D_3 (cholecalciferol), the form more commonly found in animals and better absorbed by the human body. While cooking and processing can lower vitamin D levels, substantial amounts are retained with proper preparation. Additional sources of vitamin D include fish liver oils, egg yolks, fortified dairy and plant-based milks, and breakfast cereals. However, because relatively few foods contain high levels of vitamin D, supplementation is often recommended, particularly for individuals with limited sun exposure or dietary restrictions.

References 209-213.

Poor sleep and intake of carbohydrates

> *“people who don't get enough sleep tend to have a predilection to eating more carbohydrate rich foods.”*

Scientific evidence supports a link between inadequate sleep and increased consumption of low-quality carbohydrates, particularly foods high in added sugars and refined starches. Experimental studies in adolescents and adults show that sleep restriction tends to increase evening calorie intake, especially from snacks rich in carbohydrates with a high glycemic load. This dietary shift is often accompanied by reduced intake of fruits and vegetables, compounding the risk of negative health outcomes. Observational studies further indicate that poor sleep is associated with a preference for lower-quality carbs, whereas diets rich in whole grains and high-fibre carbohydrates are linked to better sleep quality and efficiency. While some studies suggest that sleep loss may also increase fat intake or alter macronutrient ratios depending on context, the overall trend points to a bi-directional relationship: sleep deprivation promotes poor dietary choices, which may in turn further disrupt sleep and metabolic health.

References 214-217.

Interferon and immunity: fever, infection, and COVID-19

"The major effector of this innate immune system is something called interferon. Interferon is a very important molecule in the body and it is so effective at preventing viral infections that just about every single viral infection that plagues the human body today has a defense mechanism against interferon (...) Interferon production goes up with temperature, and in fact, the body's fever mechanism is one of the ways that it tells the body that it needs to increase interferon to deal with the viral infection (…) there was a study that was published, last year where they looked in mice (...) and they found that there was like five different regulatory proteins, all of which led to one endpoint, and that was to produce this thing called interferon (...) there was a study that was done looking at lymphocytes and taking them out of the human body and at different temperatures, once it hit about 38, 39 degrees, there was 10 tenfold increase in interferon, which is exactly what you would want to have (...) there was a study that was done that showed that high levels of interferon correlated with more mild SARS-CoV-2 infections, and that people that had low interferon levels had very severe COVID-19 infections."

Interferons are key antiviral signalling molecules in the innate immune system, activated early in response to viral infection. When cells detect viral components, they release type I (e.g., IFN-α, IFN-β) and type III (e.g., IFN-λ) interferons, which bind to receptors on nearby cells and trigger the expression of interferon-stimulated genes (ISGs). These genes encode proteins that inhibit viral replication, block viral entry, and degrade viral RNA or DNA. Type II interferon (IFN-γ), produced by immune cells, enhances these defences by activating macrophages and coordinating broader immune responses. The central role of interferons is reflected in the fact that many viruses have evolved strategies specifically to evade or suppress interferon activity. Genetic deficiencies in interferon signalling increase vulnerability to viral infections, underscoring their importance as the body's first line of antiviral defence.

Interferon and fever

Although fever and interferon production often occur together during viral infections, evidence indicates that interferon plays a causal role in inducing fever, not the other way around. Interferons, particularly type I, are produced early in the immune response to viral invasion and help initiate a cascade of cytokine signalling that leads to elevated body temperature.

Proteins converge on interferon production in miice

A 2024 review in Signal Transduction and Targeted Therapy outlines how five distinct interferon regulatory factors (IRFs), namely IRF1, IRF3, IRF5, IRF7, and IRF8, converge on a shared functional outcome: the production of type I interferons. Drawing on evidence from mouse knockout models and infection studies, the review highlights how each of these transcription factors contributes to the antiviral innate immune response, often in overlapping or compensatory ways. The coordinated activity of these proteins ensures a robust and redundant antiviral signaling network, supporting the idea that multiple upstream regulators drive the same interferon-producing endpoint in mammalian immunity

Higher immune activity at fever temperatures

A 1988 study found that raising core body temperature to 39°C significantly enhanced interferon-γ (IFN-γ) production in human lymphocytes. IFN-γ is a critical signalling protein in the immune system that activates macrophages, enhances antigen presentation, and plays a central role in the body's defence against viruses and intracellular pathogens. In this experiment, healthy adult volunteers underwent warm water immersion until their temperature reached 39°C. Blood samples taken before and after the heat exposure revealed that lymphocytes stimulated in vitro produced roughly 10 times more IFN-γ at the elevated temperature (from ~380 to 4,000 U/mL). The study also observed shifts in T-cell subsets and a rise in interleukin-2, suggesting a broader immune activation.

Interferon levels and COVID-19

Scientific research shows that low levels of interferons, particularly type I (IFN-α) and type III (IFN-λ), are strongly associated with more severe COVID-19 outcomes. Studies consistently report that patients with severe or life-threatening infections often exhibit weakened interferon responses, including lower circulating levels of these antiviral signalling proteins compared to those with milder illnesses or healthy individuals. This impaired interferon activity correlates with higher viral loads, increased systemic inflammation, and worse clinical progression, suggesting that a robust early interferon response is key to controlling SARS-CoV-2 infection. Some evidence also links older age to reduced interferon production, potentially contributing to the elevated risk of severe disease in elderly populations. While a few meta-analyses have questioned whether interferon levels reliably

differentiate between mild and severe COVID-19 cases, the broader body of evidence supports a clear relationship between insufficient interferon signalling and poor clinical outcomes.

References 218-225.

Fever management

> *"we should not really be treating fevers unless they're so high that other complications could occur, like racing heart rates or having seizures."*

Scientific research increasingly supports the view that routine treatment of fever is unnecessary in most cases. Fever is a natural, adaptive response that enhances immune activity and helps the body combat infection. Suppressing it, particularly with antipyretics like acetaminophen or ibuprofen, may even be counterproductive when fever remains in the moderate range. Clinical studies and meta-analyses, including in critically ill adults, have shown no survival advantage from aggressively lowering fever. While elevated temperatures can increase metabolic strain, particularly in individuals with underlying heart conditions or neurological injury, fever should typically only be treated when it reaches levels that risk seizures (especially in young children) or cardiovascular stress. Medical guidelines suggest that the focus should be on patient comfort and risk thresholds, rather than reflexively lowering any elevated temperature. Overuse of fever-reducing medication is common and often fuelled by "fever phobia," despite limited evidence that such interventions improve outcomes in otherwise healthy individuals.

References 226-229.

Frequent sauna use linked to lower cardiovascular mortality

> *"people who use sauna 4 or 5, 6, 7 times a week are more likely to have less death from cardiovascular disease than people who use sauna once a week."*

Large-scale studies indicate that regular sauna use, particularly four to seven times per week, is associated with a significantly reduced risk of death from cardiovascular disease. Longitudinal

research from Finland has shown that people who use saunas more frequently have lower rates of fatal cardiovascular events, including coronary heart disease, sudden cardiac death, and overall cardiovascular mortality, compared to those who use the sauna only once a week. These benefits appear dose-dependent, increasing with both the frequency and duration of sauna sessions, and remain significant even after adjusting for other health and lifestyle factors. Proposed mechanisms include improved blood vessel function, reduced blood pressure, decreased arterial stiffness, and anti-inflammatory effects, as well as enhanced regulation of the autonomic nervous system. Combining sauna use with good physical fitness may yield even greater cardiovascular and overall health benefits. While more research is needed to fully explain these effects, current evidence supports frequent sauna bathing as a potentially valuable practice for promoting heart health and reducing cardiovascular risk.

References 230-233.

Hot and cold therapy

> *"Let's say 20 minutes in the sauna (...) what you're doing is you're heating up the body. And, the whole purpose of that is to increase the body temperature. What the cold at the end does is it does two things. They believe the first thing that it does is it causes vasoconstriction. So you put a brief amount of cold onto the body, it's gonna cause vasoconstriction superficially so that when you're done, you're not gonna lose as much heat through those blood vessels. And so you're gonna keep the core body temperature higher for longer, which is exactly what you want to do. The other thing that cold water does (...) it's well known that when you take a cold shower, your blood vessels constrict. And when you look at a blood vessel on end, in a person who's living and circulating, there are a number of white blood cells that are latched onto the inside surface of that blood vessel. When that blood vessel contracts, a lot of those white blood cells that were stuck get kicked off into circulation and they go off and they do whatever it's that they're gonna do. It's called demargination. So two things for cold right at the end doesn't have to be very long. Maybe just a minute. It causes actually to keep your body temperature higher for longer, ironically. And number two, demargination."*

Current evidence does not suggest that cold exposure after sauna helps sustain elevated core body temperature; rather, it facilitates a return to baseline. Research on traditional sauna practices,

including alternating hot and cold exposure, shows that brief cold immersion or cold showers after sauna rapidly reduce both skin and core temperatures. This cooling response allows individuals to tolerate longer or repeated sauna sessions without overheating. While cold exposure can activate thermogenic tissues like brown adipose tissue, triggering metabolic heat production, this mechanism primarily functions to defend against further heat loss, not to preserve heat gained during sauna. Reviews note that the combined thermal effects of heat and cold exposure remain incompletely understood, but current findings consistently show that cold applied after sauna accelerates cooling rather than prolonging elevated core temperature.

While cold exposure is well known to cause rapid vasoconstriction, a narrowing of blood vessels that helps conserve heat, current research does not support the idea that this vasoconstriction triggers the release of white blood cells (leukocyte demargination) into circulation. Some have speculated that cold-induced vessel constriction might “shake loose” white blood cells adhered to vessel walls, sending them into active circulation. However, studies in healthy individuals undergoing repeated cold water immersion show no consistent increase in circulating white blood cell counts; in fact, some immune cell types, such as neutrophils, may actually decrease. Although cold exposure does influence immune responses, modifying cytokine levels and immune cell populations, there is no strong scientific evidence that vasoconstriction leads directly to demargination in humans.

References 234-237.

Health benefits of forests and phytoncides

“But there's been actually a number of studies looking at plants and trees and the fact that they can give off things like phytoncides. These are our aromatic compounds that the tree actually gives off. And when we look to see the effect of these compounds on the human body, they're actually very beneficial. They interact with our immune system and elevate our immune system, and it actually can make us more relaxed. There's, there's a lot of data in the Japanese literature on, on this in the, what they call the Enoki Cyprus forests, where they looked at, um, these CEOs. There's a podcast about CEOs. There's these CEOs in Japan, and they took them from their, their jobs and basically took them up into the mountains of the Hanoku Cyprus and had them walk around, took blood tests, and they found that the natural killer cells, which are so important in terms of immunity, were not only increased in number, but they were also the, the, um, the, the enzymes within them that break down, uh, uh, diseases or viruses was also increased. So when they brought them back down to, uh, the city in Japan, they put them up in hotels and they infused some of these, uh, these chemicals, these, um, naturally produced, uh, phytoncides they're called. And they had almost exactly the same effect in, in these, uh, in these, uh, subjects. ”

Forests provide a range of health benefits, both through direct exposure to forest environments and via substances they emit, such as phytoncides. Spending time in forests can reduce stress, improve mental and physical health, and may help prevent certain diseases. Phytoncides, natural compounds released by trees, are believed to play a key role in these positive effects. Forest visits are linked to reduced stress, improved mood, lower blood pressure, and enhanced immune function. These effects are attributed to a combination of clean air, pleasant scenery, and exposure to natural compounds like phytoncides and negative air ions. However, more research is needed to fully understand the mechanisms and maximise forest-based health interventions.

References 238-244.

Proximity to a window and length of hospital stay

> *“There's studies that have been done. People in a two bedroom, if you are the bed closer to the window, you get discharged from the hospital faster on average. ”*

Proximity to a window in a shared hospital room is generally associated with a shorter hospital stay, especially in non-ICU settings and when the window offers a natural view. However, this effect is less clear or absent in certain intensive care populations. The quality of the window view and patient characteristics may further influence outcomes.

References 235-249.

Presence of windows in hospital rooms

> *“there's so much evidence for this. People who are in hospitals that are, have bigger windows, they give better surveys and hospitals, uh, reimbursement is tied to the surveys that they get from patients. ”*

Hospital rooms with larger, accessible windows are consistently associated with better patient satisfaction and more favourable survey responses. Patients value real window access highly, and lack of windows can negatively affect their hospital experience.

References 250-252.

Melatonin

“So if you are having difficulty falling asleep, a little tiny dose of melatonin no more than five milligrams can be actually very beneficial. If you're wanting to shift your circadian rhythm back instead of it being pushed back. But you want it to be advanced forward, melatonin can be very beneficial. It's very beneficial for jet lag. It's also beneficial for a few sleep diseases, but I would not recommend routinely for no other reason taking large doses of melatonin.

Steve: What's the trade you said earlier in that everything has side effects, right? Yeah. And it impacts another part of the treat.
Roger: So taking high doses of melatonin can actually make you more irritable and have I irritable. In what regard? Just mentally irritable”

- Melatonin doses between 0.5 mg and 5 mg are similarly effective, but 5 mg may help people fall asleep faster and improve sleep quality. Doses above 5 mg do not provide additional benefit.
- Multiple high-quality reviews and trials show that melatonin is effective in preventing and reducing jet lag, especially for flights crossing five or more time zones, and is most beneficial for eastward travel. The number needed to treat (NNT) is 2, meaning one in every two people benefits from melatonin use for jet lag.
- Melatonin reduces the time it takes to fall asleep (sleep onset latency) in adults with primary insomnia and delayed sleep phase syndrome, and helps regulate sleep patterns in blind individuals with non-24-hour sleep-wake disorder.
- Melatonin can lower sleep onset latency and increase total sleep time in people with sleep disturbances due to other medical conditions, though effects on sleep efficiency are less clear.
- Prolonged-release melatonin (2–10 mg) is recommended for insomnia in mood disorders, schizophrenia, autism spectrum disorder, and neurocognitive disorders. Immediate-release melatonin (<1 mg) may help with circadian rhythm disturbances.
- Melatonin is effective and safe for improving sleep onset and total sleep time in children with neurodevelopmental disorders, autism, and atopic dermatitis, with minimal side effects.
- Melatonin is considered safe and beneficial for sleep disturbances in the elderly and in conditions like Parkinson’s and Alzheimer’s disease.

- Melatonin is generally well-tolerated with no serious adverse events reported in clinical trials across age groups and conditions. Mild side effects may occur but are uncommon. Serious or clinically significant adverse events are rare. The most frequently reported side effects of melatonin are daytime sleepiness, headache, dizziness, and other mild symptoms.
- Irritability is mentioned as a possible side effect, but it is not among the most common reactions. Other mood-related effects like agitation and mood swings have also been reported, but these are infrequent and usually resolve on their own or after stopping melatonin.
- Effects on sleep efficiency and daytime functioning are inconsistent.
- Optimal dosing and long-term safety, especially in children, require further study.

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